Appendix A – Study Request Letters

ORIGINAL

The River Residents Association

Dedicated to preserving a life worth living on a river worth loving
Montague ~ Gill ~ Northfield
Box 405 Montague MA 01351
707 548 4817
bleenanew@gmail.com

25 February 2013

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, D.C. 20426

RE: Connecticut River concerns -

- EXTREME WATER LEVEL FLUCTUATIONS
- CAMPSITE LICENSE TERMS

Turners Falls Project No. 1889-081
Northfield Mountain Pumped Storage Project No. 2485-063

Dear Commission,

I represent the people of the River Residents Association, as well as being a member. I own a cottage within the Project Lands, on the Horse Race section of the Connecticut River in Montague Massachusetts.

The Association is comprised of people who own camps, cottages, and homes along the river. There are 24 "licensed" sites on project lands, and, there are also private land owners, and members of private clubs that recreate on the Connecticut River within the Turners Falls/Northfield MA section of the river.

We are concerned for the future of this beautiful natural resource, as well as our existence along the rivers banks. We take exception to it being called the "lower reservoir" of the Northfield Mountain Pumped Storage project.

As many of us live on the river, we see things changing, sometimes on a daily basis.

Our major concern is the negative effects we see occurring from extreme erratic water level fluctuations.

The following are observations by people who live and recreate along the river. Many of us have spent decades here.

Observations included but not limited to -

- erosion along the shores
- loss of recreation areas that allowed boat access, now have no shoreline, only steep banks to climb
- lack of adequate tenting facilities
- silt and sediment buildup
- sand bars that come and go
- algae growth in Barton Cove
- damage to personal property at "low tides" – torque damage to docks, boats stranded rocks/stuck in mud
- wetland/cattail/marsh habitat changing/vanishing
- land mass loss to islands
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- beaches appear and disappear within hours
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We believe everyone here wants to work together to ask the right questions and find effective solutions. We feel we, the river residents, are an integral part of this process.

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Our other concern is about our continued existence as residents along the river. Most of us in this association are "Camp" owners with a "License" agreement allowing us to occupy the land.

Our existing structures are a historical use that began back in the early 1920's and the previous licensees for these projects issued permits to manage their use. However, prior to 2008, the previous licensors did not seek Commission approval of these uses and occupancies of project property. Someone dropped the ball along the way. We owe great thanks to Mr. John Howard of the Northfield Mountain Pumped Storage facility for noticing this oversight. He realized there was no mention of the existing residential and private structures and took action to correct this. An application was filed in October

2008, requesting Commission authorization to issue revocable 5-year licenses, as well as, life-use licenses (permits) for us on lands at the Northfield Mountain and Turners Falls

Hydroelectric Projects (FERC Project Nos. 2485-050 and 1889-069). The Commission granted an ORDER MODIFYING AND APPROVING NON-PROJECT USE OF PROJECT LANDS AND WATERS. It was issued October 28, 2009.

As licensees, we are mandated to do certain things, inspected once every year and be "in compliance" with the terms FirstLight Hydro Generating Company sets forth. As you can imagine, it's unsettling to not know if all our love, sweat and money spent on our river homes will be for naught at the end of a 5-year license. The power company reaps many rewards using the river to generate power. For nearly 100 years our families have lived and recreated on this stretch of the river. My grandchildren are the 5th generation to grow up at our cottage, learning to swim in this river, fostering a love and respect for the natural world provided by this incredible watershed. We see ourselves as assets to this majestic waterway, and yet we have no reassurance that we'll have any future past 5 years. It's a very one sided situation and tenuous position to be in.

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We realize we make the assumption that you, the Federal Energy Regulatory Commission and FirstLight Hydro Generating Company, want us to remain on project lands. It would be nice to know how you actually view us. What laws, if any, protect our interests?

We'd like a clearer understanding of how the licenses are administered. We've been under the impression that FERC governs over the use of the lands. However, according to the language in the "Order" approving use of project lands dated October 2009, it appears that FirstLight Hydro Generation Company makes the decisions governing us, the licensor's. Does FERC have any say in our interests? Is there a liaison within the FERC organization that can work with our Association in helping us better understand our rights

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We endeavor to continue to assist and promote an ongoing cooperative relationship with all parties interest in mind. We are dedicated to a life worth living on a river worth loving. We thank you for your time and respectfully submit this inquiry and photographs to the Commission.

Sincerely,

Leena Newcomb

Leena Newcomb
The River Residents Association
Montague ~ Gill ~ Northfield
Massachusetts

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Sincerely, Peter W. Conway

47 Riverview Drive
Gill, Mass 01354

cell: 413-824-2132

The River Residents Association
Montague ~ Gill ~ Northfield
Massachusetts

a year-round resident on the Conn. River

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Stanley & Geri Johnson, 28 Oak St, Gill, MA. 01354

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Robert & Linda Emond
Camp 7E – West Camp Road
Montague, MA 01351

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Massachusetts

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Walter & Mary Ann Patenaude
Camp 8E – West Camp Road
Montague, MA 01351

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Michael and Diane Kane
Camp 10E – West Camp Road
Montague, MA 01351

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Dear Commission,

I have resided in Gill for 35 years and own 7 acres that abutt First Light's property, I own Camp #14W located at the corner of King Philip's Abyss and Horse Race and have a Life-Use License with First Light GDF Suez.

I am a member of The River Residents Association. The Association is comprised of people who own camps, cottages, and homes along the river. There are 24 "licensed" sites on project lands, and, there are also private land owners, and members of private clubs that recreate on the Connecticut River within the Turners Falls/Northfield MA section of the river.

We are concerned for the future of this beautiful natural resource, as well as our existence along the rivers banks. We take exception to it being called the "lower reservoir" of the Northfield Mountain Pumped Storage project.

As many of us live on the river, we see things changing, sometimes on a daily basis.

Our major concern is the negative effects we see occurring from extreme erratic water level fluctuations.

The following are observations by people who live and recreate along the river. Many of us have spent decades here.

Observations included but not limited to -

- erosion along the shores
- loss of recreation areas that allowed boat access, now have no shoreline, only steep banks to climb
- lack of adequate tenting facilities
- silt and sediment buildup
- sand bars that come and go
- algae growth in Barton Cove
- damage to personal property at "low tides" – torque damage to docks, boats stranded rocks/stuck in mud
- wetland/cattail/marsh habitat changing/vanishing
- land mass loss to islands
- sand bank habitat and swallows gone
- beaches appear and disappear within hours
- backwaters/shallows/coves depths diminishing
- less heron, osprey and kingfisher sightings
- less dragonflies seen
- changes in fishing bounty
- Fish egg nests exposed at "low tides" drying out and dying
- Waterfowl breeding grounds unexpectedly become submerged and eggs rot or offspring drown

We believe everyone here wants to work together to ask the right questions and find effective solutions. We feel we, the river residents, are an integral part of this process.

Is there a way to create moderation, or eliminate altogether, dramatic water level fluctuations? Can it be, should it be, regulated differently? For the record, the Association strongly favors research into a "closed loop" system. It would be a true man-made reservoir that would no longer involve the river for the generation of electricity.

We have prepared a visual exhibit. We hope it will enlighten, and underscore some of the concerning observations we have stated.

Our other concern is about our continued existence as residents along the river. Most of us in this association are "Camp" owners with a "License" agreement allowing us to occupy the land.

Our existing structures are a historical use that began back in the early 1920's and the previous licensees for these projects issued permits to manage their use. However, prior to 2008, the previous licensors did not seek Commission approval of these uses and occupancies of project property. Someone dropped the ball along the way. We owe great thanks to Mr. John Howard of the Northfield Mountain Pumped Storage facility for noticing this oversight. He realized there was no mention of the existing residential and private structures and took action to correct this. An application was filed in October

2008, requesting Commission authorization to issue revocable 5-year licenses, as well as, life-use licenses (permits) for us on lands at the Northfield Mountain and Turners Falls

Hydroelectric Projects (FERC Project Nos. 2485-050 and 1889-069). The Commission granted an ORDER MODIFYING AND APPROVING NON-PROJECT USE OF PROJECT LANDS AND WATERS. It was issued October 28, 2009.

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The power company reaps many rewards using the river to generate power. For nearly 100 years our families have lived and recreated on this stretch of the river. We see ourselves as assets to this majestic waterway, and yet we have no reassurance that we'll have any future past 5 years. It's a very one sided situation and tenuous position to be in.

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As proprietors of our footprints, we take seriously the investment in our lifestyle on the Connecticut River, both financially and emotionally. The majority of us have remodeled and made improvements to our properties. We have taken great pride in bettering our environments. We have given gladly and are gifted by the beauty, serenity and solitude the river offers. We delight in her recreational diversity. We celebrate family and friends, generation after generation. And, we continue on year after year in blind faith, that our 5-year licenses will be renewed. Does this seem equitable?

We realize we make the assumption that you, the Federal Energy Regulatory Commission and First Light Hydro Generating Company, want us to remain on project lands. It would be nice to know how you actually view us. What laws, if any, protect our interests?

We'd like a clearer understanding of how the licenses are administered. We've been under the impression that FERC governs over the use of the lands. However, according to the language in the "Order" approving use of project lands dated October 2009, it appears that First Light Hydro Generation Company makes the decisions governing us, the licensor's. Does FERC have any say in our interests? Is there a liaison within the FERC organization that can work with our Association in helping us better understand our rights

and responsibilities? How can we alter the current arrangement to meet our present and future needs?

We respectfully ask for consideration in lengthening the license term commensurate to the number of years approved for First Light Hydro Generation Company's new license to operate beginning in 2018. What is the procedure to effectuate this?

We endeavor to continue to assist and promote an ongoing cooperative relationship with all parties' interest in mind. We are dedicated to a life worth living on a river worth loving. We thank you for your time and respectfully submit this inquiry and photographs to the Commission.

Sincerely,

Cynthia S Dale

Ms. Cynthia S. Dale
14 Horserace View Road
Gill, MA 01375
413-824-8883

ORIGINAL

The River Residents Association

Dedicated to preserving a life worth living on a river worth loving
Montague ~ Gill ~ Northfield
Box 405 Montague MA 01351
707 548 4817
bleenanew@gmail.com

25 February 2013

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, D.C. 20426
REF: Docket #'s P-1889-081, P-2485-063

RE: Connecticut River concerns -

- EXTREME WATER LEVEL FLUCTUATIONS
- CAMPSITE LICENSE TERMS

Turners Falls Project No. 1889-081
Northfield Mountain Pumped Storage Project No. 2485-063

Dear Commission,

Robert Stafford and Family
Camp 16-E (Montague)
PO Box 61
Whately, MA 01093

I am a member of The River Residents Association. The Association is comprised of people who own camps, cottages, and homes along the river. There are 24 "licensed" sites on project lands, and, there are also private land owners, and members of private clubs that recreate on the Connecticut River within the Turners Falls/Northfield MA section of the river.

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We act as caretakers, we are self appointed "Stewards." We are the eyes and ears of the woods and waters. We investigate smoke sightings in the woods and have aborted forest fires, provide shelter and rides to people in canoes caught in storms, tow boaters out of gas or with broken engines and props, rescue anglers and others who fall over board and can't swim, rescue kayakers who flip during cold water months, pick up countless amounts of trash after the "weekend warriors," assist novice boaters and escort weary paddlers, rescue women in labor off the water to get to hospital, and sadly, even help search for bodies.

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We endeavor to continue to assist and promote an ongoing cooperative relationship with all parties interest in mind. We are dedicated to a life worth living on a river worth loving. We thank you for your time and respectfully submit this inquiry and photographs to the Commission.

Sincerely,

Robert T. Stafford

The River Residents Association
Montague ~ Gill ~ Northfield
Massachusetts

P-1889-081
P-2485-063

The River Residents Association

Dedicated to preserving a life worth living on a river worth loving
Montague ~ Gill ~ Northfield
Box 405 Montague MA 01351
707 548 4817
bleenanew@gmail.com

2013 FEB 28 P 2:27

2013 Feb 28

31 January 2013

United States of America
Federal Energy Regulatory Commission

Good day to the Commission,

My name is Leena Newcomb. I own a cottage on the "Horse Race" section of the river here on the Montague side.

I have been asked to speak on behalf of the River Residents Association. We are dedicated to preserving a life worth living on a river worth loving.

The Association is comprised of people who own camps, cottages, homes, and land, and also members of private clubs that recreate on the Connecticut River within the Turners Falls/Northfield MA section of the river.

We are concerned for the future of this beautiful natural resource, as well as our existence along the rivers banks.

As many of us live on the river, we see things changing, sometimes on a daily basis.

Our major concern is the negative effects we see occurring from extreme erratic water level fluctuations.

The following are observations by people who live and recreate along the river. Many of us have spent decades here.

Observations included but not limited to:

- shifts in the shoreline and river bed
- erosion along the shores
- loss of recreation areas that allowed boat access, now have no shoreline, only steep banks to climb
- lack of adequate tenting facilities
- silt and sediment buildup
- sand bars that come and go
- algae growth in Barton Cove
- damage to personal property at "low tides" – torque damage to docks, boats stranded on rocks/stuck in mud

- wetland/cattail marsh habitat changing/vanishing
- land mass loss to islands
- sand banks and swallows gone
- beaches appear and disappear within hours
- backwaters/shallows/coves depths diminishing
- less heron, osprey and kingfisher sightings
- less dragonflies seen
- changes in fishing bounty
- Fish egg nests exposed at "low tides" drying out and dying
- Birds nesting grounds unexpectedly become submerged

We believe everyone here wants to work together to ask the right questions and find effective solutions. We feel we, the river residents, are an integral part of this process.

Is there a way to create moderation, or eliminate altogether, dramatic water level fluctuations? Can it be, should it be, regulated differently?

We have prepared a visual exhibit for you to keep. We hope it will enlighten, and underscore some of the concerning observations we have stated.

{exhibit shown}

Our other concern is about our continued existence as residents along the river. Most of us in this association are "Camp" owners with a "License" agreement allowing us to occupy the land.

Our existing structures are a historical use that began back in the early 1920's and the previous licensees for these projects issued permits to manage their use. However, prior to 2008, the previous licensors did not seek Commission approval of these uses and occupancies of project property. Someone dropped the ball along the way. We owe great thanks to Mr. John Howard of the Northfield Mountain Pumped Storage facility for noticing this oversight. He realized there was no mention of the existing residential and private structures and took action to correct this. An application was filed in October 2008, requesting Commission authorization to issue revocable 5-year licenses, as well as, life-use licenses (permits) for us on lands at the Northfield Mountain and Turners Falls Hydroelectric Projects (FERC Project Nos. 2485-050 and 1889-069).

The Commission granted an ORDER MODIFYING AND APPROVING NON-PROJECT USE OF PROJECT LANDS AND WATERS. It was issued October 28, 2009.

As licensees, we are mandated to do certain things, inspected once every year and be "in compliance" with the terms FirstLight Hydro Generating Company sets forth. As you can imagine, it's unsettling to not know if all our love, sweat and money spent on our river homes will be for naught at the end of a 5-year license. The power company reaps many rewards using the river to generate power. For nearly 100 years our families have lived and recreated on this stretch of the river. My grandchildren are the 5th generation to grow up at our cottage, learning to swim in this river, fostering a love and respect for the natural world provided by this incredible watershed. We see ourselves as assets to this majestic waterway, and yet we have no reassurance that we'll have any future past 5 years. It's a very one sided situation and tenuous position to be in.

We act as caretakers, we are self appointed "Stewards." We are the eyes and ears of the woods and waters. We investigate smoke sightings in the woods and have aborted forest fires, provide shelter and rides to people in canoes caught in storms, tow boaters out of gas or with broken engines and props, rescue anglers and others who fall over board and can't swim, rescue kayakers who flip during cold water months, pick up countless amounts of trash after the "weekend warriors," assist novice boaters and escort weary paddlers, rescue women in labor off the water to get to hospital, and sadly, even help search for bodies.

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We respectfully ask for consideration in lengthening the license term commensurate to the number of years approved for FirstLight Hydro Generation Company's new license to operate beginning in 2018. What is the procedure to effectuate this?

We endeavor to continue to assist and promote an ongoing cooperative relationship with all parties interest in mind. We thank you for your time and respectfully submit this inquiry and photographs to the Commission.

Sincerely,

The River Residents Association

The River Residents Association

Dedicated to preserving a life worth living on a river worth loving
Montague ~ Gill ~ Northfield

25 February 2013

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, D.C. 20426

RE: Connecticut River concerns -

- **EXTREME WATER LEVEL FLUCTUATIONS**
- **CAMPSITE LICENSE TERMS**

Turners Falls Project No. 1889-081
Northfield Mountain Pumped Storage Project No. 2485-063

Dear Commission,

Vivien Venskowski
Camp 8W – Trenholm Way
Gill, MA 01354

I am a member of The River Residents Association. The Association is comprised of people who own camps, cottages, and homes along the river. There are 24 “licensed” sites on project lands, and, there are also private land owners, and members of private clubs that recreate on the Connecticut River within the Turners Falls/Northfield MA section of the river.

My major concerns are listed as follows:

- **One major concern is the negative effects we see occurring from extreme erratic water level fluctuations.**
- **silt and sediment buildup**
- **how wildlife and habitat is effected by the instability of the river level (too much too little)**
- **erosion along the shores**
- **wetland/cattail/marsh habitat changing/vanishing**
- **vanishing sandy beaches**

Is there a way to create moderation, or eliminate altogether, dramatic water level fluctuations?

Another concern is about our continued existence as residents along the river. Most of us in this association are “Camp” owners with a “License” agreement allowing us to occupy the land.

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Thank you for your time.

Respectfully submitted,

Vivien Venskowski
A member of The River Residents Association
Montague ~ Gill ~ Northfield
Massachusetts

The River Residents Association

Dedicated to preserving a life worth living on a river worth loving
Montague ~ Gill ~ Northfield
Box 405 Montague MA 01351
707 548 4817
bleenanew@gmail.com

25 February 2013

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Federal Energy Regulatory Commission
888 First Street, NE
Washington, D.C. 20426

RE: Connecticut River concerns -

- EXTREME WATER LEVEL FLUCTUATIONS
- CAMPSITE LICENSE TERMS

Turners Falls Project No. 1889-081
Northfield Mountain Pumped Storage Project No. 2485-063

Dear Commission,

Betsy and Jean Egan
Hill Road
Gill, MA 01354

I am a member of The River Residents Association. The Association is comprised of people who own camps, cottages, and homes along the river. There are 24 “licensed” sites on project lands, and, there are also private land owners, and members of private clubs that recreate on the Connecticut River within the Turners Falls/Gill/Northfield MA section of the river.

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Sincerely,

Betsy and Jean Egan

The River Residents Association
Montague ~ Gill ~ Northfield
Massachusetts

P-2485-063
P-1904-073
P-1889-081

January 31, 2013

To: U.S. Federal Energy Regulatory Commission
From: The Greater Northfield Watershed Association (GNWA)
P.O. Box 44, Northfield, MA 01360
Re: Application for re-licensing of the Northfield Mountain Pumped Storage Project (P-2465-063), the Vernon Project (P-1904-073) and the Turners Falls Project (P-1889-061)

Submitted by Jennifer Tufts, Member, Northfield Open Space Committee

Attached is a copy of the Survey Results Summary from the 2011 Open Space and Recreation Survey conducted by the Northfield Open Space Committee as part of the updating of the 2005 Open Space and Recreation Plan (OSRP). Also enclosed is a printed copy of table 9-1 'Recommended Action Steps to Implement the 2012 Northfield OSRP'.

The Open Space Committee has made it a priority to monitor the FERC re-licensing as part of its commitment to Coordination and Water resource oversight (see OS2.7 and OS6.5).

There is a wealth of information in the OSRP which we would commend to the FERC re-licensing team. The complete 2005 OSRP and the draft 2012 OSRP as well as more information on the extensive Survey process can be found at http://www.northfield.ma.us/index.php?id=156.

Jennifer Tufts

2013 FEB 28 P 2:27

P-2485-063
P-1889-081

101 Cross Rd

Northfield, Ma. 01360

1/31/2013

tpshearer@yahoo.com

Federal Energy Regulatory Commission

Washington DC

re: Northfield Mountain Pumped Storage Project

presented at FERC hearing at Turners Falls

Greetings,

We own the first privately owned parcel upstream (aprox. 1000 yards upstream) of the Northfield Mountain Pumped Storage Project. We have a verbal agreement with Chuck Momney of First Light for a repair of a previous repair of the Conn. River bank done in 1996. The promise is to do it this year or next.

If this agreement is not fulfilled as has happened in the past, we would like to reserve the right to bring it to your attention in the next couple years.

Sincerely,

Thomas R Shearer
Patricia E Shearer

Thomas R Shearer

Patricia E Shearer

Present and Increased Noise Level Determination and (possible) Mitigation of Northfield Mountain Project

5.9(b)(1)--Describe the goals and objectives of each study proposal and the information to be obtained.

The goal of this study is to evaluate the current level of noise produced by the Northfield Mountain Project as heard by neighbors to the project; to determine if the proposed changes to the project (including utilizing more storage in the upper reservoir and increasing the unit and station capacity) increase the noise level; and to mitigate any present and future noise.

Specifically, the objectives of the study include:
* determine a baseline current noise level for the Northfield Mountain Project. Is the Northfield Mountain Project responsible for noises heard in the area?
* determine if changes to the project increase the noise level
* mitigate any existing and future noise levels

5.9(b)(2)--If applicable, explain the relevant resource management goals of the agencies of Indian tribes with jurisdiction over the resource to be studied.

Not applicable.

5.9(b)(3)--If the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.

It is in the public's interest that this project and its expansion not negatively impact the quality of life for Northfield Mountain Project's neighbors. Noise negatively impacts quality of life.

Background and Existing Information

5.9(b)(4)---Describe existing information concerning the subject of the study proposal, and the need for additional information.

According to Scoping Document 1 for Northfield Pump Storage Project, FERC No. 2485-063 B, no Aesthetic or Socioeconomic issues have been identified for this project. Noise levels are not only aesthetic, but also socioeconomic if they affect real estate values in the area immediately surrounding the project. Thus additional information is needed on this subject.

Project Nexus

5.9(b)(5)---Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resources to be studied, and how the study results would inform the development of license requirements.

Northfield Pump Storage Project runs pumps to move water to a holding reservoir, and turbines to harvest energy from the water. Both these operations involve large equipment that makes a lot of noise. This noise may be broadband, low frequency, or infrasonic pressure or vibration. Increasing the pump and/or turbine operation in frequency, size, or number could impact the amount of noise this equipment makes, so that it is more audible to neighbors. Noise might need to be mitigated e.g. via insulation, or prescribed combinations of equipment running, etc. to reduce noise impact on neighbors.

Proposed Methodology

5.9(b)(6)--Explain how any proposed study methodology (including any preferred data collection and analysis techniques or objectively quantified information, and a schedule including appropriate field season(s) and the duration is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.

Massachusetts Department of Environmental Protection recognizes noise pollution:
"Noise is a public health concern that falls within the scope of Massachusetts Department of Environmental Protection (MassDEP) authority as a form of regulated air pollution (M.G.L. Chapter 111, Sections 142A-M provide statutory authority for MassDEPs Air Pollution Control Regulations, 310 CMR 7.00"
(http://www.mass.gov/dep/air/laws/noisepol.htm, accessed 1/31/13)

We propose to use MassDEP testing standards, should the noise need testing. Tests for infrasonic pressure or vibration should be included as well, where standards exist.

To simplify the process and possibly eliminate unnecessary tests, we propose a 2-part process: Part A to determine if the unexplained noises heard in the area are caused by the Mountain, and Part B using DEP protocol to determine how loud the noises are and if mitigation is called for. Mitigation would follow as needed. Each of these parts would need to be conducted before and after any change in the project (increased capacity etc).

Proposed methods include:
Part A: (1 year)
* Having neighbors to the project record unexplained noises including what type of noise and when.
* Comparing these lists with operating records of the Northfield Mountain Project to see if correlation exists.
Part B: (1 year)
* If correlation exists, further study would be needed using MassDEP protocols. This part could be done simultaneously with Part A to increase turn-around time, or left until afterwards on the chance it would not be needed. It could also be the first step in the process if Part A was not considered necessary.

Level of Effort and Cost

5.9(b)(7)--Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs

The estimated cost of determining a baseline noise level and comparing any old/new noises with the operating records is relatively low. Possibly there is already a community liaison from Northfield Mountain who could interface with neighbors, leaving only the cost of printing out existing operations records over a 1 year period to take into account tree leafing and other seasonal changes. Estimate: less than $500.

If it is determined that the Northfield Mountain Project is making noise (either now or after installation of further equipment), then the cost of measuring the noise level would include hiring qualified engineers to do so, possibly tens of thousands of dollars. Mitigating the noise would be even more expensive, include hiring qualified engineers and installing noise mitigation equipment, likely several hundred thousand dollars.

Since there are no proposed alternative studies, it is unknown if any would meet the stated information needs.

Board of Selectmen
Town of Montague
1 Avenue A (413) 863-3200 xt. 110
Turners Falls, MA 01376 FAX: (413) 863-3231

February 6, 2013

Mr. Robert Quiggle, RPA
HDR Engineering Inc.
1304 Buckley Road
Suite 202
Syracuse, NY 13212-4311

Hello Robert:

We met at the FERC Relicensing Hearing in Turners Falls last week. I promised that I would send you a copy of the National Register Eligibility Notification for the Turners Falls Ceremonial Site and my concept paper for the Great Falls Native Cultural Park.

The Town of Montague is particularly interested in having this information seriously considered during the relicensing process. This would include the importance of providing access to the area immediately below the Turners Falls dam, with the area developed as a native cultural park. Other possible areas of interest are the Cabot Woods area which has potential for development of interpretive and educational features.

I would appreciate hearing your feedback with respect to the potential for incorporating our plans into the licensing process.

Frank Abbondanzio
Town Administrator

Landowners and Concerned Citizens for License Compliance

March 1, 2013

Honorable Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

RE: Relicensing of the Northfield Mountain Pumped Storage Project (FERC No. 2485-063 and the Turners Falls project (FERC no. 1889-08
Comments on the Preliminary Application Document, Scoping Document 1, and Study Requests

Dear Secretary Bose:

The Landowners and Concerned Citizens for License Compliance consists primarily of Gill and Northfield farm and conservation landowners who organized after seeing our riverbanks continue to wash down the Connecticut River in the Turners Falls Pool. Current and previous landowners have consistently advocated for more and better work to stabilize and repair areas of bank erosion. It has been said during the relicensing process that mitigation strategies must await studies to determine the causes of erosion. This is an old discussion that seemed to be resolved decades ago with licensee acknowledgement that much of the erosion problems are a result of project operations.

Some of our members filed a letter to the FERC Secretary on May 16, 2008 documenting landowner concerns having been continuous since 1972, starting with letters to the then Federal Power Commission (FPC). This filing also contained a chronology by previous landowners of thirty-five years of advocacy by concerned landowners and public agencies, that began with the activation of Northfield Mountain Pumped Storage Project in 1972, to address streambank erosion on the Connecticut River.

This chronology excerpts a July 12, 1976 Northeast Utilities letter to the FPC stating that: "Early in the planning stages of the Northfield Project, it was recognized that increased fluctuations on water levels in the Turners Falls Pond would cause damage to trees along the river's edge….Since the initial operation of the Project in late 1972, Northeast Utilities has been aware of bank erosion and has been monitoring a number of these areas along the pond."

A similar viewpoint is contained in the March 1977 "Streambank Erosion Control Evaluation and Demonstration Projects (Section 32) in New England," Haverhill, New Hampshire and Northfield, Massachusetts by the Department of the Army, New England

Division, Corps of Engineers, Waltham, Mass. It states on page 16: "Northeast Utilities (NU) constructed a pump-storage electric facility at Northfield Mountain which uses the Turners Falls pool as the lower impoundment. Turners Falls pool was raised 5.5 feet in 1973 and this area is one of the most actively eroding reaches of the Connecticut River today. The Corps has submitted a project proposal within the pool for construction under Section 32. NU acknowledges that much of the problem is a result of power pool operations."

The LCCLC has been and continues to be concerned with the frequent and significant water level fluctuation associate with the operation of the Northfield Mountain Pumped Storage and Turners Falls projects, which result in streambank erosion and impacts to water quality, threatened and endangered species, fisheries, and riparian and littoral habitat. In particular, we believe that the Northfield Mountain Pumped Storage project and its operational use of the Connecticut River have been a long-term experiment that has resulted in significant adverse environmental impacts. We now have an opportunity to seriously consider the benefits of halting the use of the Connecticut River as the lower reservoir and creating a closed-loop lower reservoir which would address most of the environmental impacts and specific resource concerns raised by Federal and state agencies and stakeholders.

The LCCLC presented a photographic record of the erosion just upstream and across from the tailrace to the assembled FERC staff at the Scoping Meeting on January 30, 2013. Our scoping meeting presentation demonstrated why the current and previous owners of this conservation land have been so persistent in drawing FERC's attention to the severity of erosion of our riverbanks and why the current restoration effort is several decades too late. In 1960 an Oak tree on the featured riverbanks stood approximately 30' from the top edge of the bank. It is now less than 6' from the top edge of the heavily eroded bank. This tree marks the site of Cross Section 8A that has been used by the Licensees over the years to monitor erosion in the Turners Falls Pool on the Connecticut River. So, quantitative data should be available to document this erosion, which we have previously placed in an information request to FERC.

Preliminary Application Document (PAD)

The 2008 Full River Reconnaissance (FRR) stated that the rate of erosion is decreasing in the Turners Falls Pool in the Connecticut River, which FirstLight continues to maintain in Section 4.2.4.1 of the PAD under FRR Studies. This contention is in spite of numerous challenges by the Connecticut River Streambank Erosion Committee (CRSEC) and professional studies commissioned by LCCLC, all of which have been filed with FERC and made a part of the licensing proceeding.

For reasons articulated in previous correspondence with FERC, we are concerned with the applicant's plan to use information from the earlier Full River Reconnaissance (FRR) studies (2001, 2004 and 2008) and the Riverbank Erosion Comparison along the Connecticut River (2012) report, which the applicant updated to PAD 5.2.1 at the Scoping Meeting. We are currently working with the applicant and the Connecticut

River Streambank Erosion Committee to develop a suitable Quality Assurance Project Plan (QAPP) and appropriate methodology for the 2013 FRR. This initiative and an outline for a Hydrologic, Hydraulic, and Geomorphic Analysis of Erosion in the Turners Falls Impoundment were also added to the PAD 5.2.1 at the Scoping Meeting. However, the Erosion Study has not been shared so the CRSEC and the LCCLC are not able to provide specific comments other than we hope that the findings and recommendations for further study found in detail in the 2007 Field Geology Services report, cited but only selectively referenced in PAD 4.2.4.3, are reflected in the proposed study.

We appreciate the opportunity to submit our comments on the Preliminary Application Document (PAD), Scoping Document 1, and eight Study Requests. Study Requests that we support are summarized by Scoping Document 1 resource areas. The full narratives of the studies that we are requesting to be undertaken may be found in the Appendix.

<u>Scoping Document 1</u>

3.5 Alternatives to the Proposed Action

On page 8 of the Scoping Document, the text reads that "[i]n accordance with NEPA, the environmental analysis will consider the following alternatives, at a minimum: (1) the no-action alternative, (2) the applicant's proposed action, and (3) alternatives to the proposed action." The LCCLC strongly urges the FERC staff to consider a closed-loop alternative for the lower reservoir serving the pumped storage project and requests that the applicant complete a study of this alternative to the proposed action.

6.0 Request for Information and Studies (See Appendix for full Studies)

<u>Geology and Soil Resources</u>

The LCCLC is primarily concerned with the various effects of erosion of the riverbanks in the Turners Falls Pool. With this in mind, we request that the 1999 Erosion Control Plan for the Turners Falls Pool of the Connecticut River be continued and a Full River Reconnaissance be conducted every 3-5 years with improved methodology that is documented with a Quality Assurance Project Plan. Our concerns relate to the environmental effects of the frequent and significant water level fluctuations and river flow dynamics resulting from the operation of the Northfield Mountain Pump Storage Project and the Turners Falls Dam. These concerns include riverbank stability, shoreline habitat, farmland, wetlands, riparian and littoral habitat, and water quality. We request that the following studies be conducted to address our concerns on these issues: (Full narratives are to be found in the Appendix.)

- **Study of Shoreline Erosion Caused by Northfield Mountain Pumped Storage (NMPS) Operations. (See Study Request #1a)**
- **Study the Impact of Operations of the Northfield Mountain Pumped Storage Project and Turners Falls Dam on Sedimentation and Sediment Transport in the Connecticut River (#2a)**

- **Study of the Feasibility of Converting the Northfield Mountain Pumped Storage (NMPS) Facility to a Closed-loop or Partially Closed-loop System (#3a)**
- **Study Climate Change as it Relates to Continued Operation of Northfield Mountain Pumped Storage and Turners Falls Projects (#4a)**

Water Resources

Many residents in the Turners Falls Pool are riverside dwellers and express on-going concern for what they observe happening to the River on a daily basis. Residents report that swimming and boating have become increasingly unpleasant, and at times water levels are so low as to ground boats. Our River has historically provided diverse recreational opportunities with benefits to our regional economy. The Town of Gill's 2011 Open Space and Recreation Plan Public Survey results, on recreational use by Town residents, show that 90% of the respondents use the Connecticut River and Barton Cove for recreation at least yearly. With this in mind, the LCCLC wishes to explore levels of turbidity and suspended sediment in the river and what fluctuations in the water levels might have on the spread of exotic and invasive species, such as water chestnuts, and thus requests the following studies:

- **Study the Impact of Operations of the Northfield Mountain Pumped Storage Project and Turners Falls Dam on Sedimentation and Sediment Transport in the Connecticut River (#2a)**
- **Water Quality Monitoring in the Turners Falls Impoundment and Downstream of the Turners Falls Project (#5a)**
- **Quantify the Impacts of Water Level Fluctuations on Riparian and Aquatic Vegetation Including Invasive Species and their Associated Habitats in the Turners Falls Dam project Impoundment (#6a)**
- **Model River Flows and Water Levels Upstream and Downstream from the Turners Falls Project Dam Generating Stations and Integration of Project Modeling with Upstream and Downstream Project Operations (#8a)**

Socioeconomic Resources

The loss of agricultural and conservation land from soil erosion and the impact of the Turners Falls Dam on recreational use of the river are two major impacts on the socioeconomic resources from the Projects. The LCCLC is increasingly aware of the costs of the two Projects to the riverbanks, the habitat and water quality. The relicensing process is a once-in-a-lifetime opportunity to ensure that impacts on these areas are fully understood and defined, and that subsequent relevant resource management goals and public interest considerations are effectively addressed.

Consideration of all possible solutions to these questions is in order, from investigating a full-closed loop system to any number of partial-loop systems, thereby eliminating some of the negative consequences.

With this in mind we request:

- **Study of the Feasibility of Converting the Northfield Mountain Pumped Storage (NMPS) Facility to a Closed-loop or Partially Closed-loop System (#3a)**
- **Study Climate Change as it Relates to Continued Operation of the Vernon, Bellows Falls, Wilder, Northfield Mountain Pumped Storage, and Turners Falls Projects (#4a)**

Aquatic Resources

The LCCLC wishes to conserve, protect, and enhance habitats for fish, wildlife, and plants. The fact that land directly across from the NMPS tailrace (the old Stacey's Ferry Landing) and upstream has been eroding since the project went into operation, serves to heighten our concern that Project operations negatively affect resident and migratory fish species.

With this the mind we request the following studies:

- **Impacts of Water Level Fluctuations on Riparian and Aquatic Vegetation Including Invasive Species and their Associated Habitats in the Turners Falls Dam Project Impoundment (#6a)**
- **Model Flows in the Northfield Mountain Pumped Storage Project Discharge Tailrace and Connecticut River 1 Kilometer Upstream and Downstream of the Discharge Using Two-Dimensional Computational Fluid Dynamics (CFD) Model Techniques (#7a)**
- **Model River Flows and Water Levels Upstream and Downstream from the Turners Falls Project Dam Generating Stations and Integration of Project Modeling with Upstream and Downstream Project Operations (#8a)**

We appreciate the opportunity to provide comments on the PAD, Scoping Document 1, and to submit Study Requests. We look forward to continuing our active engagement in the relicensing of the Connecticut River projects.

Respectfully Submitted,

/s/Michael Bathory, Member
Landowners and Concerned Citizens for License Compliance
144 River Road
Gill, MA 01354
mjbathory@comcast.net

cc: John Howard, First Light Hydro generating Company
Robert McCollum, MA Department of Environmental Protection
Peggy Sloan, Franklin Regional Planning Board
Tom Miner, Connecticut River Streambank Erosion Committee
Ken Hogan, Federal Energy Regulatory Commission
Congressman James McGovern
Jennifer Soper, MA Department of Conservation and Recreation
Paul Jahnige, MA Department of Conservation and Recreation

Appendix
Landowners and Concerned Citizens for License Compliance - Study Requests

Numerical listing of Study Requests with full Studies to follow:

Study Request 1a: Study of Shoreline Erosion Caused by Northfield Mountain Pumped Storage (NMPS) Operations.

Study Request 2a: Study the Impact of Operations of the Northfield Mountain Pumped Storage Project and Turners Falls Dam on Sedimentation and Sediment Transport in the Connecticut River

Study Request 3s: Study of the Feasibility of Converting the Northfield Mountain Pumped Storage (NMPS) Facility to a Closed-loop or Partially Closed-loop System

Study Request 4a: Study Climate Change as it Relates to Continued Operation of the Vernon, Bellows Falls, Wilder, Northfield Mountain Pumped Storage, and Turners Falls Projects

Study Request 5a: Water Quality Monitoring in the Turners Falls Impoundment and Downstream of the Turners Falls Project

Study Request 6a: Quantify the Impacts of Water Level Fluctuations on Riparian and Aquatic Vegetation Including Invasive Species and their Associated Habitats in the Turners Falls Dam project Impoundment

Study Request 7a: Model Flows in the Northfield Mountain Pumped Storage Project Discharge Tailrace and Connecticut River 1 Kilometer Upstream and Downstream of the Discharge Using Two-Dimensional Computational Fluid Dynamics (CFD) Model Techniques

Study Request 8a: Model River Flows and Water Levels Upstream and Downstream from the Turners Falls Project Dam Generating Stations and Integration of Project Modeling with Upstream and Downstream Project Operations

Study Request 1a - Study of Shoreline Erosion Caused by Northfield Mountain Pumped Storage (NMPS) Operations

Development of the current configuration of the Northfield Mountain Pumped Storage project included raising the dam height at Turners Falls by 5.9 feet in 1970 in preparation for NMPS operations. Operations began in 1972; since then all project operations have operated under this raised dam environment. The additional 5.9 foot in elevation changed the elevation of the Turners Falls impoundment, which extends some 20 miles upstream. The increase in river elevation also resulted in motorized boat traffic becoming more popular and makes the use of larger boats more possible. The presence of motorized recreational boats increases wake energy that can accelerate bank erosion rates.

The operation of NMPS causes alterations to the river as a direct feature of plant functionality. The alterations include: 1) daily fluctuating pond levels which at times in some places can exceed six feet (the license allows fluctuations up to 9 feet measured at an undisclosed location near and upstream of the Turners Falls dam), 2) altered flow and velocity profiles of river and 3) changes to the downstream hydrograph. Elevation data for the river in Appendix E of the PAD indicate that stage changes of 2 to 3 feet during the summer of 2012 were not uncommon.

Raising the level of the river can saturate bank soils. These same soils can quickly become dewatered when the river is lowered by the NMPS pumping cycle. Repeated saturation and dewatering of banks can lead to bank instability which in turn can lead to bank failure and eroded material entering the river. See Field (2007)[1] for an extended discussion on bank erosion and failure mechanics. Elevated levels of turbidity and suspended solids in the water column can diminish rearing and migratory habitat for fish. When too much fine grain material is deposited on channel bed substrates, particularly those substrates used for spawning, spawning success of resident and migratory fish is compromised, potentially reducing recruitment and carrying capacity.

Goals and Objectives

The goals of this study request would be to determine the environmental effects of the presence and operation of the licensed facilities on river bank stability, shoreline habitat, agricultural farmland, wetland resources, bed substrate, and water quality in the Turners Falls impoundment. We recognize that data from other studies will be made available and we think that the data from these other studies could be used to help meet the objectives of this study request.
Objectives of the study include the following:

1. Calculate the total volume of eroded material, calculate resulting nutrient loading of eroded material, and document and describe the three dimensional changes to

[1] Field Geology Services. (2007). *Fluvial geomorphology study of the Turners Falls Pool on the Connecticut River between Turners Falls, MA and Vernon, VT*. Prepared for Northfield Mountain Pumped Storage Project. Farmington, ME: Field Geology Services.

the bank, including lateral bank recession, changes to bank slope, and the presence and subsequent inundation of pre-project beaches and shoreline since the Turners Falls Dam was raised and the Northfield Mountain Pumped Storage facility came on-line.

2. Document and describe the changes to banks upstream and downstream of riverbank restoration projects, including bank recession.
3. Identify the changes that have occurred to bed substrate as a result of fine grain material being eroded from the banks and being deposited on the channel bed.

Relevant Resource Management Goals and Public Interest Considerations

Our management goal is to ensure high quality habitat for migratory diadromous fish. Shortnose sturgeon, American shad and American eel all require suitable spawning, rearing, migratory and foraging habitat. Eroding banks and subsequent increases in turbidity and deposition of fine grained material onto bed substrates in the Turners Falls impoundment, the bypass reach and downstream of the Turners Falls project reduces the quality of habitat for these species. Elevated levels of suspended sediment are associated with a diminution in water quality which also affects the quality of habitat encountered by trust resource species.

In addition to habitat effects, soil erosion contributes to nutrient loading. In 2001, the U.S. EPA approved New York and Connecticut's Long Island Sound (LIS) dissolved oxygen TMDL. As a result, the New England Interstate Water Pollution Control Commission (NEIWPCC) established the Connecticut River Workgroup and the Connecticut River Nitrogen Project. This project is a cooperative effort involving staff from NEIWPCC, the states of Connecticut, Massachusetts, New Hampshire, and Vermont, and EPA's Region 1 and Long Island Sound (LIS) offices. All are working together to develop scientifically-defensible nitrogen load allocations, as well as an implementation strategy, for the Connecticut River Basin in Massachusetts, New Hampshire, and Vermont that are consistent with TMDL allocations established for LIS. Since its inception, the Connecticut River Workgroup has participated in a number of projects to better understand nitrogen loading, transport, and reductions in erosion.

Public Interest Considerations if Requester is not a Resource Agency

The Landowners and Concerned Citizens for License Compliance (LCCLC) consists primarily of Gill and Northfield farm and conservation landowners who organized after seeing our riverbanks continue to wash down the Connecticut River in the Turners Falls Pool. Current and previous landowners have consistently advocated for more and better work to stabilize and repair areas of bank erosion with numerous filings to FERC, including professional studies commissioned by LCCLC, all of which have been made a part of the licensing proceeding.

The LCCLC has active members on the Franklin Regional Council of Governments' (FRCOG) Ad Hoc committee, the Connecticut River Streambank Erosion Committee (CRSEC). The CRSEC was convened in 1994 to bring together the Northfield Mountain Pumped Storage Project operator, state and municipal entities, landowners, and NGO's to carry out bioengineering projects to stabilize and repair areas of bank erosion. We are currently working with the FirstLight and the CRSEC to develop a suitable Quality Assurance Project Plan (QAPP) and appropriate methodology for the 2013 FRR.

The LCCLC looks forward to continuing our active engagement in the relicensing of the Turners Falls Dam and Northfield Mountain Pumped Storage Projects

Existing Information and Need for Additional Information

The PAD makes reference to several studies in section 4.2.4 including the Erosion Control Plan (Simons & Associates, 1999), previous Full River Reconnaissance studies (1998, 2001 – maps but no report generated, 2004, and 2008), Field Geology Services' 2007 fluvial geomorphic investigation of the Turners Fall impoundment, and 2012 investigations by Simons & Associates.
Field Geology Services' 2007 investigation provided several good recommendations for future work in section 9.3 of its report which, if implemented, could provide for: a) an improved understanding of the causes of erosion; b) more accurate monitoring of erosion; and c) more successful bank stabilization efforts. This document is a good point of reference. The Simons & Associates' (2012) documents are qualitative and based on several unstated assumptions that may not be valid. Full River Reconnaissance efforts have been undertaken using varying methodologies, making for difficult comparisons from one report to the other.

We believe that these existing studies do have data that can be useful if certain new analyses are undertaken. These analyses of existing data would help fill in our gaps of understanding of bank erosion in the Turners Fall impoundment. We are also asking for some additional field collected data. With the existing information, it should be possible to better display what changes have occurred to streambanks over time. Current Geographic Information System (GIS) software allows for various types of data to be assembled into a map and into a database such that change over time analysis can be conducted fairly easily. The change over time analysis is a critical analysis that is needed, and was already started under Field (2007).

Photos that have been taken at or near the same location but at different times exist. For example, the last three Full River Reconnaissance efforts have included continuous videotaping of the riverbanks with locational information. With these data, "snapshots" of the bank at various locations could be extracted and compared over time. Field (2007) photo locations could be re-shot as well. This existing information should be presented such that it is easy to discern where the photo was taken and what changes have occurred over time. A comparison of the bank every 100 ft could be compared over the years.

Historic aerial photography for the Turners Fall impoundment should be gathered and analyzed. Examples of good photographic datasets include the Field 2007 appendices and 1929 aerials. The location of the shoreline over time should be noted such that it is easy to discern where bank retreat has been most severe and where the river has been relatively stable since the earliest aerial photograph was taken.

Very little turbidity data for the Turners Falls impoundment, the bypass reach or stretches of the Connecticut River downstream of the Turners Fall project exist. Thus far, implementation of the *Northfield Mountain Pumped Storage Project Sediment Management Plan* (revised February 15, 2012) has yielded few results, and many technological difficulties (see *2012 Sediment Management Plan – 2012 Summary of Annual Monitoring* dated November 30, 2012). Suspended sediment monitoring equipment is installed at the Route 10 Bridge upstream of the project and inside the powerhouse, theoretically taking readings representative of pumping and discharging through the turbines. An analysis of how turbidity might change relative to rapidly changing impoundment levels would be very useful information.

Nexus to Project Operations and Effects

The construction of the NMPS project was contingent upon the Turners Falls project raising the dam crest elevation by 5.9 feet. The NMPS project operations rely on the Turners Falls impoundment as the source of water to be pumped up and then discharged back into the river through turbines. The importance of this river reach to the NMPS operation is made clear by FirstLight's reference to this portion of the river as the "lower reservoir." Daily pumping and discharging changes the ponded elevation of the Connecticut River which in turn leads to bank material that repeatedly becomes saturated and then dewatered. Weakened bank material can then become eroded and the fine grain material from the banks can enter the water column and be transported in suspension in the river and eventually settle onto bed material. The raising of the Turners Falls impoundment also made recreational boating more popular, including the introduction of large, high-horsepower powerboats that were not previously present. Because of the fluctuating water levels, boat wakes impact the shoreline to a much greater extent than would occur if levels were more constant, thus exacerbating both the effects of the wakes and the fluctuating levels. For these reasons, erosion caused or contributed by NMPS project operation can negatively affect spawning, rearing and migratory habitat for trust species and the endangered shortnose sturgeon. The requested study will help inform the Commission when contemplating mitigation measures and or operational modifications.

Proposed Methodology

1. This study should determine the net soil loss in cubic yards between 1970 and the present; a density estimate of the eroded material should also be provided. Provide an analysis of where the greatest loss has occurred, location of proximity to the tailrace, soil type, riparian land use, and vegetative cover in that area. Calculate nutrient loadings (nitrogen and phosphorus compounds) to the river system based on soil loss.

2. Obtain copies of the original survey plans for the project, and complete a new survey using the same landmarks used previously. The Field (2007) report states

on page 11 that the original survey plans of the river are still retained by Ainsworth and Associates, Inc. of Greenfield MA. Use pre-operation aerial photos and current aerial photos to complete a 10-foot topographic map of the section of river between Turners Falls Dam and Vernon Dam and the 200-foot buffer regulated under the Massachusetts Rivers Protection Act. The Field (2007) report on page 11 states that Eastern Topographics, Inc. determined that sufficient information is known about the 1961 aerial photos (e.g., height of airplane) to create a 10-foot topographic map of that time period, and that 1961 aerial photos could be accurately overlayed with recent aerial photos. Field (2007) states that this analysis would enable a more reliable determination of small-scale shifts in channel position and changes in bank height that may have resulted from the erosion of a low bench that previously existed along portions of the river. Among other things, create a single map showing areas of erosion and deposition, and also overlay the Field report's hydraulic modeling analysis of the river channel.

3. With respect to the January 22, 2013 submittal from FirstLight to FERC regarding its long term monitoring transects in the Turners Fall impoundment, we ask that any data errors (as discussed in Field, 2007) and problems that have occurred over the years at each site be mentioned. We also ask that an analysis for each cross section extending to the top of the bank and including a portion of the floodplain be provided.
4. Take the information presented in Figure 4.2.3-1 "Soils in the vicinity of Turners Falls and Northfield Mountain projects" in the PAD and convert from 63 categories to just a few that are defined in a key that will allow readers to understand which soils are easily erodible, which aren't, and where there is bedrock along the banks.
5. Complete detailed surficial mapping (topographic map or LIDAR) to identify the various geomorphic surfaces, height of benches/terraces above the river level, and types of sediments underlaying the surfaces. This will allow one to determine how erosion varies with geomorphic conditions. One could then normalize the amount of erosion to a specific type of bank material/geomorphic surface/terrace.
6. Another information request covers the range of daily water level fluctuations. In this study request, we ask for an analysis on the degree to which boat wakes increase that fluctuation range. The task would be to observe boat wakes under a range of boat sizes and flow rates on the river. We recommend implementation of the 2007 Field report recommendation that states, "A more thorough study of boat waves is merited to better document how many boats use the Turners Falls Pool, how fast they travel, the type and size of waves they produce, and their impact on shoreline erosion."

A component of this study request is not necessarily for new data, but for existing data to be presented in a more clear, coherent and comprehensive manner. All existing photographs of banks that have been collected either by FirstLight, on behalf of FirstLight or on behalf of the Franklin Regional Council of Governments' (FRCOG) Streambank Erosion Committee should be georeferenced in such a way that it is easy to discern where the photograph was taken and the date should be easily discernible as well. These photos should be presented in a manner that makes it easy to visually see how a particular section of bank has changed over time. Providing geographic context for photographic data of river banks and making these photos comparable over time should be standard practice. The 2007 Field report contains the following recommendation on page 47: "An attempt should be made to overlay the 1961 aerial photographs with a current flight and to create a topographic map from the 1961 flight. The feasibility of this effort has been confirmed by Eastern Topographics, Inc. This effort will identify the previous extent of the low bench and identify areas of the most significant bank recession the past 45 years." Given that this statement was written in 2007, we request that that the analysis is extended to current conditions.

Given the complexity of this study request and the expertise necessary to implement it, we request that the FRCOG and the mandatory conditioning agencies be involved with the selection of the hired consultant.

Level of Effort and Cost

The level of effort to compile existing information and to make the data available in a map and searching for existing bed substrate material data should not take more than a few days. The level of effort for the bed sampling work will vary based upon how much existing historic information exists. Much of the effort of this study request is essentially office work that compiles and better presents existing data. While an estimate on the amount of field time required is difficult to make, we estimate that up to two weeks of field work could be required and that some of the data collection could be done while other field studies are occurring.

Study Request 2a – Study the Impact of Operations of the Northfield Mountain Pumped Storage Project and Turners Falls Dam on Sedimentation and Sediment Transport in the Connecticut River

Goals and Objectives

The goal of this study request is to provide hydraulic and sediment transport modeling of both the intake and discharge conditions (current and proposed) at the Northfield Mountain Pumped Storage Project. The results of the study should provide information sufficient to enable MA DEP staff and stakeholders to understand current and proposed effects on water level fluctuations and relate to potential increase in sedimentation to the Connecticut River. MA DEP staff and stakeholders should be able to identify techniques that could be used to mitigate the effects of project operations or other mitigation techniques that could be developed to reduce riverbank erosion within the impoundment. In addition, an assessment of means to minimize the sediment load passing through the Turners Falls Canal during and after maintenance drawdowns should be conducted.

The specific objectives of this study are as follows:

- Assess hydraulic and sediment dynamics in the Connecticut River from Vernon Dam to Turners Falls Dam, the upper reservoir at Northfield Mountain, and downstream of the Turners Falls Dam.

- Identify management measures to minimize erosion and sedimentation.

- Determine areas of sediment deposition and beach formation in the Project Area and 1 km downstream of Cabot Station and describe habitat features of these areas, recreational uses and effects on invasive species, if any. Habitat areas include but are not limited to coves (e.g. Barton Cove), back channels, islands, wetland habitats, shorelines, shoals, deep water areas and channels.

- Identify management measures to mitigate for substrate (habitat) impacts and recreational impacts in sediment-starved areas below the dam and sediment accumulation areas upstream of the dam.

Relevant Resource Management Goals and Public Interest Considerations

The resource management goal is to ensure that the Connecticut River, which is designated as a Class B river for its entire length in Massachusetts, meets its designated uses of habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation. Class B waters must also have consistently good aesthetic value and meet minimum criteria for numerous water quality indicators to achieve compliance with the standards set forth in the regulations. The other resource management goal is to protect prime farmland soils, which are eroding, and riparian habitat. Eco-based tourism is important to the economy of Franklin County so maintaining the water quality of the river and protecting scenic landscapes along the river from erosion are important.

Public Interest Considerations if Requester is not a Resource Agency

The Landowners and Concerned Citizens for License Compliance (LCCLC) consists primarily of Gill and Northfield farm and conservation landowners who organized after seeing our riverbanks continue to wash down the Connecticut River in the Turners Falls Pool. Current and previous landowners have consistently advocated for more and better work to stabilize and repair areas of bank erosion with numerous filings to FERC, including professional studies commissioned by LCCLC, all of which have been made a part of the licensing proceeding.

The LCCLC has active members on the Franklin Regional Council of Governments' (FRCOG) Ad Hoc committee, the Connecticut River Streambank Erosion Committee (CRSEC). The CRSEC was convened in 1994 to bring together the Northfield Mountain Pumped Storage Project operator, state and municipal entities, landowners, and NGO's to carry out bioengineering projects to stabilize and repair areas of bank erosion. We are currently working with the FirstLight and the CRSEC to develop a suitable Quality Assurance Project Plan (QAPP) and appropriate methodology for the 2013 FRR.

The LCCLC looks forward to continuing our active engagement in the relicensing of the Turners Falls Dam and Northfield Mountain Pumped Storage Projects

Existing Information and Need for Additional Information

The PAD provides a summary of the work that has been done to characterize streambank conditions of the Turners Falls Impoundment, to understand the causes of erosion, and to identify the most appropriate approaches for bank stabilization. There has been no work undertaken to gather and assess the data that this study request would provide. Implementation of the *Northfield Mountain Pumped Storage Project Sediment Management Plan* (revised February 15, 2012) was begun in 2011 and is scheduled to end in 2014. This is a limited study related to sediment problems in the upper reservoir, not the entire river.

Nexus to Project Operations and Effects

The Turners Falls and Northfield Mountain Pumped Storage projects operate in a peaking mode, with allowable impoundment fluctuations of up to 9 feet, with the intent to continue as such. It is proposed to evaluate increasing the volume of flow from the Northfield Mountain Pumped Storage Project through increased use of the upper reservoir, which is expected to result in additional water level fluctuations. Upstream hydroelectric facilities also operate in a peaking mode of operation. Periodically, the upper reservoir at Northfield Mountain and the power canal at the Turners Falls dam need to be dewatered for maintenance purposes. Historically, both procedures have resulted in the discharge of large quantities of sediment. Sediment from shoreline erosion and riverbank failure is one of the major contributors that negatively affect water quality and habitat by increasing the turbidity and sedimentation, smothering aquatic habitat. Repetitive water level fluctuations and flow alterations caused by hydroelectric peaking operations are known to be a major contributor to shoreline erosion.

The Proposed Massachusetts Year 2012 Integrated List of Waters shows two river segments, from the VT/NH state line to the Turners Falls dam (MA34-01 & MA34-02) impaired and considered a "Water Requiring a TMDL" due to "Other flow regime alterations", "Alteration in stream-side or littoral vegetative covers" and "PCB in Fish Tissue". In addition, the segment below the Turners Falls dam to the confluence with the Deerfield River (MA34-03) is impaired by these causes as well as total suspended solids.

Proposed Methodology

We concur with the proposed methodology developed by the MA Department of Environmental Protection, which is consistent with accepted practices:

<u>Assess hydraulic and sediment dynamics</u>

- FirstLight to continue implementing the Northfield Mountain Pumped Storage Project Sedimentation Management Plan over the full range of river flows and pumping/generating cycles. An unfulfilled task in the Plan is to develop a correlation over the full range of flow conditions between the overall suspended sediment transport through the entire cross section of the river compared to the continuous sampling at the single fixed location. Environmental Protection Agency approval of a Quality Assurance Project Plan is required for valid data acquisition.
- Provide data on the daily water level fluctuation changes from the past five years from stations listed in the PAD, and estimate fluctuations within Turners Pool assuming proposed operations and hydraulic conditions.
- Identify the most appropriate techniques for bank stabilization given the existing and proposed hydraulic conditions.

<u>Determine areas of sediment deposition in the Project Area</u>

- Field (2007) conducted a bathymetric study as part of his report. Use previous bathymetric data, if available (Field 2007 recommends putting additional effort into finding a bathymetric survey from 1913 that was partially shown in Reid 1990), and current bathymetric information to look at areas of sediment accumulation. Determine areas of sediment deposition in the Project Area and 1 km downstream of Cabot Station and describe habitat features of these areas. Habitat areas include but are not limited to coves (e.g., Barton Cove), back channels, islands, wetland habitats, shorelines, shoals, deep water areas and channels.

- Identify recreational uses and impacts in areas known to be impacted by accumulated sediment, such as Barton Cove.
- Identify invasive species (plant or animal) present in the reaches and determine if erosion and sedimentation in any way contributes to the establishment and/or proliferation of these species.
    - Investigate the formation of beaches using remote sensing, LIDAR at low pool levels or some other mapping technique to understand the processes of beach deposition the distribution of beaches in the pool, the impact of beach deposition on habitat and species, and how can this be related to operation of NMPS.
    - Evaluate management strategies to address the release of accumulated sediment through Northfield Mountain Project works during upper reservoir drawdown or dewatering activities. FirstLight should specifically evaluate the feasibility of the installation of a physical barrier across the bottom of the intake channel designed to prevent the migration of sediment during future drawdowns of the upper reservoir
  - Evaluate management strategies to minimize flow fluctuations within Turners Pool including coordination with upstream users.
  - Evaluate management strategies to minimize sediment released through spillway gates and the log sluice located near the bottom of the forebay adjacent to the Cabot Powerhouse during canal dewatering activities.
  - Identify a prioritized list of locations for bank stabilization projects in the Project Area
  - Develop a map of land owned by FirstLight within 200 feet of the Connecticut River with an overlay of land use and vegetation cover. Provide land use options aimed at reducing bank erosion.

<u>Management measures to change sediment flow below and above the dam.</u>

- Any historic information of existing bed substrate material in the Turners Falls impoundment, bypass reach or downstream of the project should be collected and assembled. To the extent possible, the location of each sample should be made available on a map. The request for new data would stem from being able to make any valid comparison to changes in bed substrate at a given location, assuming the historic data exist.
- Identify measures that could be taken to mitigate impacts to recreational use, habitat, or invasive species from sedimentation.
- Identify measures that could be taken to change or mitigate sediment starved reaches below the Turners Falls dam.

Level of Effort and Cost

Many erosion studies have already been conducted and the cost of expanding the scope of some should be reasonable. A Full River Reconnaissance under the *Erosion Control Plan for the Turners Falls Pool of the Connecticut River* (Simons & Associates, Inc. dated

June 15, 1999) is scheduled for 2013 and could accomplish many of the objectives listed above.

Study Request 3a - Study the Feasibility of Converting the Northfield Mountain Pumped Storage (NMPS) Facility to a Closed-loop or Partially Closed-loop System

Building and operating the Northfield Mountain Pumped Storage project required the Turners Falls Dam be raised 5.9 feet. The Turners Falls impoundment of the Connecticut River acts as the lower reservoir and is subject to large sub-daily fluctuations in water level. The collateral environmental consequences of using the Connecticut River during the pumping and generation cycles for the last 40 years are not fully understood, but have likely contributed to extensive erosion of streambanks, downstream sedimentation, entrainment of large numbers of resident and migratory fishes, and destruction of important spawning and nursery habitat, both within the Turners Falls Pool and downstream. Intrinsic consequences include radical fluctuations in the hydrograph at a sub-daily level, which also negatively impact recreation, habitat, and likely disrupt key life history stages of resident and migratory fishes, benthic invertebrates, and macrophytes. The vast majority of proposed new pumped storage projects currently being considered by FERC are closed-loop because of a growing consensus that open-cycle pumped storage causes unacceptable environmental damage.

Resource agencies have identified restoration of a more natural hydrograph to the Connecticut River as a key management goal, and view the current relicensing process for five projects on the Connecticut River mainstem as an opportunity to achieve this. Converting to closed-loop or partial closed-loop would allow the restoration of ecological flows to the Connecticut River, and provide much greater flexibility in operational guidance for both NMPS and the other hydropower stations on the Connecticut River. It will also eliminate or partially eliminate many of the environmental concerns expressed by Federal and state agencies and other stakeholders, which are outlined in the numerous study requests and comment letters that FERC will receive on the NMPS project and the other four hydropower projects.

Goals and Objectives

The goal of this study request is to provide resource managers, stakeholders, and the licensee with an analysis of possible options for converting the plant to a close-loop or partially closed-loop system.

The objectives of this study request would be to determine:

- Candidate locations for placement of a lower reservoir
- Costs and logistics of construction and modification of the current facility to convert to a closed-loop or partially closed-loop system
- Projected savings associated with eliminating need for ongoing mitigation measures, both for stabilizing river banks as well as likely modification to operations that the facility that will be required to implement in order to protect habitat and native fauna.
- Other ancillary costs or savings, such as eliminating requested studies, operational changes, or mitigation measures

Relevant Resource Management Goals and Public Interest Considerations

The resource management goal is to ensure high quality habitat for migratory diadromous fish. Shortnose sturgeon, American shad, blueback herring, and American eel all require suitable spawning, rearing, migratory and foraging habitat. Eroding banks and subsequent increases in turbidity and deposition of fine grained material onto bed substrates in the Turners Falls impoundment, the bypass reach and downstream of the Turners Falls project reduces the quality of habitat for these species. Elevated levels of suspended sediment are associated with a diminution in water quality that also affects the quality of habitat encountered by endangered species. Entrainment into the facility could be lethal to any of these fish. Juvenile and larval stages of resident and migratory species, including rare, threatened, and endangered species of vertebrates and invertebrates are particularly vulnerable to entrainment. This damage is aggravated by the repeated cycling of the facility—unlike standard hydro, where organisms are likely only exposed to passage events a single time and may bypass the system safely, NMPS continuously recycles river water, and therefore increases the risk of exposure to entrainment and death.

Public Interest Considerations if Requester is not a Resource Agency

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The LCCLC has active members on the Franklin Regional Council of Governments' (FRCOG) Ad Hoc committee, the Connecticut River Streambank Erosion Committee (CRSEC). The CRSEC was convened in 1994 to bring together the Northfield Mountain Pumped Storage Project operator, state and municipal entities, landowners, and NGO's to carry out bioengineering projects to stabilize and repair areas of bank erosion. We are currently working with the FirstLight and the CRSEC to develop a suitable Quality Assurance Project Plan (QAPP) and appropriate methodology for the 2013 FRR.

The LCCLC looks forward to continuing our active engagement in the relicensing of the Turners Falls Dam and Northfield Mountain Pumped Storage Projects

Existing Information and Need for Additional Information

Some data on environmental effects of NMPS and facilities that use fresh or salt water for generation and/or cooling are widely available and consistently point to these types of facilities as damaging to native and migratory fauna. Once plentiful populations of blueback herring have been entirely eliminated from this portion of the Connecticut

River. Populations of American eel are in steep decline throughout this reach, and American shad that initially used fish passage facilities downstream of NMPS have experienced dramatic reductions above Turners Falls Dam.

Section 4.4.6 of the PAD (page 4-146) discusses entrainment at Northfield Mountain of migratory fish species. Previous studies estimated 28.6% of Atlantic salmon entrained, which was reduced to 6.7% after the installation of a guide net only during upstream passage season. LMS Engineers estimated in 1993 that the facility impacted 0 to 12.4% of adult American shad passing the water intake. No studies have looked at impacts to resident fish or other migratory fish or other times of the year, but several study request address this information gap.

Other facilities in the region (Brayton Point Power Station, a coal plant in Mt. Hope Bay) have been required by EPA to switch from open- to closed cycle at very significant cost because of the extensive damage done to fragile habitats by open-cycle pumping.

Streambank erosion has been a major concern since NMPS began operation in 1972. Section 4.2.4 of the PAD summarizes the extensive work that has been done to study and mitigate erosion along the river banks. Significant loss of agricultural land has resulted from unnatural river fluctuations and increased boat wakes from a raised impoundment, and in some cases poor mitigation efforts like helicopter removal of trees along the banks. Since 1996, the licensee has reportedly spent $750,000 - $1,000,000 annually on erosion control measures. In some cases, these projects will need to be re-done in the future. Converting the plant to closed-loop operation could provide significant cost savings over the life of the upcoming license, eliminating erosion control projects, proposed studies related to use of the Connecticut River as a lower reservoir, and any mitigation or operational changes that may be contemplated as a result of relicensing.

Nexus to Project Operations and Effects

In conjunction with other study requests, parties to the relicensing process will be reviewing data and considering operation and facility conditions that will best achieve the balance between natural resource protection, property and infrastructure protection, and power generation. Making the plant closed-loop or partially closed-loop is one important consideration to the scenario and would eliminate any operation changes that might result from concerns about fishery resources, water quality effects, and farmland losses.

Proposed Methodology

- Collate existing geological and hydrologic information of areas surrounding Northfield Mountain, including preliminary design plans for suitable facilities able to accommodate the existing and proposed discharge. These plans should include any and all possible locations, including modifications to infrastructure near the current outfall, and any other locations that could accommodate the necessary volume of water.

- Provide an engineering analysis of structural modifications necessary to accommodate a full or partial lower reservoir in an alternate nearby location.
- Provide information on whether and how a smaller lower reservoir, with ties to the Connecticut River, would act as a buffer to river level fluctuations and change the hydrologic pattern of flow on the Connecticut River in the Turners Falls pool (fluctuations), the water quality effects, and decrease the possibility of entrainment.
- Provide an analysis on water losses from evaporation and leakage and how much make-up water would be needed during normal operations by season or month.
- Identify and make available any similar studies conducted during the planning phase of the existing facility in the 1960's or any other time.
- Provide a cost estimate of each option considered and evaluated.
- Provide an itemized cost estimate of how halting the use of the Connecticut River as a lower reservoir would affect other costs, such as eliminating the erosion control program, any ancillary changes to generation at Turners Falls Dam and NMPS, and fish protection measures.

These methods are consistent with accepted practice for weighing costs and benefits of environmental impacts.

Level of Effort and Cost

The level of effort to compile existing information and to make the data available in a map should be low. Development of contingency scenarios would be low. The majority of the effort of this study request is essentially office work, with some engineering and design work required to scope likely costs of various scenarios.

Study Request 4a - Climate Change as it Relates to Continued Operation of the Vernon, Bellows Falls, Wilder, Northfield Mountain Pumped Storage, and Turners Falls Projects

Goals and Objectives

The goal of this study is to determine how climate change relates to the continued operation of the Vernon, Bellows Falls, Wilder, Northfield Mountain Pumped Storage, and Turners Falls projects.

The objectives of this study are:

1. Quantify the amount of thermal loading contributed by each respective impoundment (including the NMPS upper reservoir).
2. Using climate change prediction models, calculate how much warmer the project impoundments are projected to get in the next 30-50 years.
3. Model the effect of various project modifications on river temperature under current conditions and climate change predictions (e.g., converting to run-of-river, deep-water releases, dam removal, large-scale riparian revegetation, etc.).
4. Using climate change prediction models, determine if the projects actually provide an environmental benefit with respect to mitigating against climate change impacts (vis a vis warming of air and water temperatures) by producing low greenhouse gas emitting energy. The Northfield Mountain Pump Storage assessment must be based on net energy production (i.e., NMPS generates1,143,038 MWh annually, but consumes 1,567,506 in its pumping operations; for a net consumption of 424,468 MWh annually).
5. Determine how climate change predictions will impact management of high flow events at the three projects and evaluate if changes to dam structures would mitigate adverse impacts of the existing flood management protocols.

Resource Management Goals

The Landowners and Concerned Citizens for License Compliance (LCCLC) supports the United State Fish and Wildlife Service' (Service) goals. The Service seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to climate change, the Service's goals are:

1. Minimize current and potential negative project operation effects that could hinder management goals and objectives.
2. Minimize deep headpond drawdowns associated with the loss of stanchion logs during high flow events, which are predicted to increase due to climate change.
3. Minimize project-related sources of thermal increases to Connecticut River waters to mitigate against predicted climate change impacts.

The Service, along with the National Oceanic and Atmospheric Administration (NOAA) and the Association of Fish and Wildlife Agencies developed a draft *National Fish, Wildlife and Plants Climate Adaptation Strategy* in 2012. The public comment period closed on March 5, 2012, and the agencies are working to finalize the document. Goal #7 of the Strategy calls for reducing non-climate stressors to help fish, wildlife, plants, and ecosystems adapt to a changing climate. The Strategy notes that some stressors (such as habitat loss and fragmentation and pollution) "are not only some of the things decision makers can control, they are also likely to interact with climate change to magnify negative impacts on fish, wildlife, and plants."

Goal #7 contains a number of strategies and associated actions, including:
Strategy 7.1: Slow and reverse habitat loss and fragmentation
Actions:

- Consider application of offsite habitat banking linked to climate change habitat priorities as a tool to compensate for unavoidable onsite impacts and to promote habitat conservation or restoration in desirable locations
- Identify options for redesign and removal of existing structures/barriers where there is the greatest potential to restore natural processes.

Strategy 7.2: Slow, mitigate, and reverse where feasible ecosystem degradation from anthropogenic sources through…water resource planning, pollution abatement…
Actions:

- Work with water resource planners to identify potentially conflicting needs and opportunities to minimize ecosystem degradation resulting from development and land and water use.
- Reduce existing pollution and contaminants and increase monitoring of air and water pollution.
- Increase restoration, enhancement, and conservation of riparian zones and buffers in agricultural and urban areas to minimize non-point source pollution.

The Service's study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), and the Federal Power Act (16 U.S.C. §791a, *et seq*.).

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Existing Information

The PADs contains no information relative to climate change and how climate change predictions may impact future operation of the hydroelectric plants, nor of how the projects either mitigate for or exacerbate predicted climate change impacts to freshwater ecosystems.

TransCanada's PADs provide a summary of water quality data collected in 2012. Table 1 below is a synthesis of the temperature data collected by TransCanada. It should be noted that the upper and mid-impoundment stations at each project represent the average of temperature readings taken over the entire water column, while the continuous loggers (Lower Cont. and TR) were located near the water surface. These data indicate that from the upstream end of the Wilder headpond to the Vernon tailrace, water temperature increased approximately 6°C.

Table 1. Median water temperature at monitoring stations located within the impoundments and tailraces of the three hydropower projects.

	Median Water Temperature °C			
Project	Upper Imp.	Mid-Imp.	Lower Cont.	TR
Wilder	20.86	21.83	24.08	23.59
BF	22.43	23.67	24.86	24.38
Vernon	23.81	24.49	26.73	26.35

Relative to existing flood management protocols at each station, TransCanada's PADs identify that all three dams utilize stanchion bays (two at Vernon, three at Bellows Falls, and four at Wilder). When inflows to each dam reach certain levels, the stanchion bays are removed, and cannot be replaced until inflows subside. The depth of these bays and the flows they are removed at are outlined in Table 2, below.

Table 2. Summary of pertinent stanchion bay Information for the Vernon, Bellows Falls, and Wilder projects.

Project	Stanchion Height (feet)	Flow Triggering Complete Stanchion Removal
Wilder	17	145,000 cfs
BF	13	50,000 cfs
Vernon	10	105,000 cfs

The PADs provide no information on the history of stanchion removal at any of the projects (frequency, duration, timing), nor a discussion of how predicted climate change might alter management of the stanchion bays in the future (with respect to the frequency and seasonality of occurrence). There also is no discussion of potential impacts to headpond resources that occurs as a result of stanchion bay removal. These information gaps need to be filled so resource agencies can assess the relative and cumulative impact of project operations with respect to the Service's management goals and objectives, including those identified in the Climate Adaptation Strategy document.

Data provided by the National Oceanic and Atmospheric Administration, Climate Data Center, illustrates long-term increasing air temperatures in the Northeast (Figure 1). Long-term, monthly mean water temperature data for the Vernon Dam impoundment, monitored by Vermont Yankee, has shown significant differences over time (ANOVA analyses, $P < 0.05$) that when plotted and further analyzed by linear regression, show a significant increasing trend for the period 1974 – 2011 for the months of January, September, and October (Figure 2). These analyses were performed with data from Vermont Yankee, analyzed by the Massachusetts Department of Environmental Protection.

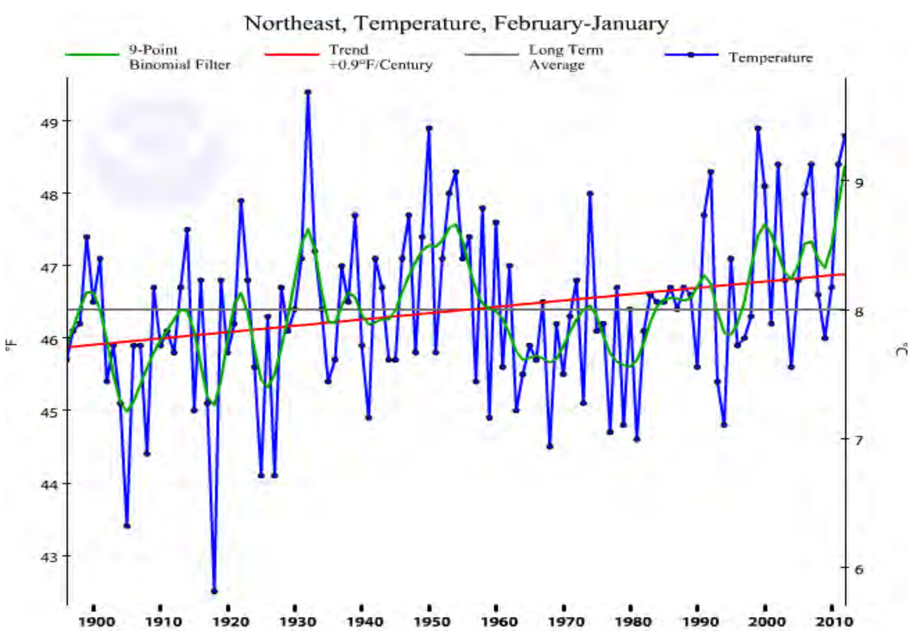

Figure 1. NOAA National Climate Data Center, Northeast 12-month average temperature for the period 1896 through 2012 (October).

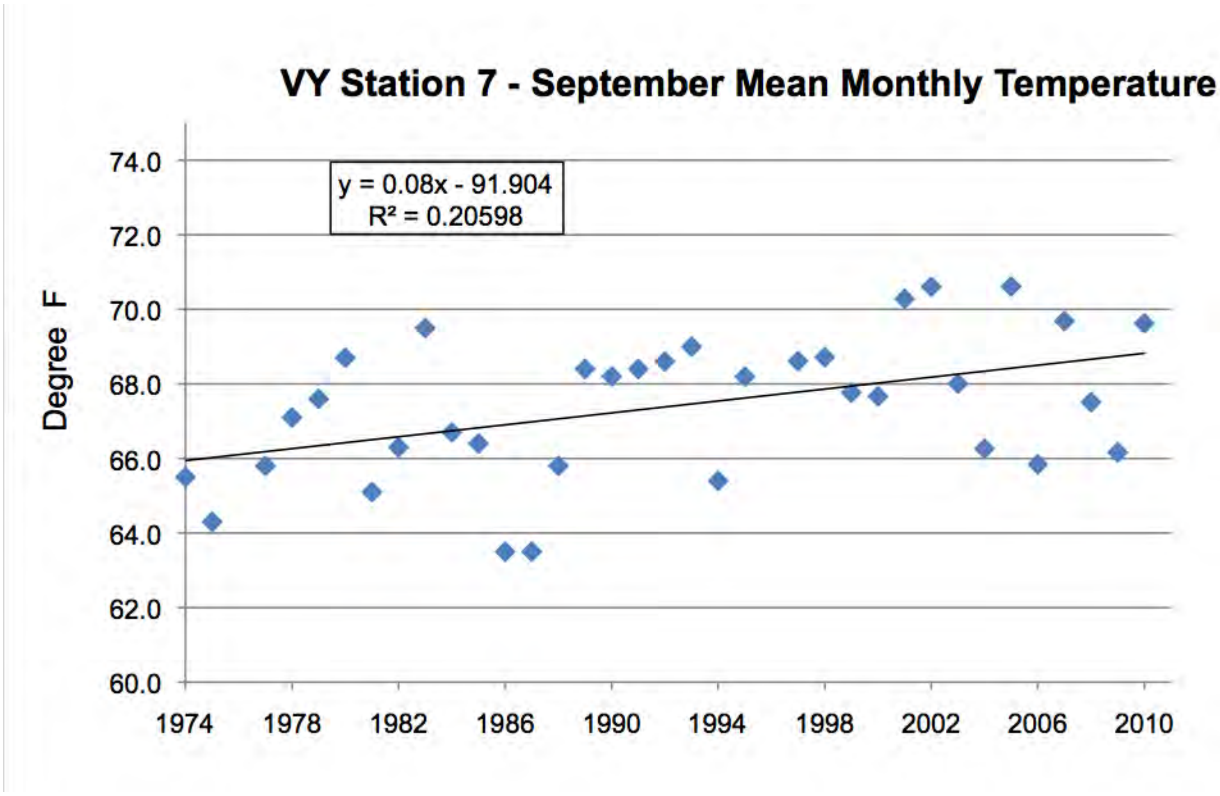

Figure 2. A plot of September's mean temperatures for Vermont Yankees' Station 7 (excludes outlier 1996 data point) for the period 1974 through 2011.

The PAD for Turners Falls and Northfield Mountain Pump Storage projects provides a summary of existing water quality data compiled by FirstLight, including water temperature data obtained from the Service. The PAD also notes a 1991 study by the former licensee that modeled thermal effects of pumping to the upper reservoir. That model reported a maximum temperature difference attributable to NMPS operation of 0.21°C in the Turners Falls reach of the Connecticut River in low flow (4,000 CFS) simulation.

Nexus to Project Operations and Effects

The four mainstem projects have very long impoundments capable of storing large volumes of water (Table 3, below). These impoundments effectively have converted large portions of the Connecticut River into a series of in-river "lakes." Because water velocities slow in these impounded sections of river, it allows for increased thermal loading and resultant higher water surface temperatures than in free-flowing sections of river.

Table 3. Relevant characteristics of the reservoirs behind the Wilder, Bellows Falls, Vernon, Turners Falls dams and NMPS.

Project	Headpond Length (miles)	Gross Storage Volume (acre-ft.)	Average Depth (ft.)	Surface Area (acres)	Flushing Rate (days)
Wilder	45	34,350	11	3,100	3
BF	26	26,900	10	2,804	<2
Vernon	26	40,000	16	2,550	2
Turners	20	21,500		2,110	
NMPS	n.a.	17,,050		246	n.a.

Depending on where the hydropower intakes withdraw water, these warmer surface waters may be discharged downstream, raising the temperature of those waters as well (the data in Table 1 above suggest that the projects do draw water from the upper levels of the reservoirs). This effect may be felt for miles downstream. If there are a series of impoundments (like on the Connecticut River), the cumulative impact is an overall warming of the river. Even small run-of-river dams have been shown to elevate downstream water temperature (Lessard and Hayes 2003; Saila et al. 2005). The most recent climate change prediction models specific to the northeast forecast warmer air temperatures, more frequent high precipitation events, more heat waves, and an increase in the incidence of short term droughts (Karl et al. 2009).

Resource concerns related to this project effect include the potential impacts to populations (reductions in abundance, structure, condition) or loss of species not tolerant of increases in temperature and other effects related to physiology such as energetic costs with warmer temperatures (Leggett 2004). As one example, American shad restoration target numbers for fish passage at mainstem dams into upstream historic habitat could be negatively impacted from artificially increased water temperatures. Water temperature has been identified as a factor in the timing (i.e., duration) of this species migration, as well as its role in gonad development and spawning (Glebe and Leggett 1981; Leggett 2004). These factors can be logical reasoned to potentially result in accelerated rates of energy reserve use and a reduced migration window, possibly reducing the ability of fish to reach up-river habitats and further reducing the ability to survive downstream outmigration.

With respect to project operations during high flow events, all TransCanada projects have stanchion bays that are used to manage water during high flow events. Each time these stanchion bays are removed, the headponds are lowered substantially (from 10 to 17 feet, depending on the project) and must remain lowered until inflows subside. Depending on the timing and duration of these deep drawdowns, headpond resources could be negatively impacted.

All of the dams also contain other mechanisms for managing flows, such as tainter gates, sluice gates, roller gates, skimmer gates and hydraulic flood gates. All of these gates have an advantage over stanchion bays in that they do not require flows to subside significantly before they can be closed to return impoundment levels back to normal. One climate change prediction for the northeast is that we will see more frequent high precipitation events which will result in high flow conditions on rivers. Therefore, it is likely that the stanchion bay removal protocol will have to be employed more frequently in the future.

Methodology Consistent with Accepted Practice

1. In order to quantify the amount of thermal loading contributed by each respective impoundment, detailed bathymetry will need to be collected. This bathymetry, combined with storage volume, tributary hydrology, and project operations, should be used to calculate the thermal loading of each headpond. The individual and cumulative increase in surface water temperature due to the impoundments should then be used to predict future warming based on climate change models.
2. Analyze different mitigation strategies to understand which have the greatest benefit in terms of building resilience against the impacts of climate change on water temperature. Potential scenarios to analyze include converting the projects to run-of-river, implementing deep-water releases, removing one or more dams, conducting large-scale riparian revegetation, etc.).
3. Input to climate change models the amount of GHG emissions that would be generated if fossil fuel plants were producing the equivalent amount of net energy as the five hydropower projects to determine the impact on air and surface water temperatures.
4. Climate change prediction model output should be assessed to determine if the frequency and timing of high flow events is likely to change in the future. If high flow events that necessitate initiating the stanchion bay removal protocol are predicted to increase in frequency and/or shift in timing, the applicant should evaluate structural and/or operational alternatives that would mitigate adverse impacts of the existing flood management protocols.

Level of Effort/Cost, and Why Alternative Studies will not suffice

The level of cost and effort for the thermal loading analysis would be low to moderate. Collecting bathymetry in the three TransCanada headponds would take two staff less than one week to collect (it took the Kansas Biological Survey two days to collect bathymetry at a 3,500 acre lake; Jakubauskas et al. 2011). Bathymetry for the Turners Falls pool and NMPS upper reservoir already exist. The remaining work would be desk-based; loading relevant information into an appropriate thermal loading model to compute the estimated thermal loading of each headpond and then comparing this information to surface water data from climate change prediction models.

The high flow flood protocol study is a desktop analysis that should require low cost and effort. Climate change models already exist and that output would be downloaded and analyzed. The remaining analysis requires a review of alternative means of managing flows without the use of stanchion bays.

The applicants did not propose any studies to meet this need in the PAD.

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Study Request 5a - Water Quality Monitoring in the Turners Falls Impoundment and Downstream of the Turners Falls Project

Goals and Objectives

Determine the current water quality of the Connecticut River within the Turners Falls impoundment. The results of the study should provide information sufficient to enable mandatory conditioning agency staff to understand water quality conditions at the project. The study plan for the water quality monitoring should be developed in consultation with the U.S. Fish and Wildlife Service (USFWS) and the Massachusetts Department of Environmental Protection (MA DEP).

The specific objectives of this study are as follows:

- Characterize water quality in the Turners Falls impoundment, bypass reach, canal and below the confluence of the bypass reach and canal discharge.
- Evaluate the potential effects of project operation on water quality parameters such as temperature, dissolved oxygen, total suspended sediment and turbidity in conjunction with various other water uses.
- Determine the level of contamination in sediment impeded by Turners Falls dam.
- Collect continuous temperature, dissolved oxygen, total suspended sediment and turbidity data during the summer period and under various hydropower operating conditions at the Northfield Mountain Project.

Relevant Resource Management Goals and Public Interest Considerations

The resource management goal is to ensure that the Connecticut River, which is designated as a Class B river for its entire length in Massachusetts, meets its designated uses of habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation. Class B waters must also have consistently good aesthetic value and meet minimum criteria for numerous water quality indicators to achieve compliance with the standards set forth in the regulations. The other resource management goal is to protect prime farmland soils, which are eroding, and riparian habitat. Eco-based tourism is important to the economy of Franklin County so maintaining the water quality of the river for boaters and kayakers is important, too.

Public Interest Considerations if Requester is not a Resource Agency

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The LCCLC has active members on the Franklin Regional Council of Governments' (FRCOG) Ad Hoc committee, the Connecticut River Streambank Erosion Committee (CRSEC). The CRSEC was convened in 1994 to bring together the Northfield Mountain Pumped Storage Project operator, state and municipal entities, landowners, and NGO's to carry out bioengineering projects to stabilize and repair areas of bank erosion. We are currently working with the FirstLight and the CRSEC to develop a suitable Quality Assurance Project Plan (QAPP) and appropriate methodology for the 2013 FRR.

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Existing Information and Need for Additional Information

The PAD provides a summary of existing water quality data. While a number of monitoring efforts have taken place and include sample sites within the project boundary, none of those studies was designed to comprehensively investigate whether all relevant project areas currently meet Class B standards: The Massachusetts DEP's Connecticut River watershed assessment monitoring occurred in 2003, it had only two stations located within the project area (both upstream of the Turners Falls dam) and only collected five to six samples from late April to early October. The Connecticut River Watershed Council's volunteer monitoring program only had one sample site within the project area (at Barton's Cove in the Turners Falls impoundment) and while those data are more recent, only three samples were collected in 2007 and only six samples in 2008 (over the course of three to four months each year). The U.S. Geological Survey's long-term water quality monitoring station located downstream of the Cabot Station tailrace only collects information roughly once per month (and no dissolved oxygen data are provided).

No directed, site-specific surveys have been conducted to determine whether waters within the Project area meet state standards. This information gap needs to be filled so that resource agencies can evaluate properly the potential impact of project operations on water quality.

Nexus to Project Operations and Effects

The project creates a 20-mile-long impoundment where there would naturally be a free-flowing river. It currently operates in a peaking mode, with allowable river fluctuations of up to 9 feet, with proposals to continue as such. Portions of the impoundment are nearly 100 feet-deep. There is a 2.7 mile-long reach of river bypassed by the Turners Falls power canal with only a nominal seasonal release required (equal to 0.05 cfsm). The below-project flow requirement is equal to 0.20 cfm (1,433 cfs). Water quality is directly affected by the operating mode of a hydropower project. Impoundments can stratify, resulting in a near-hypoxic hympolimnion. If the project intake draws off of these deep waters then it could cause low dissolved oxygen levels downstream from the project discharge.

The Landowners and Concerned Citizens for License Compliance requests that the applicant conduct a water quality survey of the impoundment, bypass reach and tailrace reach in order to determine whether state water quality standards are being met under all currently-licensed operating conditions (i.e., during periods of generation and non-generation). Results of the survey would be used, in conjunction with other studies requested herein, to determine an appropriate below-Project flow prescription, bypass reach flow(s), and to recommend an appropriate water level management protocol for the impoundment (e.g., limiting impoundment fluctuations to protect water quality). Operation of upstream hydroelectric projects as well as the Turners Falls Project and Northfield Mountain Project may impact water quality through the use of water for hydropower generation.

Methodology Consistent with Accepted Practice

Turners Falls: Water quality samples should be collected from a minimum of six locations: upstream of the impoundment, at a deep location within the impoundment, in the forebay near the intake, in the bypass reach, in the canal near Cabot Station and downstream of the confluence of the Cabot Station discharge and the bypass reach but upstream of the confluence with the Deerfield River. In order to ensure that data are collected under “worst case” conditions (low flow, high temperature, antecedent of any significant rainfall event), we recommend deploying continuous data loggers at all six locations, with biweekly vertical profiles taken at the deep impoundment location from June 1 through September 30. Results should include date, time of sampling, sunrise time, GPS location, generation status (estimated flow through canal and bypass reach), precipitation data, water temperature, DO concentration and percent saturation.

In addition, impoundment sediment adjacent to the Turners Falls dam should be analyzed for metals and polychlorinated biphenyls.

A proposed water quality sampling plan should be submitted to USFWS and MADEP for approval. A section on quality assurance and quality control must be included.

If river flow and temperature conditions are representative of an “average” or “low” water year, then one year of data collection should be sufficient to perform the study. If conditions are not representative (i.e., a “wet” or cool year) then a second year of data collection may be necessary.

Northfield Mountain: The water quality study will include two components: a) continuous dissolved oxygen and temperature monitoring at specific locations in the Northfield Mountain Project area and b) monthly *in-situ* dissolved oxygen, temperature profiles, total suspended solids and turbidity within the Northfield Mountain Upper Reservoir. It is anticipated that the study will be conducted from approximately June 1 through September 30.

Level of Effort and Cost

Cost would depend on the specific methodology chosen. If continuous data loggers are installed at all six locations and biweekly vertical profiles taken at the deep impoundment location from June 1 through September 30 then the estimated cost of the water quality study is approximately $55,000, including at least one full year of data collection. It is expected to take two technicians approximately one day to deploy the loggers, eight days to collect the vertical profiles, one day to remove the loggers, one day to download the data, and five days to write the report.

In the PAD, the applicant proposes to assess the effects of the Turners Falls and NFMPS project operations on dissolved oxygen and temperature by continuously monitoring DO and temperature at locations within the project areas and gathering vertical profiles within the TF impoundment and NFMPS upper reservoir.

Study Request 6a – Quantify the Impacts of Water Level Fluctuations on Riparian and Aquatic Vegetation Including Invasive Species and their Associated Habitats in the Turners Falls Dam Project Impoundment

Conduct a study to quantify the impacts of river level fluctuations due to project operations on riparian, wetland, Emergent Aquatic Vegetation (EAV), Submerged Aquatic Vegetation (SAV), littoral zone and shallow water aquatic habitats in the Turners Falls Dam impoundment.

Goals and Objectives

The goal of this study is to obtain baseline information on riparian, wetland, emergent and submerged aquatic vegetation, and associated shallow water aquatic habitats (subject to operational inundation and exposure to near exposure) known to occur in the project area. Information would be used to determine whether riparian, wetland, EAV and SAV, littoral, and shallow water (e.g., mid river bars and shoals) habitats are impacted by current water level fluctuations permitted under the Turners Falls and Northfield projects' licenses and whether these vegetation types and shallow water habitats can be protected and restored by modifications to project operations or other mitigation measures. This analysis needs to take into account existing and potential future limits on pond level fluctuations intended to limit recreation impacts, and the interactions of any changes in pond level fluctuation range or frequency and discharge changes under a new licenses of the Turners Falls and upstream projects. This information is needed to determine whether the projects' operation affects plants, habitat, and wildlife in the project area, whether aquatic vegetation and its habitats can be enhanced by modifications to project operations or other mitigative measures, and whether there is any unique or important shoreline or aquatic habitats that should be protected.

The specific objectives of the field study, at a minimum, include:

- Quantitatively describe and map wetland types within 200 feet of the shoreline, and describe associated wildlife;
- Delineate, quantitatively describe, and map all wetland types including invasive species and wildlife observed (e.g., bald eagle nesting, water fowl nesting) within 200 feet of the shoreline, and the extent of this habitat if it extends beyond 200 feet; and
- Quantitatively describe (e.g., substrate composition, vegetation type and abundance) and map shallow water aquatic habitat types subject to project operation inundation and exposure, noting and describing additional areas where water depths at lowest operational range are wetted to a depth less than one foot (flats, near shore areas, gravel bars, with very slight bathymetric change);

A second year of study may be required should river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period.

The field study should produce a habitat inventory report that includes:

- The results of the field study in the form of maps and descriptions;
- An assessment of project effects on wetland, riparian, littoral zone vegetation and shallow water habitats, invasive plant species, and wildlife habitat at the project; and
- Recommendations for any necessary plant, habitat type, or wildlife, protection and/or invasive species control measures.

Relevant Resource Management Goals and Public Interest Considerations

Protect and restore native riparian, wetland, EAV, SAV, littoral and shallow water habitat (i.e., spawning and or nursery areas for aquatic organisms) in the Turners Falls impoundment.

Public Interest Considerations if Requester is not a Resource Agency

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The LCCLC has active members on the Franklin Regional Council of Governments' (FRCOG) Ad Hoc committee, the Connecticut River Streambank Erosion Committee (CRSEC). The CRSEC was convened in 1994 to bring together the Northfield Mountain Pumped Storage Project operator, state and municipal entities, landowners, and NGO's to carry out bioengineering projects to stabilize and repair areas of bank erosion. We are currently working with the FirstLight and the CRSEC to develop a suitable Quality Assurance Project Plan (QAPP) and appropriate methodology for the 2013 FRR.

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Existing Information and Need for Additional Information

Existing information in the PAD does not quantify EAV and SAV in this area, or other shallow aquatic habitat types and physical features (e.g., depths, substrates, wood structure) that are the environment for aquatic biota in the project area. The PAD does provide some limited monitoring data for 2012 (2 locations) on water surface elevations that show daily fluctuations, in the upper third of this impoundment, that varied over 4 feet on a daily cycling frequency, with fluctuations generally in the 2 foot range in low flow months for the data provided in the PAD. The current license does permit a greater pool elevation operational fluctuation, up to a 9 foot change in elevation, based on the Turners Falls Dam water elevation. In the PAD it is noted these operational fluctuations under most circumstances at the Turners Falls Dam are within 3.5 feet.

In the PAD it is noted that FirstLight would like to expand its NMPS upper reservoir capacity (by up to 24%). How this may affect project operations and the habitats noted in this request is unknown. It is also noted that water is typically pumped to the upper reservoir in evening and generation back to the river occurs once to twice daily, in daytime hours, based upon power needs and power value. Under current license conditions, provided set thresholds for minimum flow and Turners Dam current license elevations are met, the NMPS may operate with no restriction in timing, frequency, or magnitude for pumping or generation. No data were provided on the operation of the NMPS plant over time relative to data on pumping and generation on an hourly basis, averaged values were provided over monthly periods. It is unclear what the actual timing, frequency and magnitude of these NMPS operations are over the course of a year and how that relates to: aquatic plant species establishment, growth, survival, littoral zone or other shallow water habitat fish spawning periods and their effects on these fishes (reproduction success and subsequent recruitment, e.g., bass and fall fish nests) in available and utilized habitat, and how the quantity and quality of these shallow water habitats are effected by project operational manipulation/alteration, as currently permitted or proposed.

The PAD provides lists of plant and wildlife species whose native ranges overlap with the project area, but it does not provide any baseline information on known occurrences of these species in the wetlands, riparian, littoral and shallow water habitats, within or adjacent to, the project area. Plant and wildlife occurring in these habitats may benefit from protection, mitigation, and enhancement (PMEs) measures, given the potential effects of continuing the current semiautomatic peaking operating regime. In addition, a large scale sediment discharge from NMPS resulted in regulatory actions by FERC, the EPA and MADEP in 2010. Continuing and as yet unresolved management plan measures relative to sediment and NMPS project operations, are further concerns for shallow water, littoral zone, and wetland habitats.

The Atlantic States Marine Fisheries Commission, Atlantic Coast Diadromous Fish Habitat: A Review of utilization, threats, recommendations for conservation, and research needs (ASMFC 2009)[2], contains a review of habitat information for these species. Recommendations in this report include: Maintain water quality and suitable habitat for all life stages of diadromous species in all rivers with populations of diadromous species.

Nexus to Project Operations and Effects

Water level fluctuations due to project operations could affect EAV and SAV habitat as well as the quantity and quality littoral and shallow water habitat. These operational

[2] Atlantic States Marine Fisheries Commission. 2009. Atlantic coast diadromous fish habitat: A review of utilization, threats, recommendations, for conservation, and research needs. Habitat Management Series #9. Washington, D.C.

water level fluctuation effects are expected to impact fish species use of these habitats and may affect spawning fishes reproductive success and subsequent population recruitment including but not limited to American shad, blueback herring, sea lamprey, fall fish, and bluegill, which spawn in mid to late spring through early summer in areas subject to daily or more frequent water level fluctuations.

The current operating mode, as well as the unknowns with proposed upper reservoir expansion, may affect wetland riparian, littoral and other shallow water habitats and promote the introduction and expansion of invasive plant species through fluctuating water levels. A study that explains the relationship between the proposed mode of operation and the type and quantity or wetland, riparian, littoral, shallow water habitats, and invasive species affected would help inform a decision on the need for protection and/or control of these resources in the license.

Methodology Consistent with Accepted Practice

The PAD currently contains maps portraying general wetland types from the Cabot Station tailrace upstream to the Vernon Dam. In addition, we understand that recent bathymetry exists for the Turners Falls impoundment (Field, 2007). The proposed study should utilize this existing information in conjunction with field surveys designed to describe the characteristics of each mapped wetland, riparian, littoral and shallow water habitat including plant species composition, relative abundance/density, habitat quality, and land use. These surveys should be conducted to describe these habitats at the lowest water level operational range permitted on a daily operation schedule, under low flow conditions. Information collected should include:

- Plant species composition, and their relative abundance/density and condition/structure (e.g., seedlings);
- Structured data, including estimates of average heights and aerial cover of each vegetation layer (specifically denoting invasive species);
- Aquatic habitat substrate composition, quantity (i.e., percent types and area), wood structure (relative abundance measure applied by area), water depths (inundated, exposed, and water less than one foot);
- Predominate land use(s) associated with each cover type;
- Wildlife sightings should be noted;
- Field verified wetland, riparian, and littoral and shallow water habitats and invasive species occurrences, should be geo-referenced as polygons and overlain on orthophoto at a suitable scale.

Level of Effort and Cost

In the PAD, First Light identified impacts of the project operations on wetlands, riparian and littoral zone habitat as a potential issue to be addressed in relicensing, and proposed wetland vegetation mapping. However, additional analysis as described above is needed to understand the impacts of the project on these resources and habitats.

A wetlands, riparian, littoral/shallow water, invasive species inventory, of the scope envisioned, would likely require 6-8 months to complete and cost $40,000 to $50,000.

Study Request 7a - Model flows in the Northfield Mountain Pumped Storage Project discharge tailrace and Connecticut River 1 kilometer upstream and downstream of the discharge using two-dimensional Computational Fluid Dynamics (CFD) model techniques.

Goals and Objectives

The goal of this study is to determine the potential impacts (both project-specific and cumulative) of the Northfield Mountain Pump Storage Project operations (pumping and generating) on the zone of passage for migratory fish near the Northfield Mountain turbine discharge/pump intake, on natural flow regimes in the area of the Connecticut River immediately upstream and downstream of the project, on the potential for entrainment during pumping operations, on the potential for creating flow reversals in Connecticut River during pumping cycles that may confuse migratory fish attempting to pass the project, and on bank erosion on both sides of the river in the vicinity of the tailrace.

Specific objectives of the study include:

- Develop a 2-dimensional CFD modeling capability for the area of the Northfield Mountain discharge and tailrace, along with the full width of the Connecticut River 1km upstream and 1 km downstream of the discharge.

- Model flow characteristics upstream and downstream of the project under existing project operations (pumping and generating) and at several representative river flow levels, as well as proposed operations such as those proposed in section 3.4.4 of the PAD, and any other modifications under consideration, to assess potential impacts to fish and wildlife resources, recreational use, agricultural resources, and historical resources.

- Assess velocities at and in proximity to the Northfield Mountain intake/discharge structure, when pumping or generating and their potential to interfere with fish migration.

- Assess the potential for velocity barriers in the mainstem river resulting from pumping and generation flows at the project, alone or in combination with generation flows from the upstream Vernon Project.

- Assess potential for Northfield Mountain project operations to create undesirable attraction flows to the intake/discharge that may result in entrainment or delay of migratory fish.

- Assess the potential of a mainstem instream local flow reversal associated with pumping operations to impact migrating fish. The Connecticut River in the area of the Northfield Mountain tailrace has been said to flow upstream potentially confusing migratory fish keying in to flow as a directional aid to upstream or downstream migration, causing delay and additional "fish" energy expense and possible entrainment.

- Model and then evaluate flow characteristics under alternative project operations with potential measures to avoid, minimize, or mitigate impacts to fish and wildlife resources.
- Assess the potential for unnatural flows and eddies in the main-stem associated with pumping or generation at the Northfield Mountain Project to impact bank erosion and recreational use.

Resource Management Goals

The Landowners and Concerned Citizens for License Compliance supports the U.S. Fish and Wildlife Service's goals. The mission of the U.S. Fish and Wildlife Service (Service) is to work with others to protect, conserve and enhance fish, wildlife, plants and their habitats for the continuing benefit of the American public. Service trust resources include wetlands, endangered species, and migratory species, all of which have been documented to occur in the project area. The Service is also working with a number of federal, state, local, non-governmental organizations, and the public to restore and enhance trust resources in the Connecticut River Basin through comprehensive management plans and cooperative agreements. Instream flow is an important riverine habitat characteristic that can have a great impact on aquatic habitat for fish, wildlife, and plants. Flow is an important directional guidance cue for instream navigation and attraction to fishway entrances for migratory fish.

Public Interest Consideration if Requester is not a Resource Agency

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Existing Information

No project specific information exists that will allow for a comprehensive assessment of existing project operations (pumping and generating flows) on Connecticut River flows and on fish and aquatic organisms in the project area upstream and downstream of the project in the Connecticut River. Preliminary results from an ongoing study of radio-tagged American shad by the USFWS and USGS Conte lab indictate that shad are exposed to the intakes and some individuals spend substantial amounts of time in the vicinity of the intakes. The PAD does not contain any information or tool that will allow for predictions of impacts of alternative project operations, or potential mitigation measures to protect or enhance aquatic fish and wildlife resources.

As part of Field (2007; see appendix 4), a "Connecticut River Hydraulic Analysis – Vernon Dam to Turners Falls Dam" was completed by Woodlot Alternatives in July 2007. For this analysis, a 2-dimensional flow model was developed for the entire Turners Falls impoundment. This study was geared towards looking at shear stresses from high-flow events, and did not focus in detail around the tailrace or examine how pumping and generation may affect flows in the vicinity of the tailrace under a variety of flows.

As a result of the hydraulic analysis, Field (2007) on page 20 states that "While erosion does occur where high flow velocities and shear stresses approach near the bank, significant amounts of erosion also occur where flow velocitieis near the bank are low." No specific examination was done in the report on the ±1 km area near the tailrace and existing erosion sites. Banks immediately upstream and downstream and across river have all required bank stabilization projects over the last 15 years, in some cases needing several repairs.

Nexus to Project Operations and Effects

Existing project operations have a direct impact on instream flow and aquatic habitat in the pump/discharge area of the Connecticut River. The PAD in section 3.2.2 says that the velocity at the trash racks when operating at full capacity is 20,000 cfs and maximum pumping conditions are 15,200 cfs. Annual flow duration curves shown for below the Vernon Dam submitted in the PAD section 4.3.1.2 (for years 1944-1973; recent and near project flows are not available; see p. 459) indicate that river flows are ≤ 20,000 cfs more than 85% of the time. Flows released from the project must therefore influence flow patterns and velocities in the Connecticut River, particularly at flows below some unknown threshold level.

Recreational users of the Connecticut River in the Turners Falls impoundment have anecdotally described flow reversals in the mainstem river. Discharges from the project could potentially be larger than river flows or at least act like a major tributary to the Connecticut River. Project flows may influence the availability and extent of upstream and downstream migration zones, or may confuse fish and delay migration. Project flows may also impact stream banks in ways that natural river flow (or flows affected by upstream hydropower facilities) does not, and may also impact recreational use of the river.

Proposed Methodology

CFD modeling is consistent with generally accepted practice, and has been used to assess proposed modifications to the Holyoke Dam fish passage facilities, upstream of the intakes and downstream of the dam, as well as at hydroelectric projects on the Susquehanna River to assess existing and proposed project operations, and develop mitigation measures for fish and wildlife resources.

Level of Effort/Cost, and Why Alternative Studies will not suffice

This study will require a detailed elevation map of the study area upstream and downstream of the Northfield Mountain project. Information already exists in historic construction files for the project, the hydraulic analysis included in Appendix 4 of Field (2007), and possibly in conjunction with work done after the 2010 maintenance procedures that resulted a portion of the river being dredged after a large sediment dump) that are in the possession of the applicant. Additional elevation data will likely need to be collected in the field using standard survey techniques. Elevation data will then need to be entered into a CFD modeling program. The CFD computer program will need to simulate existing project operations that include all potential variations of pumping and generating, and static operation. No project specific instream flow analysis tool has been developed for the Northfield Mountain project that will allow for assessment of existing operations and alternative operational impacts on instream flow and aquatic habitat for fish and wildlife resources. The computer model, once built, can be used to simulate flow conditions in the vicinity of the project during migratory fish passage and can be used together with behavior studies (i.e., telemetry studies and entrainment studies requested herein) to assess the impacts of varying project operations or potential mitigation operations and measures on fish migration and aquatic habitat. We know of no other tool that will provide for these types of assessments. Cost is expected to be moderate to high.

Study Request 8a. Model River Flows and Water Levels Upstream and Downstream from the Turners Falls Project Dam Generating Stations and Integration of Project Modeling with Upstream and Downstream Project Operations

Develop a river flow model(s) that are designed to evaluate the hydrologic changes to the river caused by the physical presence and operation of the Turners Falls Hydroelectric Project and the interrelationships between the operation of all five hydroelectric projects up for relicensing (i.e., P-1889 Turners Falls Hydroelectric Project, P-2485 Northfield Mountain Pumped Storage, P-1904 Vernon Hydroelectric Project, P-1855 Bellows Hydroelectric Project, P-1892 Wilder Hydroelectric Project) and river inflows. The flow studies should assess the following topics:

1. Conduct quantitative hydrologic modeling of the hydrologic influences and interactions that exist between the water surface elevations of the Turners Falls Project impoundment and discharges from the Turners Falls Dam and generating facilities and the upstream and downstream hydroelectric projects. Data inputs to and outputs from the model(s) should include:
    a. Withdrawals from the Turners Falls impoundment by the Northfield Mountain Pumped Storage Project, FERC No. 2485,
    b. Discharges to the Turners Falls impoundment by the Northfield Mountain Pumped Storage Project,
    c. Discharges into the Turners Falls impoundment from the Vernon Project, FERC No. 1904 and other sources.
    d. Existing and potential discharges from the Turners Falls Project generating facilities and spill flows.
    e. Existing and potential water level fluctuation restrictions (maximum and minimum pond levels) of the Turners Falls impoundment and downstream flows from the project
    f. Existing and potential required minimum flows and/or other operation requirements at each of the four upstream projects.
    g. Minimum discharge flows ranging between 2,500 and 6,300 cfs in the bypass reach from April 15th through June 22nd to support spawning, rearing, and outmigration of shortnose sturgeon at Rock Dam.

2. Document how the existing and potential outflow characteristics from the four upstream projects affect the operation of the Turners Falls Project including downstream flow releases and Turners Falls impoundment levels.

3. Assess how the operation of the existing Turners Falls Project and upstream projects affect Holyoke Project (P-2004) operations including:
    a. How Turners Falls Project flow fluctuations affect Holyoke impoundment water levels, with emphasis on the influence on the water levels on listed Puritan tiger beetle habitat at Rainbow Beach in Northampton, MA. and assess what changes would be needed in Turners Falls operations to stabilize water levels at Rainbow Beach.

   b. How Turners Falls Project operations affect Holyoke Project discharges and what changes in Turners Falls operations would be needed to reduce fluctuations in the discharges from the Holyoke Project.
4. To the extent predictable and practical, incorporate the potential effects of climate change on project operations over the course of the license.

Goals and Objectives

Determine the extent of alteration of river hydrology caused by operation of the project and the interactions between upstream project operations, Turners Falls operations and downstream operations at the Holyoke Project. The models will provide necessary information on what changes can be made to each of the five project's flow releases and/or water levels restrictions, and how those changes affect downstream resources.

Specifically, for the Turners Falls Project continuous minimum discharge flows in the Turners Falls bypass reach need to be no less than 2,500 cfs during shortnose sturgeon spawning, rearing, and outmigration (April 15th – June 22nd). Incorporating these parameters into the model will inform what changes, if any, need to be made to operations of upstream projects to accommodate such flows.

As other specific modifications of the operations of each of the projects are identified based on results of other requested studies, these desired conditions will need to be input into the models to assess how each change affects that project and other project operations and the implications of those changes on other resources and/or the ability to achieve desired operational changes at other projects.

Resource Management Goals

The Landowners and Concerned Citizens for License Compliance support the goals of the U.S. Fish and Wildlife Service (Service). The Service seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.
3. Assist FERC to ensure that the continued operation of the facility is not likely to jeopardize the continued existence of shortnose sturgeon.

Specific to aquatic resources, the Service's goals are:

1. Protect, enhance, or restore, diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.

3. Minimize current and potential negative project operation effects on water quality and aquatic habitat.
4. Ensure that project operations are not likely to jeopardize the continued existence of shortnose sturgeon.
5. Avoid or minimize the current negative effect of project operations on shortnose sturgeon spawning and rearing within the Montague spawning area (i.e. Rock Dam and Cabot Station spawning sites and associated early life stage rearing areas).

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), and the Federal Power Act (16 U.S.C. §791a, *et seq*.).

Public Interest considerations if requester in not a resource agency

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Existing Information

Available information in the PAD does not indicate how project operations have altered downstream hydrology, which may affect resident and migratory fish, macroinvertebrates, rare, threatened, and endangered species, aquatic plants and other biota and natural processes in the Connecticut River from below the Vernon Dam downstream to the Holyoke Dam.

Information in the PAD also does not reflect data analyzed in Kynard et al. 2012, which identifies minimum discharge thresholds for shortnose sturgeon spawning and rearing at the Rock Dam spawning site. Spawning success was observed at Rock Dam when discharge was between 2,500 cfs and 22,000 cfs during the spawning period (April 27–May 22nd) (Kynard et al. 2012, chapter 3). In 1995 at the Cabot spawning area, the greatest level of spawning and spawning success occurred (i.e., 21 late stage females present, 342 ELS captured, spawning period was 17 days) even though no spawning was detected at Rock Dam (Kynard et al. 2012, chapter 3). Discharges in 1995 at Rock Dam had dropped below 2,500 cfs by March 26th (Kynard et al. 2012, chapter 3), showing that even though 1995 saw the largest number of pre-spawning adults, none spawned at Rock Dam. This may indicate the need to have adequate flow well in advanced of spawning. Discharge reductions at the Rock Dam site that occurred during spawning caused females to leave the spawning cite and not return even if flow increased to acceptable levels later during the spawning period. Researchers observed that substrate did not change during fluctuating flows and thus cessation of spawning is likely due to velocities falling below the range preferred by females. Given the current flow dynamics at Rock Dam, spawning does not occur most years (Kynard et al. 2012, chapter 3). These data represent the best available scientific information and indicates that the current minimum flow thresholds at the project are not adequate for the protection of endangered shortnose sturgeon. All modeling efforts described above must incorporate the identified minimum flow and temporal parameters.

Nexus to Project Operations and Effects

The Turners Falls Project is currently operated with a seasonally-varying minimum bypass flow (400 cfs from 5/1 through 7/15, then 120 cfs through the winter until river temperature rises to ≥ 7°C) and year-round minimum flow below the projects of 1,433 cfs. The project operates as a daily peaking project, often with large, rapid, daily flow fluctuations between the minimum and project capacity (15,928 cfs) and fluctuations in headpond elevation (175' to 186' MSL). These changes affect biotic habitat and biota upstream and downstream of the project. Project operations and potential changes to operations to mitigate impacts are influenced by inflows and operations of upstream peaking projects and the Northfield Mountain Pumped Storage Project operations and potential changes in operations of each project could affect the ability to achieve desired operational changes at other projects. Results of river flow analyses will be used to develop flow-related license requirements and/or other mitigation measures.

Methodology Consistent with Accepted Practice

River hydrology statistics and modeling are commonly employed at hydroelectric projects to assess implications of project operations on the river environment.

Level of Effort/Cost, and Why Alternative Studies will not suffice

Level of effort and cost of model development are expected to be moderate but to be valuable in developing license conditions, the model(s) will need to be run under various scenarios throughout the relicensing process to assess the implications of changes to the operations of each project on other projects and other resources. Therefore, ongoing consultation and re-running of the model(s) are likely to be needed throughout the relicensing process. The modeling exercise will also require coordination and cooperation between First Light and the upstream licensee to assure that the model inputs and outputs can be accurately related.

We would anticipate that the expected level of effort and anticipated costs will be comparable to that experienced on similar FERC relicensing projects of this size (e.g., Conowingo, FERC No. 405).

Mary Jo Maffei, Amherst, MA.
Re-licensing Northfield Mountain P-2485-063

Northfield Mt. is a treasure. There are beautiful hiking, snowshoeing and cross-country trails and the grooming of the ski trails is excellent. As a parent and manager of the Amherst High School Nordic ski, the mountain provides a place for the kids to ski and train. However, more access needs to be provided. Skiers at Notchview run by the Trustees of the Reservation in Windsor, MA can ski any time, skiers should be able to ski any time at Northfield Mt. The mountain needs lights for night skiing and the ability to make snow. Currently, the mountain is closed on Monday and Tuesdays and closes at 4:30 PM. Our team skis after school, arrives at the Northfield around 3 PM and can only ski for an hour and half although there is adequate light to ski for longer. Often the mountain is closed when there is snow on upper trails, but not lower trails. Also, Northfield should be available to host high school Nordic ski meets. Currently they are unwilling to do this.

Northfield Mt. would be an ideal place to make snow. There is no trouble accessing water and the lower trails are in the shade and would hold snow for a long period of time. A five kilometer loop of man-made snow would be ideal. This would allow for skiing throughout the season and would make Northfield Mt. a truly valuable resource for outdoor recreation in Massachusetts.
Northfield Mountain should provide:

1) Expanded ski hours – 24/7
2) Snow making for a loop – ideally 5 kilometers
3) Lights for snow making loop for night skiing.

Thanks you and please feel free to contact me for more information.
Mary Jo Maffei
533 West Pelham Road
Amherst, MA 01002
mjmaf@aol.com
413-259-1263

Nathan L'Etoile, Co-Owner
Four Star Farms, Inc.
496 Pine Meadow Rd
Northfield, MA 01360

February 20th, 2013

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
88 First Street, N.E.
Washington, DC 20426

RE: Northfield Mountain Pumped Storage Project, FERC Project No.2485

Dear Secretary Bose:

My family farms roughly 275 acres in the Pioneer Valley of Western Massachusetts. For more than 25 years we have drawn water for irrigation purposes from the above referenced project area. Over the years we have made considerable efforts to comply with every governmental requirement, and many additional voluntary ones. We possess all applicable local, state, and federal permissions for our withdrawals. We have however been involved in a protracted legal struggle with First Light Power Resources and their predecessor Northeast Utilities regarding the need for us to receive permission from them for these same withdrawals. As part of the relicensing effort we request that First Light's license be amended to include language clarifying that First Light does not have authority over withdrawals for irrigation purposes.

My parents purchased the land on which the farm now operates in 1986 and have worked much of their adult life to pay off the mortgage, raise a family and create not only a world class farm, but one that is sustainable both environmentally and financially. While my parents are still the primary owners of the farm, we are currently undergoing a transition both of ownership and management to my brother and I. We grew up on this farm, we were ages 8 and 10 when it was bought, and have spent most of our lives on it. After college and brief periods off the farm, we have both returned to it, built homes and families, and hope to continue what my parents have started.

The farm has grown a variety of crops over its 25 year history. Sod has been a major crop for the entire period, but we have also grown nursery stock, and raised fish. In the last 5 years we have made a gradual transition and have begun to produce food crops, returning hops and many small grains to the valley, something that hasn't been done on the scale we have achieved here in Western Massachusetts for over 100 years. It's been a struggle, and it hasn't been inexpensive. We have however always found a way not just to get by, but to grow incredibly high quality crops in an environmentally sustainable manner and to market them at a price that sustains our family.

One of the centerpieces of our farm, one of the key factors that attracted my parents to it, was its access to water. With over a mile and a half of frontage on the Connecticut River (with existing access) and the finest soils in the world, it was impossible to not make the leap from the small farm they operated in Rhode Island and move north those 25 years ago.

That river supplies our farm with a lifeline for the crops we grow – water. Without a reliable access to water we cannot make the investments we need to assure a viable farm in the future. Each crop we grow has required this water and its proximity and ease of withdrawal is one of the farms greatest assets.

Over the years we have taken great efforts to comply with every local, state and federal rule and voluntary program we have encountered. We have all the necessary permits and licenses to pump from the river (at a cost of over $50,000 despite not needing to move a shovel full of dirt or cut a single branch within 100 feet of the river). Several years ago however we were approached by then "Northeast Utilities" (NU), a power generation company that operated the Northfield Mountain Pump Storage Project and were told we could no longer pump from the area of the river used as the lower reservoir of their pump storage facility. The license they held from the Federal Energy Regulatory Commission (FERC) gave rights to draw from this portion of the river to NU, and allowed them to grant permission directly to those withdrawing from the area. Further it required that NU monitor and take all lawful measures to assure that such withdrawals where in compliance with the law. We would need to obtain permission from them or they would sue us in federal court.

We strongly disagreed with their legal interpretation of the license and traded letters for many years. Our position was simple – while FERC may have granted extensive powers to NU, Congress's grant of powers to FERC was limited and specifically did not grant FERC the power to affect state laws governing the use or distribution of water used in irrigation [see US Code Title 16, Chapter 12, Subchapter 821 – States laws and water rights unaffected]. Massachusetts has an array of laws, permitting mechanisms, water resource management plans, and constitutional provisions guaranteeing access to water for agriculture, all of which would clearly be affected by an interpretation of the project license in such a way that required permission from the utility for such withdrawals. NU eventually just stopped responding to our replies and the issue seemed dormant.

Northeast Utilities sold the Northfield Mountain Project to First Light Power Resources several years ago, and after an initial period of quiet, the letters began again, likely in preparation for First Light's upcoming license renewal. We again tried the same tactic, with the help of an attorney showing the simple argument that while FERC may have given First Light what First Light perceives as clear instructions in its license to control all access to the river, the matter was not so simple and the license must be taken in context to the power that FERC has. This was unsuccessful, and in a simple calculation of the effect on our farm's viability that tens of thousands of dollars for a protracted legal battle in federal court would have, we decided to acquiesce and obtain from a 100% private company the right to use a public water body that the farm had always used. That permission may be revoked with or without cause at any time by First Light with no appeal, and leaves our farm at the mercy of a private corporation.

On October 30th, 2012 First Light Power Resources submitted a combined pre-application document for relicensing of the Northfield Mountain Pumped Storage Project, FERC Project No.2485; and Turners Falls Hydroelectric Project, FERC project No.1889. It is the language of the license that has First Light convinced that they not only may, but in fact must, police and grant or deny permission for all withdrawals from the portion of the river that we draw from.

For project licensing by FERC, their rules specifically state that before approval the project "shall be such as in the judgment of the Commission will be best adapted . . . for other beneficial public uses, including irrigation . . ." [US Code Title 16, Chapter 12, subchapter 803, (a) (1) Modification of plans; factors considered to secure adaptability of project; recommendations for proposed terms and conditions].

We are seeking assistance to add language to First Light's license that clarifies that use of water within the lower reservoir for irrigation is not subject to oversight in any way by First Light. We are not seeking any exemptions or special accommodation for irrigation use of the river from the state or federal government, and possess all required permits and approvals from them for this activity. We are asking for your assistance to remove First Light as an unnecessary intermediary in an area that Congress never intended they be. Addition of such language would help make the project better adapted for irrigation use and provide the certainty necessary for our farm. The oversight of the local, state, and federal government, while challenging at times, is subject to basic elements of good governance (open meeting laws, public records request, both administrative and judicial appeals, etc . . .). We feel that these protections while not being a 100% assurance of our access to water provide greater certainty and reliability and will thus allow us to continue to invest in long term projects on our farm.

Sincerely,

Nathan L'Etoile
Co-Owner, Four Star Farms, Inc.

Cc: Senator Elizabeth Warren, US Senate
Senator William Cowan, US Senate
Representative Jim McGovern, US House of Representatives
Senate Majority Leader Stanley Rosenberg, Massachusetts Senate
Representative Paul Mark, Massachusetts House of Representatives
Commissioner Greg Watson, Massachusetts Department of Agricultural Resources
Linda Dunlavy, Executive Director, Franklin Regional Council of Governments
Richard Bonnanno, President, Massachusetts Farm Bureau Federation
Roger Noonan, President, New England Farmer's Union
Lenard Roberts, President, Franklin County Farm Bureau
Jay Savage, Owner, Savage Farms, Inc.
Donald Patterson, Owner, Patteson Farm, Inc.
Tim Nourse, Owner, Nourse Farms, Inc.
Bernard Smiarowski, Owner, Teddy Smiarowski Farm

Suggested language to be added to the Northfield Mountain Pumped Storage Project (No.2485) License, either as a new Article or as an addition to Article 43. Much of the language is taken from *US Code title 16, Chapter 12, subchapter 821, States laws and water rights unaffected.*

Article XX. Nothing in this license shall be construed as affecting or intending to affect or in any way interfering with the control appropriation, use or distribution of water used in irrigation; nor does it give the Licensee authority over withdrawals from the project area for irrigation purposes; nor does it provide any exemption or prohibition for withdrawals from the project area for irrigation purposes.

Western Mass climber's coalition

25 PARKVIEW DRIVE
SOUTH HADLEY, MA 01075
413.493.1974 WWW.CLIMBGNEISS.ORG

February 20, 2013

Federal Energy Regulatory Commission
Attn: Ken Hogan

RE: Northfield Mountain Pumped Storage Project
FERC No. 2485-063

The Western Massachusetts Climbers' Coalition respectfully submits the following scoping comments with regards to the Northfield Mountain Pumped Storage Project. The Western Massachusetts Climbers' Coalition (WMCC) is a 501(c)(3) non-profit organization representing over 500 members and whose primary mission is to advocate for the protection and preservation of the unique and valuable outdoor rock climbing resources in western Massachusetts. As such, we request that three additional issues be considered in the scoping document for the Project.

First, we request that rock climbing be considered as a valid and important outdoor recreational opportunity within the Project boundaries. The Northfield Mountain Pumped Storage Project property contains two of the most significant rock climbing resources in southern New England, Rose Ledge and Farley Ledge (aka Rattlesnake Mountain). These two cliffs have been attracting New England based climbers, adventure programs and school groups since the 1940's. These sites represent significant historical resources for the sport. As the popularity and interest in rock climbing continues to grow, high quality and accessible climbing resources close to major population centers become increasingly important.

Second, we request that a change in the collection and evaluation of recreational survey data. We feel that methodologies should be expanded to include online surveys and/or surveys distributed through, or with the help of, organizations such as the WMCC who have a better understanding of the ways in which their members and supporters use and access the available resources. Particular site conditions, weather, timing and access points are generally different for each user group and without an understanding of those specific environments, a large percentage of recreational is potentially ignored.

Lastly, we request that additional protection efforts be considered for important and valuable resources currently within Project boundaries that are otherwise unprotected. The environmental resources that comprise Farley Ledge and its immediate surrounding have been identified by the Massachusetts Natural Heritage and Endangered Species Program as Core Habitat area containing a Priority Natural Community and Species of Special Concern. These resources include valuable animal habitats such as that of the peregrine falcon. This species has - with the help of the WMCC - reestablished itself on the cliffs, making Farley the first natural nesting habitat in Massachusetts for the species since the 1970's. Additionally, the vegetative community found among the cliffs has been identified as an Acidic Rock Cliff Community and an Acidic Talus Forest/Woodland. This unique combination of plants and flora is one of only six identified in the state. We are requesting that FERC and First Light consider additional protection efforts and conservation restrictions, with the help of the WMCC and other agencies, to ensure the protection of these valuable natural resources in perpetuity.

Sincerely,

Jeffrey Squire
President
Western Massachusetts Climbers' Coalition

TOWN OF NORTHFIELD
Conservation Commission
69 Main Street, Northfield, Massachusetts 01360
Phone: (413) 498-2901 Fax: (413) 498-5103 www.northfield.ma.us

ORIGINAL

TOWN OF NORTHFIELD INCORPORATED 1723

February 22, 2013

To: U.S. Federal Energy Regulatory Commission
From: Northfield Conservation Commission
69 Main St.
Northfield, MA 01360
Re: application for re-licensing of the Northfield Mountain Pumped Storage Project (P-2485-063), the Vernon Project (P-1904-073) and the Turners Falls Project (P-1889-081)

Submitted by Joan Deely on behalf of the Northfield Conservation Commission

The Northfield Conservation Commission serves the Town of Northfield, MA. Ours is the only community in the entire watershed that is bisected by the Connecticut River, which flows past prime farmland on both sides.

Consequently, the health and function of the river, and its impact on our lands, are of great importance to us.

The public-access boat ramp in Northfield is often inaccessible to boats due to extreme fluctuations in water levels on the river. This is a critical point of entry for emergency responders from the Northfield Dive Team, which plays an important role in the safety of recreational boaters and citizens alike.

Our daily lives are impacted by the three project referenced above.

We are keenly interested in identifying and implementing solutions that protect prime farmland, structures, and other natural resources, not only in Northfield, but in all the communities along the Turners Falls Pool.

Since the new licenses for the three projects will be valid for 30 to 50 years, we all have a "once in a lifetime" opportunity to participate in the process to identify, evaluate and mitigate the environmental impacts of these projects.

It is vital for the residents and municipalities of Franklin County to be actively represented and engaged in the relicensing process to ensure that the health and vitality of the river is sustained; to protect the region's treasured prime farmland, riparian and aquatic habitat for rare and endangered species; to ensure the safety of those using the river for recreation; and to make sure that recreational areas and facilities are maintained. We hope that FERC will hold the owner of the hydroelectric projects to high standards and expectations.

We have been and continue to be concerned with the frequent and significant water level fluctuations associated with the operation of the Northfield Mountain Pumped Storage and Turners Falls projects, which result in streambank erosion and impacts to water quality, threatened and endangered species, fisheries, wetlands, and riparian and littoral habitat. In particular, we believe that the Northfield Mountain Pumped Storage project and its operational use of the Connecticut River have been a long-term "experiment" that has resulted in significant adverse environmental impacts.

Our regional economy benefits from the number and variety of recreational resources associated with the projects. We appreciate the applicant's efforts to maintain and enhance the projects' recreational opportunities over the years. We encourage the applicant to continue their stewardship and to proactively engage with local towns and regional groups to expand and enhance the recreational opportunities, which in turn will help to strengthen the economy of Franklin County. Tourism is important to the economy of Franklin County, which is one of the poorest counties in the state.

We now have an opportunity to seriously consider the benefits of taking the river "off-line" and creating a closed-loop lower reservoir that would address most of the environmental impacts and specific resource concerns raised by Federal and state agencies and stakeholders.

We believe that the magnitude of river alteration caused by these projects, along with the complexity of issues involved and controversies about the best approaches to maintain power generation while not decimating aquatic communities and other natural resources, fully warrants an Environmental Impact Statement (EIS) under NEPA. We endorse FERC's approach to developing a single EIS for the five Connecticut River hydroelectric facilities to evaluate their individual and cumulative impacts on the river ecosystem. Now is the best opportunity in the near and long term to look at all these facilities holistically.

We have expressed our concerns about the methodology, findings and conclusions of the 2008 Full River Reconnaissance to FirstLight and FERC. We want to reiterate our concerns here, and state that accurate data and a reproducible methodology are essential for documenting the type and stage of erosion in the pool, and for evaluating whether the pace of erosion control work is keeping up with the rate of erosion. We request that the relicensing record reflect our continuing objections to the findings of the 2008 FRR, and specifically, our objections to including statements in the PAD that reference the 2008 FRR, and all of the text on page 4-12 of the section *4.2.4.2 Shoreline and Streambank Characterization.*

Concerns of the Northfield Conservation Commission include the following:

- The original purpose of the hydro-electric plant was to generate electricity. The project seems to have deviated from its original purpose, which begs the question: What is the rationale for the Pumped Storage Project now?

- We support the idea of a study that explores the effects of deregulation, and would be interested in contributing to it.

- Regarding the stated intent to add more water to the storage area, we want to see objective, detailed studies of the projected impacts on the river, on water quality, on river ecology, and on streambank erosion. If the increase in storage capacity results in increased profits how will the utility pass along that benefit to affected communities and offset anticipated environmental impacts?

- We encourage FirstLight to seriously research a closed loop system for pumped storage facility.

- We acknowledge that mitigation of streambank erosion on both sides of the river in Northfield has been on-going, although often at a glacial pace that doesn't keep pace with the constant need for mitigation. We urge the utility to commit more resources and expertise to this work, rather than continue unproductive wrangling over the causes of the damage.

Thank you for this opportunity to address the Commission with our concerns.

Sincerely,
Bill Llewelyn

Bill Llewelyn, Chair
Northfield Conservation Commission

Cc: Franklin County Regional Council of Governments

Ashuelot River Local Advisory Committee

Washington Lempster Marlow Gilsum Sullivan Surry Keene Swanzey Winchester Hinsdale

Feb. 24, 2013

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

Re: Northfield Mountain Pumped Storage Project, FERC Project No. 2485
Turners Falls Hydroelectric Project, FERC Project No. 1889

Dear Secretary Bose:

The Ashuelot River Local Advisory Committee (ARLAC) was established in 1994, one year after the Ashuelot River was enrolled into the New Hampshire Rivers Management and Protection Program. Members are nominated by Ashuelot River corridor municipal officials and appointed by the Commissioner of the NH Department of Environmental Services. ARLAC's mandate is to review and comment on projects within the corridor that have potential impacts on the river. We also have created, with acceptance by corridor towns, a Corridor Management Plan established in 2001 and updated in 2006. It is in this capacity that we wish to comment on the Pre-Application Document (PAD) submitted by First Light for the Northfield Mountain and Turners Falls Hydroelectric projects.

ARLAC has been supportive of the migratory fish programs implemented by NH Fish and Game as well as the Connecticut River Atlantic Salmon Commission. We support the installation of mechanisms that provide for upstream and downstream passage of diadramous fish in the Ashuelot, and have concern for the ability of these species to make their way from the Ashuelot watershed spawning habitat to the ocean, and their return from the ocean to the Ashuelot to spawn. Dams severely limit access to spawning habitat, and the proper operation of fish ladders is imperative to successful migration patterns of American eel, Sea lamprey, American shad, and Blueback herring. Dams also impact the natural movement of resident species. Along with supporting the proprosed studies (noted in section 5.1.4) on the efficacy of the existing fish passage systems as listed in the PAD, consideration should be given to year-round operation of these facilities to enable both resident and migratory species to move freely throughout the river system.

Wide and frequent fluctuations in water levels not only increase sedimentation from erosion of the stream banks but can also dry out nesting areas, preventing successful fish breeding. Low water levels may also limit the ability of fish to reach tributaries for spawning, foraging, and shelter. Additionally, invasive plants are more tolerant than native species to fluctuating water levels; this leads to monocultures of invasive plants – which are of little benefit to native wildlife – in otherwise natural riparian habitat. With these issues in mind we support the proposed studies (noted in 5.2.5.1 & 5.1.6) of the effects of the Turners Falls Hydroelectric Project and Northfield Mountain Project operations on wetland, riparian and littoral zone habitat within and adjacent to their project boundary, with a baseline inventory of botanical resources to include the confluence with the Ashuelot River. Consideration of run-of-river mode for the Turners Falls Hydroelectric Project and perhaps a closed loop system of reservoirs for the Northfield Mountain project should be evaluated.

Respectfully submitted,
Barbara Skuly, Chairman

cc: J. Colburn, NH Rivers Management and Protection Program

Karl Meyer, M.S. Environmental Science
Greenfield, MA, 01002
February 25, 2013

To: Federal Energy Regulatory Commission
RE: Comments on FERC Relicensing Projects: No. **P- 2485-063** (Northfield Mountain Pumped Storage Project) and No. **P-1889-081** (Turners Falls Hydroelectric Project)

Dear Commissioners,

Please carefully adhere to the standard FERC relicensing processes and deadlines as you relicense these two projects. Holding public and agency site visits in early October 2012 may have been deemed convenient for circumventing winter weather that might have affected visits, however it placed invested parties in the difficult position of having to view and judge hydro operations and configurations at both facilities without the benefit of knowing what operational changes and information FirstLight Power Resources was including in it PAD.

Further, of the three FERC group tours at Northfield/Turners Falls, only one group, mine, was able to view the area of the By-Pass Reach and the Turners Falls Canal and head gates from the downstream side of the Turners Falls gate house. This is a critical area to view, and the excuse being given was that there was construction happening on the Turners Falls Bridge. However, unrestricted access to view these sites was available to any passing citizen just yards away via a bike and walking path, open to the public. My group only received access because I made a direct request to FirstLight's John Howard, who was my former boss.

The two other tour groups did not get to see the confused flows created by the 14 head gates at the upstream end of the Turners Falls Canal. The canal has been a major disappointment as the upstream conduit for all migratory fish these last 34 years. Those head gates are open at full bore during much of the upstream fish migration season, they should have been a key component of the tour. Nor did interested parties get to view the exposed rock bed and de-pauperizing flow regimes created by flood gate manipulations at the Turners Falls Dam that renders the By-Pass Reach a non-river. FERC should place particular emphasis on any studies that redirect upstream migrating fish away from the confused and failed conditions experienced in the Turners Falls Power Canal, and send them directly upstream to a lift at TF Dam. That configuration has worked quite effectively at Holyoke Dam these last 58 years.

In late January 2013, GDF-Suez FirstLight Power Resource representative noted at public hearings that it intends to apply to FERC with a Proposed Study Plan to begin its own investigations of flows in the reach below Turners Falls Dam this April 2013, rather than the 2014 and 2015 study seasons noted in the FERC Relicensing Process. No study in this critical segment of river known as the By-pass Reach should be undertaken without a full vetting of the proposals. This section of river is critical spawning habitat for the federally-endangered Connecticut River shortnose sturgeon, also listed as endangered under the Commonwealth of Massachusetts Natural Heritage and Endangered Species Act. It is also the age-old upstream route for spawning federal-trust American shad and blueback herring. It is noteworthy that in their expedited study application that FirstLight cites the area below Cabot Station as a key shortnose sturgeon spawning location, while the critical site for these fish—used for likely thousands of years, is the natural escarpment in the riverbed known as Rock Dam, a half mile upstream of Cabot Station.

In a letter from FERC to Mr. John Howard of FirstLight Power Resources dated March 12, 2010, the Commission noted that FirstLight had failed to comply with Article 34 of the license for the

Turners Falls Project, releasing just 120 cubic feet per second to this segment of the river to protect shortnose sturgeon from the effects of low flows. The minimum requirement is 125 CFS.

With respect to measured, in-depth, long-term investigations on flow and river regulation in this reach I would direct you to the 17 years of research done by Dr. Boyd Kynard and colleagues at the Conte Anadromous Fish Research Center adjacent to this river segment in Turners Falls, MA. The work was largely conducted via the federal Conte Lab under the US Fish & Wildlife Service and later, under the US Geological Survey, when it took over responsibilities for Conte Lab after 1999. These investigations were also supplemented by funds, research and personnel from the University of Massachusetts at Amherst.

This research is documented in: ***Life History and Behaviour of Connecticut River shortnose and other sturgeons***, published in 2102 by the World Sturgeon Conservation Society and produced by Books on Demand, GmbH, Norderstedt, Germany: ISBN 978-3-8448-2801-6. Copies can be obtained from the **North American Sturgeon and Paddlefish Society**: www.nasps-sturgeon.org/#!publications Chapter 3 concerns the long-term study of flows and river regulation on spawning success of the last 300, spawning-capable, federally endangered shortnose sturgeon in this river system—covering the period of 1993 – 2005. This is critical, long-term research that includes seven years of findings from the time before Northfield Mountain Pumped Storage and Turners Falls Hydroelectric Project operated as a regulated utility, and the seven years when Northfield's pumping was unconstrained by regulations and operated to profit from price spikes and drops in the energy spot market using the public's river. Deregulation was fully implemented here in 2000 or thereabouts. All of these issues need careful consideration before sanctioning a rushed study plan in such a critical river reach.

When considering a new license for these facilities, careful consideration of the public's interest should be made respecting the changes and power generation, flows, and operational practices from the commencement of the current licenses down to the present. In 2012, Northfield Mountain Station added 40 megawatts of power to its generating facilities through retooling two of its turbines. This increase nearly equals the total power generated at HG&E's Holyoke Dam, the next downstream project licensed by FERC. Two remaining turbines await power up-rates, which is a considerable addition to the generation at this plant, originally proposed and installed at 1,000 megawatts. Currently, due to mid-license changes, it now produces 1,119 megawatts of power in an unregulated power market.

Also noteworthy and important to be considered in weighing the public's right to a living ecosystem, upstream fish passage, and protection of endangered species, is that Northfield Mountain's original license was for a plant used to create "peaking power, and as a reserve unit." It can only produce 6-8 hours of stored power before it is spent and needs to purchase replacement power on the open market. Its stated intention was to peak twice daily in high-demand winter and summer months, and once a day during shoulder months in spring and fall when energy demand is low. Northfield now generates when demand is present, or—when energy prices will make the greatest profit for investors. The river and the states have been impoverished by this profound change.

The building of Northfield was based on the availability of current and proposed power from collected regional nuclear sources (New England Power Pool) that included Maine Yankee (closed 1997); Yankee Rowe (closed 1992) Connecticut Yankee's Haddam Neck (closed 1994), as well as two proposed nuclear plants at Montague, MA (never built.) Vermont Yankee is currently the only "local" nuclear plant still operating, and its 40 year operating license expired March 21, 2012. Its continued operation is contingent on findings in the courts. It is currently operated at a loss by Entergy, and has a failing condenser system which could force its closure. In short, Northfield is now operated well beyond the bounds of its originally stated purpose. The public's river is paying a high price for power, much of it now imported to pump river reserves uphill to Northfield's reservoir from sources outside the region. The ecological impacts to fish runs and the damaging flow regimes imperiling endangered species in the river are apparent.

As a facility with great ecological impacts that cannot produce any of its own power--one totally dependent on outside sources for power, one proposed for using this stored power source put before the Federal Power Commission in the 1960s was that Northfield not operate during the spring fish migration due to its impacts on the runs. It is time to revisit the option of silencing the effects of Northfield Mountain so that towns and cities including Greenfield, Montague, Gill, Turners Falls, and Northfield, MA; and all the towns north to Vernon, Brattleboro and Bellows Falls, VT, and Hinsdale and Walpole, NH receive their share of the river's ecological bounty.

Northfield does serve a function as an emergency "reserve unit" for ISO New England (Independent Systems Operator) during times of severe heat waves, or high winter demand, to deliver a high volume of power on short notice to accommodate spikes in the power grid. Northfield could be taken off-line and kept in reserve to be operated by ISO New England solely for that purpose during the low-demand spring energy months when fish are migrating. This would greatly benefit river ecology, species, and all upstream stakeholders. New England's power grid resources are currently rated at 15% above demand. Removing the damaging effects of these operations on river ecology during critical months is a simple, equitable solution.

Northfield and Turners Falls have greatly profited by incremental power increases and operational changes over the past 34 years, while the public has watched flows, regulation, and conditions in the By-pass Reach wither to a brutal, feast-or-famine regime that denies spawning for endangered fish, and passage for upstream migrants. This situation has effectively privatized the 2-1/2 miles of river, depriving my town, Greenfield, as well as Gill, of its share of fish and a river. This de-pauperization has impacted all the towns upstream of Cabot Station and Turners Falls dam into central Vermont and New Hampshire. None of these municipalities have received compensation, though in many states the loss and damage to these fish populations would be considered "take" under state statutes. Damage in the By-Pass Reach tothe Connecticut River's last 300, spawning-capable Connecticut River shortnose sturgeon carries a significant federal fine, as well as possible imprisonment.

FirstLight's new requests for more generation at both licensed sites should be rejected, and the damaging mid-license flow and power increases should be reversed in any new license. Indeed, since there have now been no less than FIVE different owner/operators of this facility in the last 14 years, it would be prudent to grant only the shortest license possible in order to help track and minimize damage to the ecosystem due to operational/managerial changes, and protect the public's interest in a living river.

Northfield's impacts have never been fully measured with respect to flows in the By-pass Reach, but it is clear that fish passage is now at, or below, the paltry levels of the 1980s, and just a fraction of the 40 – 60% passage upstream long-targeted by the US Fish & Wildlife Service of fish that had been passed at the Holyoke Fish Lift. Regulated, continuously monitored flows should be returned to the By-pass Reach at this time, and continuous monitoring should be included in any new licenses issued. FirstLight has noted that in-stream data loggers for river levels and flow have been subject to vandalism. Continuous camera monitoring of river levels and open and closed gate positions at the Turners Falls Dam would go a long way toward insuring compliance with any new license conditions. This is an inexpensive solution that could easily include a back-up system.

With a federally endangered species present in the By-pass Reach, as well as federal-trust migrating American shad and blueback herring, FERC would do well to consider enforcing regulated flows in this stretch in accordance with law and statutes in the current license. NOAA's National Marine Fisheries Service has had the USGS Conte Lab findings from studies in the By-Pass reach by Kynard et al, in their possession since 2007. This agency—as well as the MA Division of Fisheries and Wildlife, could intervene at any time. These impacts are also affecting the success of the federal/state Connecticut River Migratory Fisheries Restoration, begun in 1967, which stipulates that all the states share equally in the bounty of migratory fish—as both a recreational and seafood resource. In several studies by the Massachusetts Cooperative Fisheries Unit at UMass/Amherst from the 1980s it is noted that blueback herring, (Alosa aestivalis) were noted gathering at the base of Turners Falls Dam, and were also noted spawning in the mouth of the Fall River--just 300 feet downstream of the dam, by then Conte Lab Director Steve Rideout.

Further, in the late 1980s, in another mid-license power up-rate, up to 5,000 CFS was redirected out of the By-pass Reach and into the Turners Falls Power Canal for use by Cabot Station and a refurbished Unit # 1, some 1-1/2 miles upstream of Cabot. This was undoubtedly another blow to the shortnose sturgeon attempting to spawn at their ancient grounds at the Rock Dam, though sturgeon spawning in the Connecticut here was not confirmed until 1993.

In the PAD, it is noted that FERC had not found any compliance issues during its inspections these two projects. However, as well as a failure to release minimum flows for sturgeon in 2009, I would direct you the US Environmental Protection Agency's August 3, 2010 letter and Administrative Order Docket No. 10-016, sent to Mr. James Ginnetti, FirstLight Vice President, noting violations of the federal Clean Water Act. FirstLight knowingly dumped up to 45,000 cubic square yards of silt into the Connecticut River below its fouled pumped storage plant in an attempt to clear its tunnels and intake. This illegal enterprise was undertaken by FirstLight after failing to conduct silt removal in a manner consistent with the "due diligence" stated in its operating license. This dumping took place throughout upstream fish migration season, May 1, 2010, or thereabouts, and continued until the EPA Cease and Desist Order of August 2010. At that time, FERC then became involved in this egregious license violation, requesting a full report from Mr. John Howard, Plant Manager, in a FERC letter dated August 10, 2010.

In a subsequent fall meeting with agency and non-profit river interests, a FirstLight representative stated that they did not know how to remove silt from their upper reservoir, and that it had never been done successfully. That admission came after 40 years of operating their plant. Hence, the public, and FERC are being asked to grant a new license to operators who have not shown they can successfully maintain their facility without profoundly affecting a navigable four-state waterway and a migratory fish highway. FirstLight has now asked for deadline relief, and is promising to have a study of siltation completed in 2014. Perhaps all study decisions should be held in abeyance until that time, 2014—which would comply with FERC Licensing Guidelines.

Sincerely,
Karl Meyer
85 School Street, # 3
Greenfield, MA 01301
413-773-0006; karlm@crocker.com

MASSACHUSETTS FARM BUREAU FEDERATION, INC.

"The Voice of Agriculture"

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February 25th, 2013
Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
88 First Street, N.E.
Washington, DC 20426

RE: Northfield Mountain Pumped Storage Project, FERC Project No.2485,
Docket p-2485, sub docket 63

Dear Secretary Bose,

As president of the Massachusetts Farm Bureau Federation I represent approximately 6,000 members statewide. It is on behalf of these members that I write to you concerning issues with water withdrawals by farmers, and the permitting of First Light Power Generation for their operation on the Connecticut River in Massachusetts.

The issue boils down to the permit, and the authority given to the holder in allowing or disallowing other parties to withdraw water from the river. Under the provisions of the previously issued permits for this facility (held by a number of different entities), this has been a contentious issue with local farmers and was tied up in an ongoing legal exchange. Farmers are legitimately concerned that the license holder would prohibit them from withdrawing water during periods of drought, putting crops, livestock, and the farmer's livelihood at risk.

It would seem inherently unfair to that one private party would be granted decision-making power over another in determining which has access to public, natural resources. A better alternative would be to defer to existing state statutes and regulations in Massachusetts governing water withdrawal. The Massachusetts regulatory system relative to water withdrawals is objective and designed to balance the need for water withdrawal against environmental concerns and between parties competing for water access.

We ask that you do not include provisions in the above-mentioned permit which would allow the holder to govern water withdrawals. Instead, we ask that you defer to the regulatory system already in place and governed by the Commonwealth of Massachusetts.

On behalf of the agricultural community in Massachusetts, I appreciate your consideration.

Sincerely,

A. Richard Bonanno, Ph.D.
President

February 26, 2013

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

RE: Turners Falls Project 1889-081 & Northfield Mountain Pumped Storage Project 2485-063

Dear Commission;

I am a concerned resident that own property along the river. I am concerned for the future of this beautiful natural resource, as well as the existence along the rivers banks.

I have attached photos of my property, I strongly favor research into a "closed loop" system, it would be a man-made reservoir that would no longer involve the river for the generation of electricity.

Thank you for your time.

River Resident
Montague, Gill, Northfield
Massachusetts

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
55 Great Republic Drive
Gloucester, MA 01930-2276

FEB 27 2013

Kimberly D. Bose, Secretary
Federal Energy Regulatory Division
888 First Street, N.E.
Washington, D.C. 20426

RE: Comments on FirstLight Power Resources Notice of Intent to File License Application and Filing of Pre-Application Document for the Turners Falls Hydroelectric Project (No. 1889) and Northfield Mountain Pumped Storage Project (No. 2485)

Dear Secretary Bose,

On December 21, 2012, you issued a Notice of Intent to file a license application, filing of Pre-Application Document (PAD), commencement of pre-filing process, and scoping; request for comments on the PAD and Scoping Document, and identification of issues and associated study requests by FirstLight Power Resources (P-1889-P-2485). The PAD contains information about the project itself and the environmental resources that are affected by the project. As part of the Integrated Licensing Process, we (the National Marine Fisheries Service (NMFS)) have an opportunity to comment on the PAD and to submit study requests.

Attached for filing, please find our comments regarding the PAD. In addition, we are including fourteen requested studies. If you have any questions or need additional information, please contact Bill McDavitt (William.Mcdavitt@noaa.gov) or 978-675-2156 or Jessica Pruden (Jessica.Prudena@noaa.gov) or 978-282-8482.

Sincerely,

Louis A. Chiarella
Assistant Regional Administrator
for Habitat Conservation

Mary A. Colligan
Assistant Regional Administrator
for Protected Resources

cc: Service List

National Marine Fisheries Service's Comments and Study Requests on FirstLight Power Resources Pre-Application Document for the Turners Falls Hydroelectric Project (FERC No. 1889) and Northfield Mountain Pumped Storage Project (FERC No. 2485)

February 27, 2013

1 PROJECT BACKGROUND

The Turners Falls Hydroelectric Project (P-1889) is located at approximately river mile 122 on the Connecticut River. The Turners Falls Dam creates the Turners Falls Impoundment, which is approximately 20 miles long and extends upstream to the base of Vernon Dam. At the southwest end of Turners Falls Dam is the gatehouse. Below the dam, originating at the gatehouse is the Turners Falls power canal. Parallel to this power canal is the bypassed section of the Connecticut River. The power canal is associated with two hydroelectric generating facilities: Station No. 1 and Cabot Station. Station No. 1 is located approximately one-third of the way down the power canal. Water is conveyed from the power canal to a small branch that feeds the Station No. 1 turbines before discharging into the bypassed reach of the Connecticut River. Cabot Station is located at the downstream terminus of the power canal where the canal rejoins the main stem of the Connecticut River. Station No. 1 and Cabot Station discharge into the Connecticut River approximately 0.9 miles and 2.7 miles downstream, respectively of the Turners Falls Dam. Northfield Mountain Pumped Storage Project (NMPS) (P-2485) consists of an upper reservoir, an underground powerhouse and a tailrace that withdraws and releases water to the Turners Falls impoundment.

2 NOAA TRUST RESOURCES

We (NOAA's National Marine Fisheries Service (NMFS)) acts on behalf of the U.S. Department of Commerce (DOC) as a trustee for natural resources. We protect and restore aquatic organisms and their habitat on behalf of current and future generations of Americans.

We are a trustee for coastal and living marine resources, including commercial and recreational fisheries; diadromous species; marine mammals, and estuary and coastal habitat systems. Estuaries and coastal riverine habitat systems, including rivers such as the Connecticut River, provide an integral component of significant ecological functions for the larger marine environment. Many living marine resources are supported by estuaries and coastal rivers throughout their life cycles. Species such as endangered shortnose sturgeon (*Acipenser brevirostrum)*, alewife (*Alosa pseudoharengus)*, blueback herring (*Alosa aestivalis*), American shad (*Alosa sapidissima*), American eel (*Anguilla rostrata*), and sea lamprey (*Petromyzon marinus*) rely on these coastal systems for refuge, spawning, rearing and nursery habitat. NOAA's 2009-2014 National Strategic Plan (Strategic Plan) recognizes the significance of these resources in its mission goals, which include: "Protect, restore, and manage the use of coastal and ocean resources through an ecosystem approach to management." Historically, all these species were present within the Turner's Falls project reach. Currently, neither blueback herring nor alewives are found in this reach of the Connecticut River.

Overall, we are guided by three goals in carrying out these responsibilities as a trustee:

- Reducing threats to coastal resources and human health through planning and prevention;
- Protecting coastal resources and human health by recommending and implementing appropriate response actions; and
- Restoring injured trust resources

3 LISTED ENDANGERED SPECIES IN THE PROJECT AREA

Shortnose sturgeon

Shortnose sturgeon are listed as endangered under the Endangered Species Act of 1973, as amended (ESA). The species is listed throughout its entire range, with populations occurring in several rivers along the Atlantic coast. As noted in the Preliminary Application Document (PAD), endangered shortnose sturgeon inhabits the Connecticut River downstream of the Turners Falls Dam to Long Island Sound. Turners Falls is believed to be the historic upstream boundary of shortnose sturgeon in the Connecticut River (Kynard *et al.* 2012a) and there have been only a few anecdotal sightings of sturgeon upstream of the dam. Currently, the Connecticut River population of shortnose sturgeon is separated into an upstream and downstream segment bisected by the Holyoke Dam: upstream in a 36.9 mile reach between the Turners Falls and the Holyoke Dam, and downstream in a 87.5 mile segment between the Holyoke Dam and Long Island Sound. While literature indicates that shortnose sturgeon were separated following construction of the Holyoke Dam, recent behavioral and genetic information indicates shortnose sturgeon in the Connecticut River are of a single population impeded, but not isolated, by the dam (Kynard 1997, Wirgin *et al.* 2005, Kynard *et al.* 2012a) Individuals upstream are typically found as far north as river mile (RM) 121.3, but adults have occasionally been reported at the base of the Turners Falls Dam (RM 123.8; Kynard *et al.* 2012a.

The two main shortnose sturgeon spawning sites in the Connecticut River are both located approximately 2.5 miles downstream of the Turners Falls Dam (Kieffer and Kynard 2012). Researchers refer to the main spawning site as “Cabot Station” because it occurs in the tailrace of the Cabot Station powerhouse (RM 120). This site is approximately 2.7 hectares (ha) in area and receives water from above Turners Falls Dam that is diverted through the power canal for the Cabot Station powerhouse. A secondary, smaller site (0.4 ha in area) is located at Rock Dam (RM 121.3). Rock Dam is a natural rock barrier located in the natural river reach flowing from the Turners Falls Dam (Kieffer and Kynard 2012. Although shortnose sturgeon early life stages (ELS) have been captured downstream of the Holyoke Dam, evidence indicates that only minimal spawning occurs, leaving the Montague reach (RM 119.9-120.5) home to the primary spawning recruitment sites for the entire river.

Researchers have studied shortnose sturgeon spawning at these sites for 17 years (Kieffer and Kynard 2012). Spawning females restrict movement to a small area and females require 20 plus hours to spawn with egg deposition continuing until completion (Kynard *et al.* 2012b). Researchers used the following as indicators of successful or likely spawning: 1) ELS were captured at the site identified by tracked females verifying spawning success; 2) females restricted movement and were located repeatedly for 20 or more hours on suitable substrate and velocity habitat or a location where spawning had previously been identified; and 3) on-site locations of females occurred within the spawning period as defined by ELS captures (Kieffer and Kynard 2012). Spawning suitability windows were defined using day length, temperature, and discharge data and described ranges of environmental conditions under which all spawning activity was observed. Temperature loggers were used to define temperature suitability and U.S. Naval Observatory data were used to identify day length. Discharge suitability had to be defined differently between both spawning sites due to the data available. For some years discharge data were available from the Northeast Utilities Service Co. (NUSCo), for other years USGS gauge data and modeling were used to identify discharge conditions and suitability (Kieffer and Kynard 2012). Day length and discharge were identified as the two most critical factors influencing the timing of shortnose sturgeon spawning in most years. However, within the appropriate day length window, discharge and temperature windows also had to be open simultaneously for spawning to occur. High spring discharge or brief increases in discharge (spikes) in excess of the suitability window during ongoing spawning activity delayed or stopped spawning.

Continuous monitoring between 1991–2007 revealed spawning succeeded at the Cabot Station site 71% of years and at the Rock Dam site, 21% of years. When spawning failed, it was due to river regulation, which created bottom velocities either too low or too high, or created discharge so low that females were either unable to reach or not attracted to spawning sites (Kieffer and Kynard 2012). Tagged pre-spawning adults arrived at Montague as early as 13 April and departed by 1 June. In years where spawning succeeded, adults remained at the Montague spawning sites as long as 4 weeks, though actual spawning periods were short (approximately 3-17 days). In successful spawning years, 1–324 ELSs were captured each year in anchored D-net sampling. Spawning periods, back-calculated from estimated ages of sampled ELS, occurred between 27 April and 22 May. In all years, spawning occurred as river temperature was increasing and river discharge was decreasing. During estimated spawning periods, daily mean temperature ranged from 6.5–15.9 °C and daily mean discharge ranged from 901–121 m^3/s. All spawning occurred during photo-periods of 13.9–14.9 hours (corresponds with 27 April–22 May). From 1993–1995, researchers measured bottom velocity and depth on spawning sites over 24-h sampling periods (Kieffer and Kynard 2012). Mean spawning depths (for both sites) were 1.8m (range; 1.2–5.2m) and mean bottom velocities of 0.7m/s (range 0.3–1.2m/s). Both sites occurred in areas of swift water resulting in rubble substrate continuously swept clean of fine particles and algae.

Candidate species

Candidate species are those petitioned species that are being considered for listing as endangered or threatened under the ESA, as well as those species for which we have initiated an ESA status review that has been announced in the *Federal Register*. "Candidate" status does not carry any procedural or substantive protections under the ESA. Two candidate species, alewife and blueback herring (collectively, river herring) historically occurred in the project area. We are currently conducting a status review of river herring to determine if either species warrants listing under the ESA. For more information on the status review process and river herring please visit:
http://www.nero.noaa.gov/prot_res/CandidateSpeciesProgram/RiverHerringSOC.htm.

4 FEDERAL STATUTORY REQUIREMENTS

We are responsible for conservation, management, and protection of America's living marine and aquatic resources throughout jurisdictional river basins in coordination with other state and federal agencies, local governments, Indian tribes, fisheries commissions, commercial and recreational fishers, and conservation organizations. Our authority to manage diadromous fish in these river basins comes from Congress. Specifically, Congress has directed us (NMFS) to manage diadromous species in river basins, including a grant of discretionary authority to us, to order fish passage at dams licensed by the Federal Energy Regulatory Commission. NMFS' congressionally mandated statutory authorities include the Federal Power Act, the Endangered Species Act, the Magnuson-Stevens Fishery Conservation and Management Act, the Atlantic Coastal Fisheries Cooperative Management Act, the Fish and Wildlife Coordination Act, and the National Environmental Policy Act.

4.1 The Federal Power Act (FPA) (as amended)(16 USC §§791a, *et seq*.)

Section 18 of the FPA - Section 18 of the FPA expressly grants to the DOC and the Department of the Interior unilateral authority to prescribe fishways. Section 18 of the FPA states that FERC must require construction, maintenance, and operation by a licensee at the licensee's own expense of such fishways, as may be prescribed by the Secretary of Commerce or the Secretary of the Interior. Within the DOC, the authority to prescribe fishways is delegated to the NMFS Regional Administrators.

Section 10(j) of the FPA - Under Section 10(j) of the FPA, licenses for hydroelectric projects must include conditions to protect, mitigate damages to, and enhance fish and wildlife resources, including related spawning grounds and habitat. These conditions are to be based on recommendations received from Federal and State fish and wildlife agencies. FERC is required to include such recommendations unless it finds that they are inconsistent with Part I of the FPA or other applicable law, and that alternative conditions must adequately address fish and wildlife issues. Before rejecting an agency recommendation, FERC must attempt to resolve the inconsistency, giving due weight to the agency's recommendations, expertise, and statutory authority. If FERC does not adopt a Section 10(j) recommendation, in whole or in part, it must publish findings that adoption of the recommendation is inconsistent with the purposes and requirements of Part 1 of the FPA or other applicable provisions of law, and that conditions selected by FERC adequately and equitably protect, mitigate damages to, and enhance fish and wildlife and their habitats.

Section 10(a)(1) of the FPA - Resource agencies may also recommend conditions under Section 10(a)(1) of the FPA for the protection, mitigation and enhancement of fish and wildlife (including related spawning grounds and habitat).

4.2 Endangered Species Act (ESA) (as amended) (16 USC §1531 *et seq.*)

Section 7(a)(2) of the ESA, states that each Federal agency shall, in consultation with the Secretary, insure that any action an agency authorizes, funds, or carries out is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. Any discretionary federal action that may affect a listed species must undergo Section 7 consultation. Section 7(a)(1) requires Federal agencies to use their authorities to further the conservation of listed species. We expect that FERC, as the lead Federal agency, will initiate consultation with us on the effects of the proposed relicensing on listed species under our jurisdiction.

4.3 Magnuson-Stevens Fisheries Conservation and Management Act (MSA) (as amended) (MSA) (16 USC §§1801, *et seq*)

The 1996 amendments to the MSA set forth a number of mandates for us, the Fisheries Management Councils (Councils), and other Federal agencies to identify and protect important marine and diadromous fish habitats. The councils are required to identify and describe essential fish habitat (EFH) for all managed species in order to protect habitat from fishing impacts and to allow for consultation with federal agencies whose actions may adversely impact essential fish habitat. EFH is defined as "those waters and substrates necessary to fish for spawning, breeding, feeding or growth to maturity." 16 U.S.C. § 1853(a)(7) and § 1802(10). The MSA requires federal agencies to consult with the Secretary of Commerce, through us, with respect to "any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken, by such agency that may adversely affect any essential fish habitat identified under this Act." 16 U.S.C. § 1855(b)(2). In the EFH consultation process, the federal action agency initiates consultation by preparing and submitting a completed EFH assessment describing the potential impacts of the action on EFH.

4.4 The Atlantic Coastal Fisheries Cooperative Management Act (ACFCMA) (as amended) (16 USC §§5101, *et seq*.)

The purpose of the ACFCMA is to provide for more effective fishery resource conservation of coastal fish species that are distributed across the jurisdictional boundaries of the Atlantic States and the Federal Government. These coastal fish species, which include American eel, shad and river herring, are managed by various species boards of the Atlantic States Marine Fisheries Commission, which develop fishery management plans and recommend management action to the states and NMFS.

4.5 The Fish and Wildlife Coordination Act (FWCA) (as amended) (16 USC §§661, *et seq*.)

The FWCA provides that fish and wildlife conservation shall receive equal consideration and be coordinated with other features of water resource development programs. A Federal action agency, such as the Federal Energy Regulatory Commission (FERC), shall consult with us with a view to the conservation of fish and wildlife resources by preventing loss of and damage to such resources as well as providing for the development and improvement thereof in connection with such water resource development. We may provide recommendations to the Federal action agency to which the action agency shall give full consideration.

4.6 The National Environmental Policy Act (NEPA) (as amended) (42 USC §§4321, *et seq*.)

The NEPA of 1969 (42 USC §§4321 *et seq*.) and its implementing regulations require Federal action agencies to analyze the direct and indirect environmental effects and cumulative impacts of project alternatives and connected actions. The NEPA requires the Federal action agency to conduct a comparative evaluation of the environmental benefits, costs, and risks of the proposed action, and alternatives to the proposed action.

4.7 Policy and coordination

Based on the above listed laws, we have developed policies designed to implement these laws.

4.7.1 NOAA Strategic Plan

To achieve this mission, NOAA's Next Generation Strategic Plan identifies the Habitat program for the protection and restoration of coastal marine habitats that support NOAA trust resources. An important objective of the Habitat program is to "improve ecosystem health through conservation and restoration of habitat." Our strategic plan further identifies the Protected Resources program to protect and work to recover species at risk of extinction, and the Fisheries Management program to ensure maintenance of fisheries at productive levels for supporting sustainability and the ecosystems to which they contribute. Strategies utilized to achieve this objective include implementing cooperative approaches at the local level in habitat conservation and restoration, including greater involvement in the review of FERC activities; and, by working to increase the survival of anadromous fish passing through hydroelectric facilities.

4.7.2 Atlantic States Marine Fisheries Commission (ASMFC)

The role of the ASMFC is to facilitate cooperative management of inter-jurisdictional fish stocks. ASMFC does this by creating Interstate Fisheries Management Plans for jurisdictional species. These plans set forth the management strategy for the fishery and are based upon the best available information from the scientists, managers, and industry. The plans are created and adopted at the ASMFC Policy Board level and the plans provide recommendations to the states and Federal government that allow all jurisdictions to independently respond to fishery conditions in a unified, coordinated way. The Atlantic Coastal Fisheries Cooperative Management Act requires the Federal government to support the ASMFC's management efforts. The Federal government enacts regulations to complement ASMFC recommendations when appropriate. To the extent the Federal government seeks to regulate an ASMFC managed species, those Federal regulations must be compatible with the ASMFC's plan and consistent with the 10 National Standards set forth in the Magnuson-Stevens Act.

The ASMFC has developed two plans that relate to our trust species. We highlight the plans' goals and recommendations below.

ASMFC's Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (2010)

The Atlantic States Marine Fisheries Commission, Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010 includes the following objective:

1. Maximize the number of juvenile recruits emigrating from freshwater stock complexes

When considering options for restoring alosine habitat, NOAA should include study of impacts and possible alteration of dam-related operations to enhance river habitat.

This document includes the following recommendations:

General Fish Passage

1) States should work in concert with the United States Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS) to identify hydropower dams that pose significant impediment to diadromous fish migration, and target them for appropriate recommendations during FERC relicensing.
2) States should identify and prioritize barriers in need of fish passage based on clear ecological criteria (e.g., amount and quality of habitat upstream of barrier, size, and status of affected populations). These prioritizations could apply to a single species, but are likely to be more useful when all diadromous species are evaluated together.
3) A focused, coordinated, well supported effort among federal, state, and associated interests should be undertaken to address the issue of fish passage development and efficiency. The effort should attempt to develop new technologies and approaches to improve passage efficiency with the premise that existing technology is insufficient to achieve restoration and management goals for several Atlantic coast river systems.
4) Where obstruction removal is not feasible, install appropriate passage facilities, including fish lifts, fish locks, fishways, navigation locks, or notches (low-head dams and culverts).
5) At sites with passage facilities, evaluate the effectiveness of upstream and downstream passage; when passage is inadequate, facilities should be improved.
6) Facilities for monitoring the effectiveness of the fish passage devices should be incorporated into the design where possible.
7) When designing and constructing fish passage systems, the behavioral response of each species of interest to appropriate site-specific physical factors should be considered.
8) If possible, protection from predation should be provided at the entrance, exit, and throughout the passage.
9) The passage facility should be designed to work under all conditions of head and tail water levels that prevail during periods of migration.
10) Passages are vulnerable to damage by high flows and waterborne debris. Techniques for preventing damage include robust construction, siting facilities where they are least exposed to adverse conditions, and removing the facilities in the winter.
11) Passage facilities should be designed specifically for passing alosines at optimum efficiency.

Upstream Fish Passage

1) American shad must be able to locate and enter the passage facility with little effort and without stress.
2) Where appropriate, improve upstream fish passage effectiveness through operational or structural modifications at impediments to migration.
3) Fish that have ascended the passage facility should be guided/routed to an appropriate area so that they can continue upstream migration, and avoid being swept back downstream below the obstruction.

Downstream Fish Passage

1) To enhance survival at dams during emigration, evaluate survival of post spawning and juvenile fish passed via each route (e.g., turbines, spillage, bypass facilities, or a combination of the three) at any given facility, and implement measures to pass fish via the route with the best survival rate.

Other Dam Issues

1) Where practicable, remove obstructions to upstream and downstream migration in lieu of fishway construction.
2) Locate water intakes where impingement/entrainment rates are likely to be lowest, employ intake screens or deterrent devices to prevent egg and larval mortality, and alter water intake velocities to reduce mortalities.
3) To mitigate hydrological changes from dams, consider operational changes such as turbine venting, aerating reservoirs upstream of hydroelectric plants, aerating flows downstream, and adjusting in-stream flows.
4) Natural river discharge should be taken into account when instream flow alterations are being made to a river (flow regulation) because river flow plays an important role in the migration of diadromous fish.
5) Ensure that decisions on river flow allocation (e.g., irrigation, evaporative loss, out of basin water transport, hydroelectric operations) take into account instream flow needs for American shad migration, spawning, and nursery use, and minimize deviation from natural flow regimes.
6) When considering options for restoring alosine habitat, include study of impacts and possible alteration of dam-related operations to enhance river habitat.

The relicensing process for the Turners Falls and NMPS projects provides an excellent opportunity to incorporate many of the ASMFC recommendations.

ASMFC's Interstate Fisheries Management Plan for American Eel (2000)

The goals in this plan include the following:

1. Protect and enhance the abundance of American eel in inland and territorial waters of the Atlantic States and jurisdictions and contribute to the viability of the American eel spawning population
2. Protect and enhance American eel abundance in all watersheds where eel now occur
3. Where practical, restore American eel abundance in all watersheds where they had historical abundance but may now be absent by providing access to inland waters for glass eel, elvers and yellow eel and adequate escapement to the ocean for pre-spawning adult eel.

Recommendations for Federal Energy Regulatory Commission Relicensing

The ASMFC recognizes that many factors influence the American eel population, including harvest, barriers to migration, habitat loss, and natural climatic variation. The ASMFC's authority, through its member states is limited to controlling commercial and recreational fishing activity; however, to further promotes the rebuilding of the American eel population, the

ASMFC strongly encourages member states and jurisdictions, as well as the USFWS, to consider and mitigate, if possible, other factors that limit eel survival. Specifically, the ASMFC requests that member states and jurisdictions request special consideration for American eel, in the FERC relicensing process. This consideration should include, but not be limited to, improving upstream passage and downstream passage, and collecting data on both means of passage.

4.7.3 Connecticut River Atlantic Salmon Commission (CRASC)

The CRASC developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management objectives in the plan include the following:

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.
2. Achieve annual passage of 40% to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem.

5 NMFS COMMENTS ON THE PRE-APPLICATION DOCUMENT (PAD)

Based on our review of the PAD submitted by FirstLight we offer the following comments.

5.1 PAD Section 3.2.3 Fish Passage Facilities

The applicant summarizes the CRASC established schedule for upstream and downstream passage facilities to be operational in Tables 3.2.3-1 and 3.2.3-2. We note that through existing fish passage agreements (memorandums of understanding) with previous owners and through FERC, the State and Federal agencies and CRASC have implemented an Annual Fish Passage Notification Letter to the main stem dam hydro-power operators. This letter is distributed to the identified owner/operators and explicitly states start and end dates of fish ladder, fish lift, fish bypass structures, gates, barrier nets, and other protective measures for the identified target diadromous species and for various life stages (e.g., adults/up, adults/down, juveniles/down). The Passage Notification letter is under the CRASC letterhead, signed by the Executive Assistant of CRASC. All dates of operation are noted as subject to change, based upon the request of the resource agencies and/or in consultation with the Licensee. Examples of recent changes to this schedule include the upstream passage operation start date for Vernon Dam fish ladder of April 15, which became effective in 2011. Other changes include the shift to start juvenile American shad downstream passage operations from September 1, to August 1 (effective in 2011). These changes reflect research study findings. With respect to upstream shad passage, recent changes in environmental conditions that may be part of a climatological trend led to the earliest upstream passage counts from the Turners Falls Dam in 2012. Such continued adjustments to the passage calendar will be important to ensure successful passage without causing delays for migratory fish.

The PAD describes the Northfield Mountain Guide Net. Given the proposed modifications to the Northfield Mountain project in section 3.4.4 of the PAD, neither this section nor section 3.4.4 (Proposed Modification) describes what changes, if any, are proposed for preventing impingement and entrainment of migratory and resident fish. Such information will be important when determining environmental impacts.

5.2 PAD Section 3.3.1 Operational License Requirements – Fishway Requirements

Table 3.3.1- 1 summarizes attraction flows for the three fishways associated with the Turners Falls project. Cabot Station has a maximum hydraulic capacity of 13,728 cfs. As percentage of maximum hydraulic capacity, the Cabot Fishway attraction flows are 2.4% for the maximum attraction flow. The PAD does not state any ladder attraction effectiveness for fish that may or may not enter the entrances to the Cabot or Spillway Fishways. We are unable to determine whether the present attraction flow is sufficient or if modifications may be required. FERC should order the applicant to provide information that indicates the effectiveness of fish entering both of their fishways on the existing auxiliary water system flows.

5.3 PAD Section 3.3.2 Turners Falls and Northfield Mountain Operations

The PAD summarizes the minimum, maximum and target elevations at the dam and in the power canal. It then goes on to summarize operations at various increasing flow ranges. Information on the statistical summary of current operation water levels such as a stage duration curve is needed. Given the proposed modifications in Section 3.4.4 (Proposed Modifications) we would like to know to what degree, if any, the stage duration curve may change under proposed conditions. We would also like to know the rate at which and when headpond elevations can change and what conditions might lead to rapid changes either increasing or decreasing. Given the migratory and resident fish that utilize the habitat in the headpond, we would like to have more information about the timing, magnitude and duration of potential headpond fluctuations. FERC should order the applicant to present how the existing flow duration curve would change under this proposal.

5.4 PAD Section 3.4.4 Proposed Modifications

The Licensee indicated their intent to use more storage in the NMPS project upper reservoir, and proposes to increase the unit and station capacity at the NMPS project. FERC should require the applicant to provide additional details and information on these proposals. Limited additional detail is provided. Given the impacts that existing operations have on the Connecticut River, we strongly urge FERC to fully take into consideration potential environmental impacts these proposals could cause to the Connecticut River and its resources during this relicensing process. As our study requests indicate, there are several significant information gaps regarding current operations. These information gaps will certainly apply if the proposed modifications are implemented.

5.5 PAD Section 4.2.4 Reservoir Shoreline and Streambanks

This section of the PAD summarizes the study efforts that have occurred on the Connecticut River within the Turners Falls project boundaries since 1979. The PAD makes reference to the 1991 Army Corps of Engineers (Corps) reconnaissance level mapping effort. This section does not identify some of the findings of this report which include the following:

"The results of this study show that riverbank erosion has increased almost threefold since 1979. Approximately one-third of the 148,000 linear feet of shoreline in this reach is undergoing some form of active erosion. In addition, the Turners Falls pool has remained the most dynamic pool on the Connecticut River, with daily fluctuations in water level averaging 3.5 feet…Recreational boating activity has also increased dramatically with the construction of public access points on the river."

The 1991 report includes a section titled "Evaluation of Causes within the Study Reach" and goes on to state, "As noted in the 1979 report, the next most significant cause of erosion is pool fluctuations which can cause an increase in the instability on the order of 18 percent of the shear stress exerted on the bank by flowing water. The impacts of hydropower development on bank stability in Turners Falls Pool have been and continue to be more severe than for other hydropower pools studies in the 1979 report due to differences in operation."

The 1991 report assigned percentages to each of the variables responsible for erosion. The Corps made these estimates for banks composed of non-cohesive material and for stratified material. In non-cohesive material, pool fluctuations and boat waves were responsible for approximately 27% of the erosion; in stratified material these two sources accounted for 30% of the erosion.

The PAD references the 2007 Field Geology Services Study which was submitted to the FERC compliance manager for Turners Falls and NMPS. The PAD summarizes some of the findings of this study, but the opening sentence in this report's closing paragraph states "Given the complexity of issues surrounding erosion in the Turners Falls Pool the results of this study are considered preliminary. Several questions regarding the reliability of the earlier erosion mapping remain." We still lack a clear understanding of the magnitude and causes of bank erosion in the Turners Falls headpond. Requested study #14 is designed to fill in this information gap.

5.6 PAD Section 4.4.5.2 Anadromous Fish Species below Turners Falls Dam – Blueback Herring

The PAD accurately reflects that we published a positive 90-day finding that the petition action to list alewife and blueback herring under the ESA may be warranted. We are currently conducting a comprehensive status review of the both species. The PAD presents biological data on blueback herring, though there is no information on alewives. Scientific data on both species should be included in the PAD. If fish passage improves at the Holyoke Dam due to future fishway modifications, alewives may be present in the vicinity of the Turners Falls project. The PAD does not contain any analysis of the effects of existing project operations on river herring and the effects of continuing operations and maintenance that would result from the proposed relicensing. It should do so.

5.7 PAD Section 4.4.6 Anadromous and Catadromous Fish Species in the Turners Falls Impoundment

Under the Cabot Station downstream subsection, the PAD references Brown 2009 and the high percentage of eels that pass the project via the turbines. This study also found that "at least 32% (9 out of 28) of the eels that used the turbines as a passage route at Cabot Station failed to continue their downstream migration and reach Hadley Falls Station. Downstream passage of large, pre-spawning females at multiple dams with this similar level of mortality will have severe cumulative effects on overall migrant eel survival and reproductive escapement." The ASMFC's policy is that FERC consider passage impacts to American eel at hydroelectric projects (ASMFC, 2000). Given that American eel have been petitioned to be listed as an endangered species, this level of mortality during the adult downstream passage season is a considerable concern for us.

5.8 PAD Section 4.4.8 Shortnose Sturgeon

The biological information presented on shortnose sturgeon in the PAD should be updated to include critical information in Kynard *et al.* (2012). The PAD does not contain any analysis of effects of existing project operations on shortnose sturgeon and the effects of continuing operations and maintenance that would result from the proposed relicensing. There is a large body of information on shortnose sturgeon in the Connecticut River. Specifically, there are significant scientific data available on shortnose sturgeon life history in the area between the Holyoke Dan and Turners Falls Dam. This information provides biological data on shortnose sturgeon spawning and rearing as well as the impact of project operations at the Turners Falls Hydroelectric Project on shortnose sturgeon. Given that shortnose sturgeon are known to be negatively affected by the Turners Falls Hydro Project operations, a complete analysis of effects is necessary.

6 REQUESTED STUDIES

We are requesting fourteen studies. Many of these studies are complex and will require additional coordination on the specific study design and methodology. FirstLight has directly engaged us and the other resource agencies to streamline development of the study requests and ensure timely implementation. Coordination commenced in 2011 and has continued throughout 2012 and 2013. FirstLight is hopeful that advanced coordination will allow them to begin modeling exercises during 2013, which should inform subsequent modeling and field studies. We support this approach. FERC and FirstLight should be aware that all scientific research targeting a species listed under the ESA requires a permit issued pursuant to section 10 of the ESA. A section 10 permit exempts the applicant from liability for take of a listed species provided the take is in the course of permitted activity. Study requests #2 and #3 seek field verification of modeling results. If the study design for these requests may result in take of any life stage of shortnose sturgeon, coordination with NMFS Headquarters Office of Protected Resources is required.

In addition to our requested studies listed below, we support the requested studies filed by the USFWS. In particular, the shad population model for the Connecticut River is an important study that will improve the resource agencies understanding of cumulative effects of the TransCanada and FirstLight projects on the Connecticut River.

6.1 Requested Study #1: Model river flows and water levels upstream and downstream from the Turners Falls Project generating stations and integration of project modeling with other project operations on the Mainstem Connecticut River

A river flow model can be designed such that it allows for an evaluation of the hydrologic changes to the river caused by the physical presence and operation of the Turners Falls Hydroelectric Project and the interrelationships between river inflows and the operation of all five hydroelectric projects up for relicensing (i.e., P-1889 Turners Falls Hydroelectric Project, P-2485 Northfield Mountain Pumped Storage, P-1904 Vernon Hydroelectric Project, P-1855 Bellows Hydroelectric Project, P-1892 Wilder Hydroelectric Project). Current modeling efforts and the associated data output already underway by the U.S. Geological Survey, U.S. Army

Corps of Engineers, The Nature Conservancy and University of Massachusetts at Amherst could potentially be used to help assist in this effort.

Goals and Objectives

The goal of this study is to determine the extent of alteration of river hydrology caused by operation of the project and the interactions between upstream project operations, Turners Falls operations and downstream operations at the Holyoke Project. The models will provide necessary information on what changes can be made to each of the five project's flow releases and/or water level restrictions, and how those changes affect downstream resources.

We anticipate other specific modifications to operations for each projects will be identified based on results of other requested studies. These conditions will need to be included in the models to assess how each change affects Turners Falls and other project operations, and the implications of those changes on other resources and/or the ability to achieve desired operational changes at other projects. Specifically, the Turners Falls Project has a required continuous minimum discharge flows in the Turners Falls bypass reach that need to be no less than 2,500 cfs during shortnose sturgeon spawning, rearing, and outmigration (April 15th – June 22nd). Incorporating these parameters into the model will inform what changes, if any, need to be made to operations of upstream projects to accommodate such flows.

The flow studies should assess the following topics:

1. Conduct quantitative hydrologic modeling of the hydrologic influences and interactions that exist between the water surface elevations of the Turners Falls Project impoundment and discharges from the Turners Falls Dam and generating facilities and the upstream and downstream hydroelectric projects. Data inputs to and outputs from the model(s) should include:
    a. Withdrawals from the Turners Falls impoundment by the Northfield Mountain Pumped Storage Project, FERC No. 2485;
    b. Discharges to the Turners Falls impoundment by the Northfield Mountain Pumped Storage Project;
    c. Discharges into the Turners Falls impoundment from the Vernon Project, FERC No. 1904 and other sources;
    d. Existing and anticipated discharges from the Turners Falls Project generating facilities and spill flows;
    e. Existing and anticipated water level fluctuation restrictions (maximum and minimum pond levels) of the Turners Falls impoundment and downstream flows from the project;
    f. Existing and anticipated required minimum flows and/or other operation requirements at each of the four upstream projects;
    g. Minimum discharge flows ranging between 2,500– 6,300 cfs in the bypass reach from April 15th through June 22nd to support spawning, rearing, and outmigration of shortnose sturgeon at Rock Dam.
2. Document how the existing and anticipated outflow characteristics from the four upstream projects affect the operation of the Turners Falls Project including downstream flow releases and Turners Falls' impoundment levels.

3. Assess how operation of the existing Turners Falls Project and upstream projects affect Holyoke Project (P-2004) operations including:
    a. How Turners Falls Project flow fluctuations affect Holyoke impoundment water levels;
    b. How Turners Falls Project operations affect Holyoke Project discharges.
    c. What changes in Turners Falls operations would be needed to reduce fluctuations in the discharges from the Holyoke Project.

Resource Management Goals

We seek to accomplish a number of resource goals and objectives through the relicensing process for this Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional diadromous fish and aquatic habitat objectives for the basin.
2. Conserve, protect, and enhance aquatic habitats for diadromous fish species that continue to be affected by the Project.
3. Assist FERC to ensure that future operation of the Project is not likely to jeopardize the continued existence of shortnose sturgeon.

Specific to aquatic resources, our goals are:

1. Protect, enhance, or restore diverse high quality aquatic and riparian habitats for diadromous species in the watershed and mitigate for loss or degradation of this riverine ecosystem.
2. Provide an instream flow regime in the bypass reach that meets the life history requirements of diadromous fish and federally listed shortnose sturgeon.
3. Minimize current and potential negative project operation effects on water quality and aquatic habitat.
4. Avoid or minimize the current negative effect of project operations on shortnose sturgeon spawning and rearing within the Montague spawning area (i.e. Rock Dam and Cabot Station spawning sites and associated early life stage rearing areas).

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to our mandates as identified in Section 4 above.

Public Interest

The requestor, NMFS, is a federal resource agency.

Existing Information and Need for Additional Information

Information in the PAD does not indicate how project operations have altered downstream hydrology, which may affect diadromous species and endangered shortnose sturgeon and other natural processes in the Connecticut River from below the Vernon Dam downstream to the Holyoke Dam.

Information in the PAD also does not reflect data analyzed in Kynard *et al.* (2012), which identifies minimum discharge thresholds for shortnose sturgeon spawning and rearing at the Rock Dam spawning site. Spawning success was observed at Rock Dam when discharge was between 2,500 cfs and 22,000 cfs during the spawning period (April 27–May 22nd) (Kieffer and Kynard 2012). In 1995, at the Cabot spawning area, the greatest level of spawning and spawning success occurred (i.e., 21 late stage females present, 342 ELS captured, spawning period was 17 days) even though no spawning was detected at Rock Dam (Kieffer and Kynard 2012). Discharges in 1995 at Rock Dam had dropped below 2500 cfs (i.e., by March 26th) before the spawning period of April 27th (Kieffer and Kynard 2012), showing that even though 1995 saw the largest number of pre-spawning adults, none spawned at the Rock Dam. This may indicate the need to have adequate flow well in advance of spawning. Discharge reductions at the Rock Dam site that occurred during spawning caused females to leave the spawning site and not return even if flow increased to acceptable levels later during the spawning period. Researchers observed that substrate did not change during fluctuating flows and thus, cessation of spawning is likely due to velocities falling below the range preferred by females. Given the current flow dynamics at Rock Dam that do not provide adequate attraction flows and flows necessary for spawning; spawning does not occur most years at Rock Dam (Kieffer and Kynard 2012). These data represent the best available scientific information and indicate that the current minimum flow thresholds (i.e., minimum bypass flow (400 cfs from 5/1 through 7/15; 120 cfs through the winter until river temperature rises to ≥ 7°C) and year-round minimum flow below the projects of 1,433 cfs) at the project are not adequate for the protection of endangered shortnose sturgeon. All modeling efforts described above must incorporate the identified minimum flow and temporal parameters. These study requests are designed to identify the minimum flows and temporal parameters necessary to protect shortnose sturgeon.

Project Nexus

The Turners Falls Project is currently operated with a seasonally-varying minimum bypass flow (400 cfs from 5/1 through 7/15; 120 cfs through the winter until river temperature rises to ≥ 7°C) and year-round minimum flow below the projects of 1,433 cfs. The project operates as a daily peaking project, often with large, rapid, daily flow fluctuations between the minimum and project capacity (15,928 cfs) and fluctuations in headpond elevation (175’ to 186’ MSL). These changes affect biotic habitat and biota upstream and downstream of the Turners Falls project. Project operations and potential changes to operations to mitigate impacts to aquatic habitat and diadromous species at the Turners Falls Hydro Project, are influenced by inflows and operations of the upstream Trans Canada peaking Hydro projects and the Northfield Mountain Pumped Storage Project operations. Potential changes in operations of each of both the First Light and Trans Canada Projects, could affect the ability to achieve desired operational changes. Results of river flow analyses will be used to develop flow-related license requirements and/or other mitigation measures.

Proposed Methodology

River hydrology statistics and modeling are commonly employed at hydroelectric projects to assess implications of project operations on the river environment.

Level of Effort and Cost

Level of effort and cost of model development are expected to be moderate but to be valuable in developing license conditions, the model(s) will need to be run under various scenarios throughout the relicensing process to assess the implications of changes to the operations of each project on other projects and other resources. Therefore, ongoing consultation and re-running of the model(s) are likely to be needed throughout the relicensing process. The modeling exercise will also require coordination and cooperation between FirstLight and the upstream licensee to assure that the model inputs and outputs can be accurately related. The lack of such coordination may lead to results that are not truly representative of anticipated discharge flows under varying operations scenarios.

We would anticipate that the expected level of effort and anticipated costs will be comparable to that experienced on similar FERC relicensing projects of this size (e.g., Conowingo, FERC No. 405).

One alternative to developing numerical hydraulic model is to develop a physical model of the river and associated structures. The level of effort to develop a physical model would be too time-consuming and cost prohibitive.

6.2 Requested Study #2: In-stream flow habitat assessment downstream of Cabot Station

We recommend the applicant conduct an instream flow habitat study to assess the impacts of the range of the proposed project discharges on the wetted area and optimal habitat for key species. The study should include non-steady flow approaches to assess effects of within-day flow fluctuations due to peaking power operations on target fish species and benthic invertebrate communities. Target fish species include: federally endangered shortnose sturgeon, American shad, American eel, and sea lamprey.

Goals and Objectives

The goal of this study is to determine an appropriate flow regime that will protect and enhance the aquatic resources from the Cabot tailrace of the Turners Falls Project downstream to the Rt. 116 Bridge in Sunderland, MA. The objective of the study is to conduct an instream flow habitat study to assess the impacts of a range of flows on the wetted area and optimal habitat for key species, including the impacts of hydro-peaking flow fluctuations on the quantity and location of aquatic habitat.

For shortnose sturgeon, the flow study will need to evaluate bottom velocities in spawning and rearing areas during discharge conditions observed from April 15th to June 22nd. Protection of shortnose sturgeon spawning will necessitate establishment of discharges that create bottom velocities suitable for spawning and rearing over a sustained period of time and avoid dramatically fluctuating flows. To protect shortnose sturgeon rearing, adequate discharge without dramatic flow fluctuations are needed to ensure the rearing shoals are wetted and velocities are sufficiently protective for early life stage (ELS) rearing.

Field verification will be necessary to confirm the flow modeling results that identify the flows needed to provide sustained bottom velocities for spawning and also maintain flows, depths, and water release regime adequate for spawning and rearing. Velocity and depth data should be collected under each potential operation scenario such that actual velocity, depth, and flow conditions occurring across the entire spawning and rearing areas including wetted shoals are documented.

Resource Management Goals

We seek to accomplish a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional diadromous fishes and aquatic habitat objectives for the basin.
2. Conserve, protect, and enhance aquatic habitats for diadromous fish species that continue to be affected by the Project.
3. Assist FERC to ensure that project operations are not likely to jeopardize the continued existence of shortnose sturgeon.

Specific to aquatic resources, our goals are to:

1. Protect, enhance, or restore diverse high quality aquatic and riparian habitats for diadromous species in the watershed and mitigate for loss or degradation of this riverine ecosystem.
2. Provide an instream flow regime in the bypass reach that meets the life history requirements of diadromous fish and federally listed shortnose sturgeon.
3. Minimize current and potential negative project operation effects on water quality and aquatic habitat.
4. Avoid or minimize the current negative effect of project operations on shortnose sturgeon spawning and rearing within the Montague spawning area (i.e. Rock Dam and Cabot Station spawning sites and associated early life stage rearing areas).

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to our mandates as identified in Section 4 above.

Public Interest

The requestor, NMFS, is a federal resource agency.

Existing Information and Need for Additional Information

Presently, FirstLight is required to release 1,433 cfs below the Project. Information included in the PAD does not provide a detailed description of how this minimum flow was established and we are not aware of any previously conducted studies that evaluated the adequacy of this minimum flow in protecting aquatic resources in the 10+ miles of riverine habitat below the Cabot Station. Therefore, an empirical study is needed to provide information on the relationship between flow and habitat in the Connecticut River downstream of the Cabot tailrace. We will use the results of this study to determine an appropriate flow recommendation.

Kieffer and Kynard (2012) examined the effects of water manipulation at the Turners Falls project on shortnose sturgeon spawning over the course of 17 years. This study represents the best available scientific information and does not support 1,433 cfs as an adequate minimum flow to support successful shortnose sturgeon spawning at Cabot Station. Peaking operations at Cabot Station cause discharge fluctuations to rapidly change bottom velocities from 0.4 m/s to 1.3 m/s over 30 minutes (Kieffer and Kynard 2012). Shortnose sturgeon have not evolved to adapt to such rapid changes in velocities and therefore, continue to spawn during fluctuations even though conditions may be unsuitable and likely result in high egg mortality. During the 10 years when spawning succeeded at Cabot Station, discharge flow decreased to less than 35,460 cfs by April 29th. The lowest discharge level observed while females remained on the spawning site was 4,700 cfs. Spawning behavior was not monitored during Cabot Station discharges at or below 3,500 cfs, so it is unclear what the minimum flow threshold is for spawning at Cabot Station. When peaking generation discharges ceased during naturally low flow years, the tailrace shoals, likely used by shortnose ELS for rearing, were exposed (observed during years ’95, ’98-99, ’04) and may have resulted in larva mortality due to stranding and exposure (Kieffer and Kynard 2012). Researchers observed that shoal exposure began when river flow below Cabot Station dropped below 7,062 cfs (Kynard and Kieffer 2007). Thus, total flow at Cabot, which may include flow from the Turners Falls Dam or Station 1, must be at least 7,062 cfs to both support adequate bottom velocities and prevent shoal exposure.

Furthermore, the emergency water control gates at Cabot Station used to sluice trash from the canal and balance canal flows spill large amounts of water. These large spill events create a plume of turbid, turbulent flow, causing some females to leave the area. These spill events scour bottom sediments which are then carried downstream over the spawning and rearing shoals where an entire year class of early life stages may be destroyed (Kieffer and Kynard 2012). Information included in the PAD does not address adequate flows for shortnose sturgeon spawning and rearing. Results of the requested modeling will be used by us to determine an appropriate flow recommendation for shortnose sturgeon.

Researchers have also looked at suitable depth and velocity habitat for shortnose sturgeon spawning (Kynard and Kieffer 1996, Kieffer and Kynard 2012). Spawning sites are characterized by moderate river flows with average bottom velocities between 0.4 and 0.8 m/s (Hall *et al.* 1991, Kieffer and Kynard 1996, NMFS 1998). Water depth at the spawning site appears to be a less important habitat feature than substrate type and flow. This information should be considered when modeling flow regimes that are sufficiently protective of shortnose sturgeon spawning and rearing. In addition, although eggs and embryos can likely tolerate very shallow depths, researchers measuring water depths between Turners Falls Dam and Cabot Station with the intention of recommending water depths suitable for shortnose sturgeon trapped in the Turners Falls Dam Plunge Pool recommend an escape route be used that is 1.5 times the maximum body depth. Because adults spawning in an artificial spawning channel frequently positioned themselves on top of one another (Kynard *et al.* 2012b), a minimum depth to facilitate spawning within the known Cabot Station spawning area is 3.0 body depths.

Project Nexus

The Turners Falls Project is currently operated with a minimum flow release that was not based on biological criteria or field study. Further, the project generates power in a peaking mode resulting in significant with-in day flow fluctuations between the minimum and project capacity on hourly or daily basis. The large and rapid changes in flow releases from hydropower dams are known to cause adverse effects on habitat and biota downstream of the project. Shortnose sturgeon larval migrants initially become bottom dwellers and transition from living off of yolk sacs to orally feeding, which is a critical stage in their life history. While the existing license does require a continuous flow of 1,433 cfs below the project (0.20 cubic feet per second flow per square mile of drainage area - cfsm), that is equal to only 40% of the Aquatic Base Flow.[1] This flow does not sufficiently protect the aquatic resources in this substantial reach of river,

[1] Aquatic Base Flow is a policy used by the USFWS for establishing minimum flows in the absence of site specific data. The Aquatic Base Flow equates to the August Median Flow as determined using unregulated hydrography or on drainage area at the project site (0.5 cfs per square mile of drainage area) if unregulated hydrography is unavailable.

especially in the context of the magnitude, frequency, and duration of changes in habitat that likely occur between minimum and generation flows.

Results of the flow study will be used to determine an appropriate flow recommendation that will protect and/or enhance the aquatic resources below the Project.

Proposed Methodology

In-stream flow habitat assessments are commonly employed in developing plant operational regimes that will reduce impacts or enhance habitat conditions downstream of hydroelectric projects.

Given the length of the river reach impacted by project operations (10+ miles), we believe a study methodology that utilizes an Instream Flow Incremental Methodology (IFIM) approach is appropriate for this site. This same protocol was used during the relicensing of the Housatonic River Project (FERC No. 2576)[2] and has been accepted by the Commission in other licensing proceedings.[3]

At a minimum, the study design should involve collecting wetted perimeter, depth, velocity, and substrate data along transects located in the reach of river below Cabot Station. The measurements should be taken over a range of test flows. This information then should be synthesized to quantify habitat suitability (using mutually agreed upon habitat suitability index curves) of each test flow for target species identified by the fisheries agencies. Habitat modeling using standard PHABSIM 1 dimensional modeling is acceptable for the river channel downstream from the railroad bridge below the mouth of the Deerfield River. The area from the Cabot Station discharge to the railroad bridge should be modeled using 2 dimensional (2D) modeling to better characterize flows and velocities in this complex channel area.

Data collected with this study must be sufficient to perform a dual-flow analysis and habitat time series or similar approaches to assess how quality and location of habitat for target species changes over a range of flows between existing minimum flow and maximum Project generation flows.

Level of Effort and Cost

Field work for instream flow studies can be reasonably extensive but will depend on consultation with the applicant on study methodology and on-site decisions on locations for data collection and the number of collection locations. Post-fieldwork data analysis would be a moderate cost and effort. We anticipate that the level of effort and costs will be comparable to that experienced on similar FERC relicensing projects of this size (e.g., the Conowingo Project, FERC No. 405).

FirstLight has not proposed an alternate study.

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[2] Housatonic River Project License Application, Volume 4, Appendix F. Connecticut Light and Power Company, August 1999.

[3] Glendale Project (FERC No. 2801) Final Bypass Reach Aquatic Habitat and Instream Flow Study in Glendale Hydroelectric Project Application for Subsequent License (FERC No. 2801), Volume 2, Appendix B, pages 7-8, October 2007.

6.3 Requested Study #3: In-stream flow habitat assessment of the Turners Falls Bypass Reach

We recommend the applicant conduct an instream flow habitat study to assess the impacts of the range of the proposed project discharges on the wetted area and optimal habitat for key species. The study should include non-steady flow approaches to assess effects of within-day flow fluctuations due to peaking power operations on target fish species including, federally endangered shortnose sturgeon, American shad, American eel, sea lamprey, and benthic invertebrate communities.

Goals and Objectives

The goal of this study is to determine an appropriate flow regime that will protect and enhance the aquatic resources from the bypassed reach between Turners Falls Dam and the Cabot Station discharge. The objective of the study is to conduct an instream flow habitat study to assess the impacts of the range of the proposed project discharges on the wetted area and optimal habitat for key species.

Target fish species

Resource Management Goals

We seek the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional diadromous fishes and aquatic habitat objectives for the basin.
2. Conserve, protect, and enhance aquatic habitats for diadromous fish species that continue to be affected by the Project.
3. Ensure that project operations are not likely to jeopardize the continued existence of shortnose sturgeon.

Specific to aquatic resources within the Turners Falls bypass reach, our goals are:

1. Protect, enhance, or restore diverse high quality aquatic and riparian habitats for diadromous species in the watershed and mitigate for loss or degradation of this riverine ecosystem.
2. Provide a flow regime in the bypass reach that meets the life history requirements of diadromous fish and federally listed shortnose sturgeon.
3. Avoid and/or minimize the current negative effects of project operations on shortnose sturgeon spawning and rearing within known spawning areas of the bypass reach (i.e., the Rock Dam).
4. Minimize current and potential negative project operation effects on water quality and aquatic habitat.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to our mandates as identified in Section 4 above.

Public Interest

The requestor, NMFS, is a federal resource agency.

Existing Information and Need for Additional Information

The Turners Falls Project bypasses a 2.7 mile-long section of the Connecticut River. Presently the only required spill releases from the Turners Falls dam to the bypass reach are 400 cfs from May 1 through July 15 and 120 cfs from July 16 until the river temperature reaches 7°C.

In addition to these flows provided at the Turners Falls Dam, the bypass reach receives flow from one small tributary (the Fall River, drainage area of 34.2 square miles), which enters the mainstem approximately 0.16 miles below the dam. The bypass reach also receives the discharge from Station 1, when it is generating (typically when there is flow in excess of Cabot Station's needs). This discharge enters the bypass reach approximately 0.9 miles below the dam.

Available information in the PAD does not indicate how project operations have altered downstream hydrology, habitat quantity and quality, and water quality, which may affect diadromous species and federally endangered shortnose sturgeon as well as natural processes in the Connecticut River from below the Turners Falls Dam downstream to the Cabot Station discharge. The PAD also provides no detailed description of the physical or biological characteristics of the bypass reach.

Little information exists on the adequacy of the existing bypass flow regime to protect water quality and aquatic life. However, there is existing information (not included in the PAD) relative to minimum flows necessary for shortnose sturgeon spawning and rearing at the Rock Dam spawning site (Kynard *et al.* 2012). Spawning success was observed at Rock Dam when discharge was between 2,500 cfs and 22,000 cfs during the spawning period of April 27th to May 22nd (Kieffer and Kynard 2012). In 1995 at the Cabot spawning area, the greatest level of spawning and spawning success occurred (i.e., 21 late stage females present, 342 ELS captured, and the longest spawning period of 17 days) even though no spawning was detected at Rock Dam (Kieffer and Kynard 2012). Discharges in 1995 at Rock dam had dropped below 2,500 cfs by March 26th (Kieffer and Kynard 2012), which may indicate the need to have mitigated flow well in advance of spawning. Flow reductions at the Rock Dam site that occurred during spawning caused females to leave the spawning site and not return even if flow later increased to acceptable levels. Researchers observed that rubble substrates remained dominant during fluctuating flows and cessation of spawning is likely due to velocities falling outside the range preferred by females. Given the current flow dynamics at Rock Dam, spawning does not occur most years (Kieffer and Kynard 2012). These data represent the best available scientific information and indicate that current minimum flow thresholds at the Turners Falls project are not sufficiently protective of shortnose sturgeon spawning and rearing.

An empirical study is needed to provide information on the relationship between flow and habitat in the bypass reach for us to use in determining a flow recommendation.

Project Nexus

The Turners Falls Project includes a 2.7 mile-long bypass reach. The Project is currently operated with a seasonally-varying minimum bypass flow (200 cfs starting on May 1, increasing to 400 cfs when fish passage starts through to July 15, then reduced down to 120 cfs until river temperature drops below 7°C). The 400 cfs release is primarily to facilitate upstream movement of anadromous migrants to the spillway fish ladder at Turners Falls and the 120 cfs was intended to provide protection to shortnose sturgeon by maintaining a wetted habitat of 1.5 x maximum adult body depth through connections between pools within the bypass reach. Neither of the currently required flows were based on quantitative, rigorous scientific studies.

This section of the Connecticut River contains habitat that supports spawning and rearing habitat for the federally endangered shortnose sturgeon. While the existing license does require seasonally-varying flow releases from the Turners Falls dam, the best available data indicates these flows are insufficient to protect shortnose sturgeon habitat and other aquatic resources within the bypass reach based upon observed spawning behavior at Rock Dam.

Results of the flow study will be used to determine an appropriate flow recommendation that will protect and/or enhance diadromous species and federally endangered shortnose sturgeon in the bypass reach for the duration of any new license issued by the Commission.

Proposed methodology

Bypass flow habitat assessments are commonly employed in developing flow release protocols to reduce impacts or enhance habitat conditions in reaches of river bypassed by hydroelectric projects.

Given the size of the bypass reach (2.7 miles long) and the important resources known to inhabit the reach, we believe a study methodology that uses an IFIM approach is appropriate for this site. This same protocol was used during the relicensing of the Housatonic River Project (FERC No. 2576)[4] and the Commission has accepted this protocol in other licensing proceedings[5].

At a minimum, the study design should involve collecting wetted perimeter, depth, velocity, and substrate data within a range of discharge levels along transects located in the reach of river between the dam and the Cabot Station discharge. The measurements should be taken over a range of test flows up to 6,300 cfs or over a sufficient range of flows to model flows up to 6,300 cfs. This information then should be synthesized to quantify habitat suitability (using mutually agreed upon HSI curves) of each test flow for target species/life stages identified by the fisheries agencies. Habitat modeling using standard PHABSIM 1 dimensional modeling is acceptable for the bypass reach from the area downstream of the spillway where the river channel constricts to Rawson Island upstream from the Rock Dam. The area from Rawson Island to the Cabot station discharge should be modeled using 2D modeling to better characterize flows and velocities in this complex channel area. Likewise, we recommend 2D modeling in the spillway area and mouth of the Falls River to the point where the channel constricts given this complex area with numerous potential flow discharge locations.

The flow study should incorporate the identified minimum flow and temporal parameters for shortnose sturgeon discussed in the Background and Existing Information section of this request.

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[4] Housatonic River Project License Application, Volume 4, Appendix F. Connecticut Light and Power Company, August 1999.

[5] Glendale Project (FERC No. 2801) Final Bypass Reach Aquatic Habitat and Instream Flow Study in Glendale Hydroelectric Project Application for Subsequent License (FERC No. 2801), Volume 2, Appendix B, pages 7-8, October 2007.

Level of Effort and Cost

Field work for flow studies can be reasonably extensive but will depend on consultation with the applicant on study methodology and on-site decisions on locations for data collection and the number of collection locations. Post-fieldwork data analysis would be a moderate cost and effort. Field work associated with this study could be done in conjunction with the below-project instream flow study request, Study #2. We anticipate that the level of effort and costs will be comparable to that experienced on similar FERC relicensing projects (e.g., the Glendale Project, FERC No. 2801). FirstLight has not proposed an alternate study.

6.4 Requested Study #4: Evaluate the frequency and impact of: 1) emergency water control gate discharge events; and 2) bypass flume spill events on shortnose sturgeon spawning and rearing habitat in the tailrace and downstream from Cabot Station

This evaluation should directly address the impact of sediment disturbance and excessive velocities on habitat in Cabot Station tailrace and downstream resulting from emergency water control gate discharge events and bypass spill events and effects of spill from the downstream fish bypass sluice on shortnose sturgeon spawning and incubation.

Goals and Objectives

The goal of this study is to determine appropriate scenarios for operation of the emergency water control gates and bypass flume that will be sufficiently protective of shortnose spawning and rearing below Cabot Station from excessive water velocities and exposure to abrasive sediments dislodged and transported across spawning and rearing areas. Furthermore, evaluating the potential for operation modifications to avoid or minimize rapid fluctuations in flow is also a goal of this study applicable to the operations of the emergency water control gates and bypass flume.

The objectives of the study are to: 1) determine how often the emergency water control gates are operated to discharge large quantities of water and evaluate the impact of these events on sediment transport and bottom velocities within known shortnose sturgeon spawning and rearing habitat below Cabot Station and 2) understand the operation of the bypass flume that results in bypass flume spill events and evaluate the impacts of these spill events on sediment transport and bottom velocities within known shortnose sturgeon spawning and rearing habitat below Cabot station. Even when bottom velocities fall within the range optimum for shortnose sturgeon spawning, rapid fluctuations may result in sediment transport having a harmful impact on developing eggs and embryos.

Specific Objectives include:

1. Field verification of site conditions during operation of the emergency water control gates for a range of spill and discharge conditions is necessary during years 2014 and 2015 if emergency water control gates will continue to be operated during shortnose sturgeon spawning and rearing (April 15th –June 22nd). Collection of sedimentation and bottom velocity data during 2014 and 2015 is necessary to verify proposed alternative operation scenarios for the emergency water control gates that will avoid or minimize negative impacts to spawning and rearing habitat.
2. Field verification during bypass flume spill events under a range of spill and discharge conditions is necessary during years 2014 and 2015 if bypass flume spill events continue to

be a part of future project operations and will occur during shortnose sturgeon spawning and rearing (April 15th - June 22nd).

Collection of sedimentation and bottom velocity data during 2014 and 2015 is necessary to verify proposed alternative operation scenarios for the bypass flume that will avoid or minimize negative impacts to spawning and rearing habitat.

Resource Management Goals

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to our mandates as identified in Section 4 above. We seek to understand current emergency water control gate bypass flume operations and associated impacts to determine potential operation scenarios that avoid or minimize negative effects on shortnose sturgeon spawning a rearing.

Public Interest

The requestor, NMFS, is a federal resource agency.

Existing Information and Need for Additional Information

The emergency water control gates are used to spill large amounts of water. In addition, Cabot Station also spills water from the bypass flume (Kieffer and Kynard 2007, Kieffer and Kynard 2012). It has been observed that these large spill events create a plume of turbid, turbulent flow, which caused some females to leave the area (Kieffer and Kynard 2007, Kieffer and Kynard 2012). Additional spill events create a scour effect on the bottom and the scoured sediments are then pushed downstream over, or deposited on spawning and rearing shoals where an entire years class of ELS may be destroyed (Kieffer and Kynard 2007, Kieffer and Kynard 2012). Information included in the PAD does not address operation of the emergency water control gates or bypass flume and impacts on shortnose sturgeon spawning and rearing.

Project Nexus

The large and rapid changes in flow releases from hydropower dams are known to cause adverse effects on habitat and biota downstream of the project. Based on best available data, the current operations of the emergency water control gates and bypass flume create flow dynamics that are not sufficiently protective of shortnose sturgeon spawning and rearing. Results of this study will be used to determine recommendations for operation of the emergency water control gates and bypass flume that will avoid or minimize sedimentation and maintain bottom velocities that are sufficiently protective of shortnose sturgeon spawning and rearing.

Proposed Methodology

River hydrology modeling is commonly employed at hydroelectric projects to assess implications of project operations on the river environment. It is assumed that the planned hydrologic modeling can incorporate emergency water control gate operations and associated impacts. Thus, an additional model would not be required for this request.

Field assessment will be needed to collect sedimentation and bottom velocity data at the emergency water control gates and fish bypass sluice discharge areas to determine which operational scenarios avoid or minimize impacts to shortnose sturgeon spawning and rearing.

Velocity gauges would be employed to collect data on bottom velocities associated with project operations at Cabot Station. Coordination of gauge placement for this request with the field measurements for the instream flow study should help minimize the number of necessary gauges. Field assessment of sedimentation may be collected using a variety of techniques. On e potential method of collection of sedimentation data would be to set fine-mesh nets similar to shortnose sturgeon larval collection nets. These nets may show changes in the amount of dislodged substrate material that travels along the spawning site as a result of powerful releases at both the Cabot spillway and bypass flume.

Level of Effort and Cost

Field verification for this study request will likely be coordinated with other field work for related study requests. It is not expected that the required field work for this request will result in significant additional cost and effort beyond what is expected for field work related to the instream flow study request. Post-fieldwork data analysis would be a moderate cost and effort. We anticipate that the level of effort and costs will be comparable to that experienced on similar FERC relicensing projects of this size (e.g., the Conowingo Project, FERC No. 405).

FirstLight has not proposed an alternate study.

6.5 Requested Study #5: Impact of project operations on shad spawning, spawning habitat, and egg deposition in the Turners Falls and Northfield Mountain Project Area

Flows within the Connecticut River can change rapidly due to FirstLight's operations, as well as the operations of upstream projects. The U.S. Geological Survey has developed unimpacted flow estimates for the Connecticut River and several tributaries and it is clear that mainstem river flows differ from these estimates (Archfield, 2012). Given these changes in flow, it is unclear how these impacts affect spawning behavior and what the impacts are to eggs that have been deposited.

Goals and Objectives

A goal of this study would be to determine if project operations (under the permitted and proposed operational ranges) negatively impact American shad spawning site use, behavior and availability, spawning habitat quantity and quality, and spawning activity in the river reaches downstream from Cabot Station and in the project bypass reach of Turners Falls Dam, in the Turners Falls Dam impoundment and in relation to Northfield Mountain Pump Storage operations. The study would also determine the areal extent and quality of identified spawning areas, and spawning activity in terms of egg deposition in those areas.

The following objectives will address this request:

1. Determine areas utilized by American shad for spawning by conducting night-time visual observation of spawning activity, identify and define areas geospatially, and obtain data on physical habitat conditions affected by project operations (e.g., water depth, velocity, discharge, substrate, exposure and inundation of habitats).
2. Determine project operation effects on observed spawning activity, under a range of permitted or proposed project operation conditions.

3. Quantify effects (e.g., water velocity, depths, inundation, exposure of habitats) of project operation on identified spawning areas for a range of conditions, over the complete period of spawning activity.
4. Quantify spawning activity as measured by night-time spawning/splash surveys and egg collection in areas of spawning activity, and downstream of these areas, to further determine project operation effects (location extent of exposure from changing water levels and flows and on associated habitats from project operations).
5. If it is determined that Project operations adversely affect the spawning activity of American shad and impact spawning area habitat, identify operational regimes that will reduce and minimize impacts spawning habitat and spawning success, within the project area.

This study will require two years of field data to capture inter-annual variability to river discharge and water temperatures and to allow for evaluation of alternative flow regimes if year one studies determine that the present peaking regime negatively affects spawning.

Resource Management Goals

The CRASC developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following:

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.
2. Achieve annual passage of 40% to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem.

The ASMFC, Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010 includes the objective maximizing the number of juvenile recruits emigrating from freshwater stock complexes. The plan further recommends:

1. To mitigate hydrological changes from dams, consider operational changes such as turbine venting, aerating reservoirs upstream of hydroelectric plants, aerating flows downstream, and adjusting in-stream flows.
2. Natural river discharge should be taken into account when instream flow alterations are being made to a river (flow regulation) because river flow plays an important role in the migration of diadromous fish.
3. Ensure that decisions on river flow allocation (e.g., irrigation, evaporative loss, out of basin water transport, hydroelectric operations) take into account instream flow needs for American shad migration, spawning, and nursery use, and minimize deviation from natural flow regimes.
4. When considering options for restoring alosine habitat, include study of impacts and possible alteration of dam-related operations to enhance river habitat.

We seek the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. Our goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.

2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.
3. Minimize current and potential negative project operation effects on American shad spawning and recruitment.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to our mandates as identified in Section 4 above.

Public Interest

The requestor, NMFS, is a federal resource agency.

Existing Information and Need for Additional Information

Since the construction of the first fish lift facility at Holyoke Dam in 1967, American shad have had access to spawning and rearing habitat upstream to the Turners Falls Dam. A number of improvements to the Holyoke fishway have occurred since that time, but while the numbers of shad lifted at Holyoke have reached as much as 721,764 and the overall shad population to the river exceeded 1.6 million shad in 1992 (CRASC 1992), total shad population, and numbers of shad passing Turners Falls and Vernon Dam have not met CRASC management plan objectives. Population number and passage numbers past Holyoke have declined substantially from those totals in recent years, with average Holyoke passage numbers over the last 10 years of 211,850. Since approximately half the population of shad returning to the river passed upstream of Holyoke, recent returns are far below management goals. Effective upstream and downstream passage and successful in-river spawning and juvenile production are necessary to help achieve shad management goals for the Connecticut River.

American shad broadcast spawn in congregations over shallow flats and rocky or sandy substrates (Davis et al, 1970, Mansuetti and Kolb 1953), at depths less than 10 feet and often far shallower with spawning fish swimming vigorously near the surface in a closely packed circle (Marcy 1972, Mackenzie et al 1985). Fertilized eggs drift downstream until hatching (Mackenzie et al 1985).

American shad are known to spawn downstream from the Turners Falls Project. Layzer (1974) identified 6 spawning sites from an area below the mouth of the Deerfield River (river mile 191.9) to river mile 161.7 below the Mill River in Hatfield, MA. Kuzmeskus (1977) verified 16 different spawning sites ranging from downstream of the Cabot tailrace to just upstream of the Holyoke dam (river mile 87.1). The only parameter that all spawning sites had in common was current (Kuzmeskus 1977). We are not aware of any more recent studies that document whether these 16 sites are still viable spawning locations for shad. We are not aware of any studies that have determined American shad spawning habitat or spawning sites upstream of Vernon Dam to Bellows Fall Dam (historic extent of upstream range).

FirstLight Power conducted studies in the late spring and summer of 2012, examined habitat conditions downstream of the Turners Falls Dam. The study documented that in low flow conditions. Cabot Station project operations produced fluctuations in water level elevations that can range over 4 feet in magnitude (daily operation) at the USGS Montague Gage Station, to lower values of 2 to 3 feet at the Route 116 Bridge, Sunderland, MA (PAD). Similar short-term, limited monitoring in the upper Turners Falls Dam impoundment identified water level changes due to project operations that d cyclically varied several feet on a sub-daily frequency.

Project Nexus

American shad are known to spawn at five locations downstream from the Turners Falls Project from an area below the mouth of the Deerfield River (river mile 191.9) and ten other locations downstream to river mile 161.7 below the Mill River in Hatfield (Layzer 1974, Kuzmeskus 1977).

Shad spawning is likely influenced by river flow, which fluctuates greatly due to the project's peaking mode of operation. These fluctuations may impact shad spawning activity by altering current velocities and water depth at the spawning sites. Effects on spawning behavior could include suspension of spawning activity, poor fertilization, flushing of eggs into unsuitable habitat due to higher peaking discharges, eggs dropping out into unsuitable substrate and being covered by sediment deposition and/or eggs becoming stranded on dewatered shoal areas as peak flows subside.

While a number of shad spawning and egg deposition studies were conducted in the 1970s, that research was aimed at assessing the potential impact of developing a nuclear power station in the Montague Plains section of the Connecticut River. We are not aware of any studies being conducted specifically designed to determine if a relationship between spawning behavior, habitat use, and egg deposition and project operations effects of the Turners Falls, Northfield Mountain Pump Storage and Vernon projects and downstream of Bellows Falls Dam.

We are concerned that peaking operations may be altering spawning behavior and contributing to the failure of the Connecticut River shad population to meet management targets.

Proposed Methodology

The first year of study should examine known spawning areas downstream of the Turners Falls Dam project, to determine operation effects on shad spawning behavior, activity, and success. In areas upstream of Turners Falls Dam the study should identify areas used for spawning by American shad. In the second year, should results from year one determine project operations affected spawning activity, access to habitat, or success, downstream of Turners Falls Dam, then an identical more detailed assessment (identified objectives) should be conducted in spawning areas upstream of Turners Falls Dam. Measures to reduce or eliminate any documented project operation impacts should be explored and evaluated in year two, downstream of Turners Falls Dam.

The impacts to spawning behavior would best be studied by night-time observations of actual in-river spawning behavior (Ross *et al.* 1993). Project discharge increases or decreases during actual observed spawning activity will provide empirical evidence of change in behaviors. We recommend observational methodology following the protocol specified in Layzer (1974) and/or as described in Ross *et al.* (1993). The analysis should use the observational field data in conjunction with operational data from the projects (station generation and spill on a sub-hourly basis). To assess the impacts of changes in generation flows, the study should include scheduled changes in project operation to ensure that routine generation changes that occur during the nighttime spawning period affect downstream spawning habitats selected for study while shad are spawning. Stier and Crance (1985) provide optimal water velocities during spawning to range between 1 to 3 ft/sec.

In areas used for spawning, the characteristics of those areas (e.g., location, depth, flow, substrate) should be recorded. The effect of project operations (discharge, water velocity, inundation and exposure) should be assessed. Drift nets should be used to collect eggs to quantify egg production before and after flow changes at the spawning site.

In the reaches above the Turners Falls dam, night time observations of splashing associated with shad spawning should be done in each reach as sufficient numbers of shad are passed above each dam. Observations should be done regularly until the end of the spawning season. The use of radio-tagged adult shad from Requested Study #7 would aid in this effort. An estimate of the total area used for spawning and an index of spawning activity should be recorded for each site.

Level of Effort and Cost

FirstLight did not propose any studies to meet this need. Estimated cost for the study is expected to be low to moderate for FirstLight, with the majority of costs associated with fieldwork labor.

FirstLight has not proposed an alternate study.

6.6 Requested Study #6: Impacts of Turners Falls canal drawdown on fish migration and populations

Currently FirstLight conducts a drawdown of the power canal for maintenance purposes. We have concerns about the time of year that this activity occurs as well as its duration based on what trust species could be present in the canal at the time of this procedure. We have received anecdotal reports of fish kills during this procedure. A well-documented study of impacts to trust species would allow us to investigate possible timing alternatives to this procedure.

Goals and Objectives

The goal of this study is to determine the impact and levels of mortality on migratory fish during the drawdown of the power canal.

Objectives of this study request include:

1. Assess the impact on juvenile American shad, adult American eel (migrants), and sea lamprey ammocetes when conducting the annual canal drawdown.
2. Evaluate measures to minimize impacts of the canal drawdown.

Resource Management Goals

The CRASC management objectives for shad includes the following:

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.
2. Maximize outmigrant survival for juvenile and spent adult shad.

The ASFMC has the stated goal of "*Protect, enhance, and restore Atlantic coast migratory stocks and critical habitat of American shad in order to achieve levels of spawning stock biomass that are sustainable, can produce a harvestable surplus, and are robust enough to withstand unforeseen threats.*" The Atlantic States Marine Fisheries Commission, Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010 includes the objective maximizing the number of juvenile recruits emigrating from freshwater stock complexes. The plan further recommends:

1. To enhance survival at dams during emigration, evaluate survival of post spawning and juvenile fish passed via each route (e.g., turbines, spillage, bypass facilities, or a combination of the three) at any given facility, and implement measures to pass fish via the route with the best survival rate .

We seek the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. Our goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.
3. Minimize current and potential negative project operation effects on diadromous fishes, including juvenile shad, adult silver eels, and sea lamprey ammocetes.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to our mandates as identified in Section 4 above.

Public Interest

The requestor, NMFS, is a federal resource agency.

Existing Information and Need for Additional Information

Existing information in the PAD does not provide data on the population size or survival rates of juvenile American shad, American eels, or juvenile sea lamprey located in the power canal during the de-watering process. The power canal is dewatered in early September of each year over a one week period to perform facility maintenance, inspections, and repairs including substantial silt removal and bank repairs. Historically, the canal drawdown occurred in July, but approximately five years ago it was moved to September, where it has occurred annually since then, with the exception of 2010. The agencies were informed in a letter by FLP that the shift to September was at the request of the Independent System Operator –New England (ISO-NE) to avoid peak load months of June through August. Studies conducted by the previous operator, NUSCO, to assess downstream clupeid survival and use (1991 and 1994 studies at Cabot Station) support the contention that juvenile shad out-migration is occurring within the current drawdown time frame. There are no data to suggest that out-migration would occur earlier than 1 August, but likely does begin in the month of August ((O'Donnell & Letcher, 2008). Based on these data, CRASC altered its Fish Passage Notification Letter for Downstream Passage Operations for juvenile shad and herring after the 2010 migration season to require the Cabot Station downstream bypass to operate August 15 and to August 1.

It is unknown, whether the power canal may, through a potential mechanism of delay, cause out-migrating juvenile shad to accumulate in the canal. This information gap leads to concerns that migrant numbers may be elevated beyond simple extrapolations of surface area comparison in the canal to main stem habitat. The existing near-surface downstream bypass structure at the Cabot Station is designed to operate within a depth of 6 feet of the surface, with the maximum depth of a 60 feet noted in the PAD for this area in the Cabot Station forebay. As a result, the downstream bypass only operates effectively for a short period during the drawdown period (timing of this is unknown). The only points of egress, once the bypass becomes unavailable are through the turbines at Cabot as well as at Station 1, and eventually at the Keith Street gate. It is unknown what the survival rates are for these passage routes, what proportion of fish are using each route, what number may become stranded and their survival rates, and how many fish are subjected to this situation. The related Study Requests #8 and 10 on Downstream Juvenile Shad Outmigration and American Eel Outmigration, respectively, outline research that would answer some of these questions.

There is also a paucity of information relative to the disposition of fish moving downstream in the impoundment during the canal drawdown. Upon the Turners Falls gatehouse closing its gates, all inflow passes over the dam. Survival rates for out migrating juvenile American shad and adult American eel moving past the project during the period of spill are not known.

Lastly, there exists an information gap regarding the fate of juvenile sea-lamprey (known as ammocetes) that reside in the soft substrate materials located in much of the lower or downstream end of the canal (personal communication, Boyd Kynard, BK Riverfish LLC). In previous drawdowns, thousands to tens of thousands of dessicated ammocetes have been observed (Matt O'Donnell, USGS, personal communication). However, the distribution and abundance of ammocetes in the canal as well as survival rates for ammocetes during the drawdown period has not been quantitatively studied but anecdotally noted and observed by agency personnel making observations during the drawdown.

Project Nexus

Previous studies at Cabot Station have documented that juvenile American shad and American eel migrate through the project area during the canal drawdown period. During normal operations, downstream migrants are able to use the Cabot bypass facility; however, as the canal water level is drawn down, the bypass is no longer available, and the only routes of egress are through the turbines at Cabot Station and Station 1, unless the Cabot Station spill gates are utilized (have a canal depth limitation approximately 16 feet). Turbine entrainment at hydropower projects has been shown to cause injury and mortality to fishes.

The canal drawdown used to be conducted in July. While ISO-NE requested that FirstLight conduct the drawdown outside of the June through August period, FirstLight chose to move it to a period of time when diadromous fishes are known to be moving through the project area.

Once the canal has been drawn down, isolated shallow pools are left standing until the canal is refilled. During this days-long period, aquatic invertebrates and lamprey ammocetes are prone to desiccation and predation.

Proposed Methodology

The methods presented here are consistent with Requested Studies #8 and #10, addressing downstream juvenile American shad passage and downstream American eel passage, with an emphasis on addressing survival and movement immediately prior to and during the canal draw down. Hydroacoustic monitoring immediately upstream of the Turners Falls Gatehouse as well as upstream of opened dam gates for spill, will provide data on the timing, frequency and magnitude of natural wild juvenile shad movement into these areas. Juvenile shad moving into the canal can be derived and compared with similar data obtained with hydroacoustic equipment monitoring upstream of the Cabot Station intake and bypass. Radio tagged and Passive Integrated Transponder (PIT) tagged shad will be tagged, released, and monitored in the canal, for movements, timing and location including Station 1 canal and forebay. PIT tagged fish will be detected at the Cabot Bypass Sluice. Radio tagged juvenile fish should be specifically targeted for released immediately prior to drawdown to assess survival and movement in and through the canal. Balloon tagged juveniles may be used to assess survival through turbine (Cabot and Station1) and gate routes (at dam and gates off of canal). Surveys of sea lamprey ammocetes may be conducted by a stratified sampling design based upon course substrate assignment filter. Lamprey densities surveys, using possibly backpack electrofishers, immediately after drawdown and in a subsequent later survey, could attempt to assess changes in observed densities, appropriate methods would need to be discussed. Surveys of remaining ponded water should be conducted immediately following drawdown and later to compare if densities increase, which may suggest movement to available water.

The canal drawdown mitigation assessment involves evaluating alternative drawdown protocols to minimize impacts to resident and migratory fish inhabiting the canal. Alternatives should include: (1) moving the drawdown to a time of year outside of migration seasons; (2) keeping or moving the timing of the drawdown, but utilize technologies to keep the majority of the canal wetted during the drawdown (e.g., portadams in the forebay immediately upstream of the trashracks); and (3) in combination with alternative #2, assess whether other existing infrastructure within the forebay could be used to pass fish safely out of the canal (e.g., low level outlets, deep gates, side spillway boards, etc.). The assessment should compare the merits and drawbacks of each alternative and provide an order of magnitude cost estimate for implementation.

Level of Effort and Cost

This Study Request has many elements that overlap directly with a larger scale study requests #8 and 10 for Downstream Juvenile American shad and Downstream American Eel, respectively. With equipment costs principally covered in those requests, many components of what has already been proposed will be used in this study. However this request does include some specific elements not specified in the other two larger requests, cost and effort are expected to be low to moderate. Some additional radio tags and balloon tags with additive days of field work to accurately assess impacts specific to the drawdown period will be required. Surveys for juvenile sea lamprey and will take several days during the drawdown period as well.

The canal drawdown mitigation assessment should require a low to moderate level of effort and cost. One staff person would evaluate alternative drawdown protocols. This should take less than one week to complete.

FirstLight has not proposed an alternate study.

6.7 Requested Study #7: Telemetry study of upstream and downstream migrating American shad to assess passage routes, effectiveness, delays, and survival

The tracking of migratory fish provides valuable information that fishery biologists use to better manage the species. Telemetry studies have been used for many years and the analyses conducted from these studies have been used to improve upstream and downstream passage conditions. Given the complexities in flow conditions and project operations that occur at the FirstLight projects and at projects further upstream in the watershed, the tracking of fish via telemetry studies is a very important requested study for us.

Goals and Objectives

The goals of this study are to assess behavior, approach routes, passage success, survival, and delay by adult American shad as they encounter the projects during both upstream and downstream migrations, under permitted project operations conditions, proposed operational conditions, and study treatment operational conditions at FirstLight Power's Turners Falls and Northfield Mountain Pumped Storage projects. There are multiple ladders and issues related to both upstream and downstream passage success at the projects. Some of these issues at the Turners Falls Project are similar to and/or pertain directly to the Northfield Mountain. Therefore, it is reasonable to address passage issues at all projects in a similar manner. The following objectives shall be addressed in these studies:

1. Assessment of any migration delays resulting from the presence of the dam and peaking flow operations of the Turners Falls Project.
2. Determine route selection and behavior of upstream migrating shad at the Turners Falls Project under various spill flow levels (e.g., movement to the dam, attraction to Cabot Station, attraction to Station 1 discharge, movement between locations, delay, timing, etc.). A plan and schedule for dam spill flow releases will need to be developed that provides sufficient periods of spill flow conditions, and various generating levels from Turners #1 Station coupled with Cabot Station generation flows (e.g., treatments will require multiple days of consistent discharge). Evaluated spill flows should include flows between 2,500 – 6,300 cfs, which relate to bypass flows identified as providing spawning opportunities for shortnose sturgeon in the lower bypass reach at the Rock Dam. (Kieffer and Kynard 2012). Sturgeon spawning and upstream shad passage occur concurrently;
3. Assess near field, attraction to and entrance efficiency of the Spillway Fishway by shad reaching the dam spillway, under a range of spill conditions;
4. Evaluate the internal efficiency of the Turners Falls Spillway Fishway;
5. Continue data collection of Cabot Station Fishway and Gatehouse Fishway efficiency, to include rates of approach to fishway entrances, entry into fishways, and passage through them, under different operational conditions that occur in these areas;
6. Assess upstream migration from Turners Falls to the Vernon Dam in relation to Northfield Mountain's pumping and generating operations and Vernon Project peaking generation operations. Typical existing and proposed project operation alterations should be evaluated;
7. Assess impacts of Northfield Mountain operations on up- and downstream adult shad migration, including delays, entrainment, and behavioral changes and migration direction shifts under existing and proposed project operations;
8. Determine downstream passage route selection, timing/delay, and survival under varied project operational flows into the power canal and spill flows at Turners Falls Dam;
9. Determine downstream passage route selection, timing/delay in the canal, Cabot Station fish bypass facility effectiveness, and survival of Cabot-bypassed adult shad that enter the Turners Falls Canal system;
10. Compare rates and or measures of delay, movement and survival etc., among project areas or routes utilized (e.g., spill at dam vs. power canal) under the range of permitted and proposed conditions; and

11. Use available data sets and further analyze raw data (e.g., 2003- 2012 Conte Lab Studies) where possible to address these questions and inform power analyses and experimental design.

Information to address all of these questions would rely on the tagging of upstream migrating adult shad at Holyoke Dam and releasing them to migrate naturally from Holyoke through the Turners Falls and Vernon projects and back downstream after spawning. Additional tagged individuals would likely need to be released farther upstream (Turners Falls Canal, and upstream of Turners Falls Dam) to ensure that enough tagged individuals encounter project dams on both upstream and downstream migrations, that these individuals are exposed to a sufficient range of turbine and operational conditions to test for project effects, and to provide adequate sample sizes for statistically valid data analyses to address the many objectives listed. This study will require two years of field data collection to attempt to account for inter-annual variability in river discharge and water temperatures.

In addition to collection and analysis of new telemetry data, substantial data has already been collected at Turners Falls from multiple years of passage assessments conducted for FirstLight by U.S. Geological Survey's Conte Anadromous Fish Research Center (Conte Lab) researchers. There are also data from the 2011 and 2012 full river study conducted by the Conte Lab that address Turners Falls and Northfield Mountain migration and passage questions that have not yet been analyzed. These data include several million records each year from more than 30 radio telemetry receivers deployed between Middletown, CT and Vernon Dam. This data will provide substantial information free from the field data collection costs and therefore should be analyzed as part of this study. This data analysis should be completed in 2013 to help inform the design of subsequent field studies.

The poor passage efficiency of the Cabot Fishway, the first and most used ladder encountered by shad arriving at the Turners Falls Project, and at the entrance to the Gatehouse Fishway, which all Cabot Fishway-passed fish must use, has resulted in very poor overall shad passage efficiency at the project. An alternative to passing fish at the Cabot Station is to install a fish lift at the dam that would put fish directly into the Turners Falls pool, thereby eliminating problems with the Cabot Fishway, and the Gatehouse Fishway entrance and the variable passage efficiency of the Gatehouse Fishway. For this to be effective, attraction of shad to the Cabot Station discharge and associated delays would need to be overcome. It is possible that spillway flow releases coupled with behavioral measures at Cabot Station that dissuade shad from that tailrace could achieve this end. To assess the possibilities, we recommend the following study be included within the scope of this study request:

1. A literature search and desk-top assessment of the possible behavioral measures that could be effective in getting shad to pass Cabot Station tailrace and continue upstream to the dam.
2. Based on results of the desk-top assessment, possible evaluation of behavioral measures that are likely to be effective.
3. Field evaluation of the effect of different levels of spill at the dam that would induce fish to move past the Cabot Station into the bypass reach and up to the dam (as noted in objectives).

Besides passage success and delays at passage facilities, these studies would assess the impacts of project operations on migration passage delay, route, timing, injury, mortality, and passage structure attraction, retention, and success. Of particular interest will be fish behavior during periods when flow releases from the project increase from the required minimum flows to peak generation flows and when flows subside from peak generation flows to minimum flows and the operation of NMPS in pumping and generation modes.

Resource Management Goals

The CRASC developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.
2. Achieve annual passage of 40 to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem.
3. Maximize outmigrant survival for juvenile and spent adult shad.

The ASMFC, Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010 includes the objective of maximizing the number of juvenile recruits emigrating from freshwater stock complexes. Further, the ASMFC provided the following recommendations for upstream and downstream passage:

1. American shad must be able to locate, enter, and pass the passage facility with little effort and without stress.
2. Where appropriate, improve upstream fish passage effectiveness through operational or structural modifications at impediments to migration.
3. Fish that have ascended the passage facility should be guided/routed to an appropriate area so that they can continue upstream migration, and avoid being swept back downstream below the obstruction.
4. To enhance survival at dams during emigration, evaluate survival of post spawning and juvenile fish passed via each route (e.g., turbines,, spillage, bypass facilities, or a combination of the three) at any given facility, and implement measures to pass fish via the route with the least delay and best survival rate.

Based on the CRASC plan, we seek the accomplishment of a number of resource goals and objectives through the relicensing process for the Project including:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.
3. Minimize current and potential negative project operation effects such as migration delays, false attraction, turbine entrainment, survival of project passage routes, and trashrack impingement that could hinder management goals and objectives.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to our mandates described in Section 4 above.

Public Interest

The requestor, NMFS, is a federal resource agency.

Existing Information and Need for Additional Information

Passage of adult shad at the Turners Falls project has been the subject of intense study by the Conte Lab since before 1999. These studies have clearly demonstrated that passage through the existing ladder at Cabot is poor (<10% in many years). Passage through the Gatehouse Fishway is better, but still rarely exceeds 80%, despite the short length of this ladder. In addition to poor passage for fish entering the ladders, shad that ascend the Cabot Fishway experience extensive delays before entry into the Gatehouse Fishway. Shad that ascend the Spillway Fishway frequently fall back into the canal and are also subject to these upstream delays. A new entrance to the Gatehouse Fishway installed in 2007 led to dramatic improvements in passage out of the canal (from 5% to over 50% in 2011), but passage still falls well short of management goals. In addition, shad spend considerable time (up to several weeks) attempting to pass. These delays likely influence spawning success and survival. Adult shad, unable to pass Gatehouse, experience similar delays in downstream passage, even after they have stopped trying to pass Gatehouse. Without spill, all outmigrating shad that have passed Gatehouse must enter the canal at the Gatehouse and may be subject to delays exiting the canal.

During the course of these studies a very large dataset has been compiled that could yield useful information for further improving passage of shad out of the canal in both the upstream and downstream directions. A unique feature of these data is a 2-dimensional array covering the canal just downstream of Gatehouse, documenting fine scale movements and occupancy of this zone. These data should be combined with computational fluid dynamics (CFD) and real-time hydraulic data to determine how canal hydraulics influence the ability of shad to locate and enter the ladder, and to identify modifications that are likely to lead to improvements in approach and entry rates. A separate CFD modeling study is requested that includes modeling of the Gatehouse Fishway entrance are at the head of the power canal.

In addition, whole-river shad telemetry studies performed in 2011 and 2012 will likely provide useful information and should be analyzed. These data should allow quantification of delay below Turners Falls, and could help guide studies requested above. Preliminary analyses of data through 2011 have been made available to FirstLight and the resource agencies (Castro-Santos and Haro 2005; Castro-Santos and Haro 2010).

The whole-river studies have also shown that, at least in 2011, most shad that pass Turners Falls rapidly progress upstream to Vernon Dam where, extensive delays also occur. Data from the 2012 study were not available at this time, but Dr. Castro-Santos stated similar patterns were noted in the data between the years on the topic of upstream delay (personal communication, Dr. Castro-Santos, USGS). Similarly, concerns relative to the downstream passage of spent shad also remain relative to delays, with existing unpublished USGS telemetry data sets suggesting this is an issue within the Turners Falls canal.

Since the first year of operation of the Turners Falls upstream fishways (1980), the percent passage of American shad annually passed upstream of Turners Falls Dam compared to the number passed at the Holyoke Fish Lift has averaged 3.6% (1980-2012 data). The highest values for this metric has not exceed 11% and are well below the noted CRASC Management Plan target range for this objective noted earlier as 40-60% on a five year running average.

Project Nexus

Existing project operations (peaking power generation) and limited bypass flows have a direct impact on instream flow and zones of passage (migration corridors). Project flow releases affect passage route selection, entry into ladders, and create delays to upstream migration. Inefficient downstream bypasses can result in migration delays and increased turbine passage. Mortality of adult shad passing through these turbines is expected to be high (Bell and Kynard 1985), additional stresses associated with passage and delay may cause mortality as shad are unable to return to salt water in a timely manner. The Project's upstream and downstream passage facilities need to be designed and operated to provide timely and effective upstream and downstream fish passage to meet restoration goals of passage to upstream habitat and maximize post-spawn survival. These factors are all critically important to the success of restoration efforts.

Proposed Methodology

Use of radio telemetry and passive PIT tags are widely accepted as the best method to assess fish migratory behavior and passage success. Fishery biologists have used them extensively to assess migration and passage issues at Turners Falls as well as other Connecticut River projects. These studies include one conducted in 2011 and 2012 by the USFWS and U.S. Geological Survey's Conte Anadromous Fish Research Center, which has provided substantial information related to some of the issues identified here. The requested study will build and expand on the information collected over the past two years.

The study design must specify sample sizes, tag configurations and receiver configurations to ensure that rates of entry and exit to the tailraces, ladders, downstream bypasses, and the bypassed reach can be calculated with sufficient precision to determine effectiveness of flow. For project assessments at Turners Falls (e.g., Cabot, Spillway and Gatehouse Fishway attraction and entry, route selection, operational effects), double tagged (radio and PIT) shad will be required for release from Holyoke Dam. Additional shad must be released directly into the Turners Falls Canal to support assessment of the various operational and structural conditions in effect, to be modified in this period, and proposed conditions within the Turners Falls power canal relative to entrances to the Gatehouse Fishway. A related request on CFD modeling (Requested Study #12) in the Cabot Station tailrace, the upper power canal near Gatehouse, and in the area around the entrance of the Spillway Fishway will address related project operational effects that will also address identified objectives in this telemetry request. Shad captured at Holyoke and tagged and released upstream of Turners Falls Dam, or tagged out of Gatehouse Fishway, would help to ensure an adequate sample size for evaluations in the vicinity of NMPS and to the Vernon Dam and the ability to address identified study objectives in those project areas. The required number of tagged fish to address study objectives may be adjusted accordingly from area to area depending on target numbers (i.e., best information on resultant viable tagged fish and power analyses to detect effects) to account for typical passage rates, survival rates, and handling effects as examples.

Existing information on captured, handled, tagged fish performance (e.g., percent that drop back, unsuitable for tracking) and factors such as timing of tagging and potentially transport, must all be carefully considered to ensure an adequate sample size of healthy (e.g., viable to characterize behavior, survival, etc.) tagged fish is available to address the many questions identified in this request (as supported by a statistical power analysis). Additionally, ensuring adequate downstream adult fish sample sizes (to address project effect questions above) requires close consideration as expected losses of healthy tagged fish during upstream passage, natural mortality rates, and tagging related effects, are expected to reduce sample sizes on downstream passage objectives/questions as the season progresses. The use of single PIT tagged fish can help improve sample sizes, but will be of limited use to answer some of the passage questions we have identified.

Due to environmental variability, two years of study work will be necessary. A large array of stationary monitoring stations (radio and PIT) will be needed to address the issues identified among the project areas. A sufficient level of radio receiver and PIT reader coverage will be required, to provide an appropriate level of resolution, for data analyses, to answer these questions on project operational effects. The study will provide information on a variety of structural and operational aspects of fish migration, relative to route selection, timing, survival, and up and downstream passage attraction, retention, delay, efficiency, survival as some examples at three projects (Turners Falls, NMPS, and Vernon). The use of video monitoring may also be utilized for specific study areas such as the Spillway Fishway, to provide additional information on shad entrance activity, with the understanding of some data limitations associated with this approach (fish identification, water visibility).

In addition to the tagging studies, use of video monitoring of the Spillway Fishway would provide additional overall data on Spillway Fishway efficiency as all shad attempting to pass could be monitored versus just those shad that have been tagged.

Level of Effort and Cost

The requested study is extensive and will require a substantial effort and cost to capture, PIT tag and radio tag a sufficient number of shad at Holyoke to release at upstream locations. We are not aware of any other study technique that would provide project specific fish behavior and migration information to adequately assess existing project operations and provide insight in possible alternative operations and measures needed to address observed negative impacts to fish migration success. Cost for the entire multi-project tagging, tracking and data analysis are expected to be very high based on past Turners Falls' studies and the 2011 and 2012 shad telemetry studies. Video monitoring of the Spillway Fishway would add a modest cost to this study.

Since tagged shad will move throughout the larger five project area, to varying degrees, there will be expected cost savings (e.g., radio tags) to both owner/operators, provided cooperation in study planning and implementation occurs.

FirstLight has not proposed an alternate study.

6.8 Requested Study #8: Impact of project operations on downstream migration of juvenile American shad

Juvenile shad that start their migration towards the sea can be as small as two inches. The degree to which turbines inflict injury or mortality on these fish at Cabot Station and Station One is not well understood. Ensuring that these trust species have safe, timely and effective passage is a condition of the Federal Power Act.

Goals and Objectives

The goal of this study request is to determine if project operations affect juvenile American shad outmigration survival, recruitment, and production. The objectives of this request include:

1. Assess project operations effects of NMPS and Turners Falls Dam on the timing, orientation, routes, migration rates, and survival of juvenile shad;
2. Determine the proportion of juvenile shad that select the Gatehouse into the power canal versus the dam spill gates as a downstream passage route, under varied operational conditions, including a range of spill conditions up to full spill;
3. Determine if there are any delays with downstream movement related to either spill via dam gates or through the Gatehouse and within the impoundment due to operations (i.e., NMPS pumping and generation);
4. Determine survival rates for juvenile spilled over/through dam gates, under varied operation conditions, including up to full spill during the annual fall power canal outage period;
5. Determine the juvenile downstream passage timing and route selection in the power canal to: Station 1; Cabot Station; and the Cabot Station log sluice bypass, and assess delays associated with each of these locations and with project operations (e.g., stockpiling in the canal);
6. Based upon year 1 study results on route selection, determine the survival rate for juvenile shad entrained into Station 1; and
7. Determine the survival rates for juvenile shad entrained into Cabot Station units;
8. If it is determined that Project operations adversely affecting juvenile shad survival, migration timing, or other deleterious population effects , identify operational solutions or other passage measures that will reduce and minimize these impacts within the project area.

This study will require two years of field data to capture inter-annual variability of river discharge, water temperatures, and variability in the timing and abundance of juvenile production and their outmigration timing, which may relate to spring, summer, and fall conditions. This study will complement the NMPS Fish Entrainment Study Request which includes assessment of impacts to juvenile shad.

Resource Management Goals

The Connecticut River Atlantic Salmon Commission developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following:

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.
2. Maximize outmigrant survival for juvenile and spent adult shad.

The ASMFC *Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management)*, approved in 2010 includes an objective to maximize the number of juvenile recruits emigrating from freshwater stock complexes. Further, the ASMFC recommends enhancing survival at dams during emigration, evaluate survival of post spawning and juvenile fish passed via each route (e.g., turbines, spillage, bypass facilities, or a combination of the three) at any given facility, and implement measures to pass fish via the route with the best survival rate.

We seek to accomplish a number of resource goals and objectives through the relicensing process for the Project including:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.
3. Minimize current and potential negative project operation effects on juvenile American shad survival, production, and recruitment.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to our mandates as described in Section 4 above.

Public Interest

The requestor, NMFS, is a federal resource agency.

Existing Information and Need for Additional Information

Since the construction of the Turners Falls Dam upstream fishways in 1980, American shad have had access to spawning and rearing habitat upstream of Turners Dam. A number of modifications to the Turners Falls fishways have occurred since that time, with the numbers of adult shad passed at Gatehouse Fishway (into Turners Falls Dam impoundment) reaching as much 60,089 in 1992 when a record 721,764 shad passed upstream of Holyoke Dam. However, since 1980 an average of only 3.6 % of the adult shad passed upstream of Holyoke Dam subsequently have passed upstream of Turners Falls Dam, and this value has never exceeded 11%. This value is well below the CRASC 1992 Shad Plan objective of 40-60% passage from the previous dam. In addition, population number and passage numbers past Holyoke have declined substantially, with the average Holyoke passage number over the last 10 years being 211,850. Because historic data suggests that approximately half the returning adult shad to the Connecticut River pass the Holyoke Dam, recent adult returns are far below management goals. Effective upstream and downstream passage and successful in-river spawning and juvenile production are necessary to help achieve shad management restoration goals for the Connecticut River, which extends to the Bellows Falls Dam. In 1990, FirstLight's predecessor, NUSCo, CRASC and its member agencies, signed a Memorandum of Agreement on downstream fish passage to address both juvenile and adults at the Turners Falls Project and Northfield Mountain Pumped Storage Project.

American shad broadcast spawn with the highest spawning activity occurring in runs and lowest activity in pools and riffle/pools (Ross *et al.* 1993). Field research by Ross *et al.* (1993) in the Delaware River further noted that a combination of physical characteristics that seems to be avoided by spawning adults is slow current and greater depth. American shad year-class strength has been shown to depend on parent stock size and environmental conditions during the larval life stages (Creeco and Savoy 1984). Delays in juvenile American shad outmigration may affect survival rates in the transition to the marine environment (Zydlewski *et al.* 2003). One published study on the Connecticut River identified that juvenile shad outmigration began when declining autumn temperatures reached 19C and peaked at 16C (O'Leary and Kynard 1986).

Juvenile American shad production has been monitored upstream of the Vernon Dam and immediately downstream of that dam by Vermont Yankee Nuclear as part of an annual monitoring program using both boat electrofishing (since 1991) and beach seining (since 2000). Sampling of juvenile shad was also conducted by a contractor hired by Northeast Utilities in the Turners Falls impoundment in 1992. O'Donnell and Letcher (2008) examined juvenile shad early life history and migration upstream and downstream of Turners Falls Dam. Their study results led to the decision by the agencies to require earlier operation of downstream fishways to protect early season juvenile shad out-migrants (1 September prior to 2010, 15 August in 2010, and since 2011, 1 August).

Downstream juvenile clupeid passage studies at Turners Falls were conducted in the fall of 1991 which included the objectives of determining the percentage of juvenile shad and herring that pass via the bypass log sluice or that were entrained in the Cabot Station turbines and related data (e.g., catch rates) were compared. The 1991 Downstream Clupeid Study did not assess survival rates for juveniles for either of these passage routes. The 1991 study report documented a higher rate entrainment into the project turbines (23.0 fish per minute) versus through the bypass sluice (11.6 fish per minute). It was concluded that only an estimated 54% (average bypass rate, weighted by estimated number bypassed) of the juvenile American shad approaching Cabot Station were bypassed via the log sluice. The range of the percent bypassed varied widely by date, between nearly 0 and 83%, with 'no clear explanation as to why." The report did not identify the percentage entrained into the turbines but it can be reasoned to be substantial based on the data presented in the report or assumed as the remaining balance (46%). as there were no spill events reported during this study, and therefore nowhere else for them to pass. It was further noted that entrainment rates for juveniles were consistently greatest for units 1 and 6 (powerhouse ends), not uniform across all units. Although no concurrent bypass sampling occurred during the first entrainment sampling events, it was noted that "entrainment rates were relatively high during the end of September." Additional modifications have occurred over time without quantitative evaluation to improve downstream passage attraction and use to the bypass sluice, including lighting systems.

The 1994 Downstream Juvenile Shad Study report assessed juvenile shad survival from passage via the log sluice, reported to be 98%, based on tagged and recaptured fish (held for up to 48 hours). Scale loss (<20%) (22 of treatment fish) compared with scale loss of >20% (5 of treatment fish) was examined and determined to occur in an overall total of 10% of study fish (adjusted by control fish data). Given these impacts to juvenile shad that were found almost 20 years ago, FERC should request the licensee to determine what level of impact current operations are having on downstream migrating juvenile shad.

Project Nexus

Adult American shad passed upstream of Turners Falls Dam use upstream spawning habitat. Juvenile American shad production occurs in these habitats upstream of Turners Falls Dam on an annual basis. Juvenile American shad require safe and timely downstream passage measures to have the opportunity to contribute to the fishery agencies' target restoration population size.

We are not aware of any studies being conducted specifically designed to determine:

- When spill gates are open at the Turners Falls Dam?
- What proportion of juvenile outmigrant shad take that route of passage?
- What is the rate of survival under a range of spill and gate configurations?
- What is the timing, duration, and magnitude of juvenile shad outmigrants in summer and fall to the Turners Falls Dam and Gatehouse?
- Are there delays in migration/movement at the dam, Gatehouse, Cabot Station, or Station 1?
- For juveniles that enter the power canal, what proportion subsequently enter the Station 1 power canal?
- As there are no downstream passage facilities at Station #1, and trash rack spacing is 2.6 inches, what is the survival rate of juvenile shad entrained at Station #1?
- What is the rate of movement through the Turners Power Canal, relative to r delay to outmigrant juvenile shad and the potential accumulation of juveniles (e.g., prior to the canal drawdown in September)?
- What proportion of juvenile shad use the downstream sluice bypass versus the Cabot Station turbines under varied operational conditions given that project operations may change (PAD notes possible increase in turbine capacity at Cabot)?
- Based upon earlier facility studies (1991 Downstream Clupeid) a large proportion and number of juvenile shad are entrained into Cabot Station turbines. What are the associated impacts in terms of short-term and longer term survival and injury.

We are concerned that project operations may impact juvenile shad outmigration survival and be contributing to the failure of the Connecticut River shad population to meet management targets. In the PAD, proposed modification include; Station 1 may be upgraded with new turbines, Station 1 may be closed, and/or the turbine capacity at Cabot may be increased. It is unclear how these scenarios will affect the questions identified in this request.

Proposed Methodology

The impact to juvenile shad outmigrants by project operations would be best studied by a combination of approaches including hydroacoustic, radio telemetry, and turbine balloon tags. Project discharge over a full range of existing and, to the extent possible, potential future operational conditions at Station 1 and Cabot, at the dam (likely increased bypass reach flows in new license) and in relation to the Gatehouse, should be examined relative to timing, duration, and magnitude of juvenile shad migration to and through these areas, with hydroacoustic equipment for natural/wild fish evaluation. In addition, study fish should be collected and tagged (PIT, radio, other mark, balloon) to also empirically determine rates of survival for fish passed over or through the dam’s gates, under varied operations, including up to full spill condition that occurs annually in fall with canal outage period. The understanding of the timing, magnitude, duration of the wild fish outmigration will help inform the design, data/results, and assessment of tagged study fish. The release of tagged or marked fish (radio, PIT) upstream of the Gatehouse induction into the power canal, will provide data on concerns of delay and route selection to Station 1, Cabot Station downstream bypass, Cabot Station spill gates, and Cabot Station turbines. Additional hydroacoustic assessment at Cabot Station forebay will provide information on wild/natural juvenile fish timing, magnitude, and duration to and through this area. Based upon Year 1 study findings relative to the frequency, magnitude, timing of juvenile American shad that end up in the forebay of Station 1, the determination of whether an entrainment survival study at that site is necessary will be made. Release sites for tagged fish will be determined based upon further consultation among the parties.

Radio tagged juvenile shad will be released in areas upstream of the NMPS facility at multiple release locations, to determine operation effects on migration rates, route, orientation, entrainment, and survival, over a full range of permitted and operational conditions.

Level of Effort and Cost

FirstLight does not propose any studies to meet this need. Estimated cost for the study is expected to be high, with the majority of costs associated with equipment (hydroacoustic gear, radio tags, radio receivers, and PIT readers) and related fieldwork labor.

FirstLight has not proposed an alternate study.

6.9 Requested Study #9: Upstream American eel passage assessment at Turners Falls

American eel are currently present in the mainstem Connecticut River. Upstream migrants have been found within the Turners Falls headpond as well as at the Vernon project (P-1904) as evidenced in the PAD filed by Trans Canada. The exact migratory routes that these eel take at the Turners Falls project are not currently well understood.

Goals and Objectives

The goal of this study is to determine where eel are likely to migrate within the Turners Falls project and determine what structures and flow paths they are most likely to follow.

This study has two objectives:

1. Conduct systematic surveys of eel presence/abundance at Cabot Station discharge, Station #1 discharge, canal discharges, and Turners Falls Dam to identify areas of concentration of eels staging in pools or attempting to ascend wetted structures that would potentially establish the most effective locations to place upstream eel passage facilities.
2. Collect eels with temporary trap/pass devices from areas identified from surveys as potential locations of eel concentration to assess whether eels can be collected/passed in substantial numbers, and whether locations are viable sites for permanent eel trap/pass structures.

Resource Management Goals

The goals of the ASMFC management plan for American eel (2000) include: (1) protect and enhance American eel abundance in all watershed where eel now occur; and (2) where practical, restore American eel to those waters where they had historical abundance but may now be absent by providing access to inland waters for glass eel, elvers, and yellow eel and adequate escapement to the ocean for pre-spawning adult eel. Addendum II contains specific recommendations for improving upstream and downstream passage of American eel, including requesting that member states and jurisdictions seek special consideration for American eel in the FERC relicensing process.

In addition, the CRASC developed A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin in 2005. The goal of the plan is "to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem…" Management objectives in the plan include the following:

1. Protect and enhance eel populations where they currently exist;
2. Where practical, restore populations to waters where they had historical abundance;
3. Provide effective upstream and downstream fish passage around dams and other barriers within the species' range in the basin; and
4. Comply with all requirements of the Fishery Management Plan of the ASMFC.

Based on these plans, we seek the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to upstream passage of American eel, our goals are:

1. Minimize current and potential negative project operation effects that could hinder management goals and objectives.
2. Minimize project-related sources of upstream passage delay, injury, and stress in order to facilitate access to historical rearing habitat.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to our mandates are described in Section 4 above.

Public Interest

The requestor, NMFS, is a federal resource agency.

Existing Information and Need for Additional Information

The PAD contains no information relative to areas where eels seeking to move upstream concentrate downstream of the dam, or annual numbers of eels attempting to ascend past Turners Falls Dam. While eels have been known to ascend the Cabot Station Fishway (personal communication with A. Haro, U.S. Geological Survey) its efficiency is unknown, and it is only operated during the American shad passage season (from April 1 through July 15). Eels are currently able to pass the Turners Falls Dam complex (as evidenced by documented presence of eels upstream), but the total number of eels attempting to pass Turners Falls and the proportion successfully passing the project is unknown (but suspected to be low). The downstream Holyoke Project has operated upstream eel passage facilities since 2004. Last year these facilities passed over 40,000 juvenile eels. While there is rearing habitat in between the Holyoke and Turners Falls dams, some eels will attempt to continue upstream, and passage needs to be provided so these fish can access historical habitat.

These information gaps need to be filled so resource agencies can determine the best locations to site upstream eel passage facilities and assess whether operating the existing anadromous ladders would be an effective mechanism to move juvenile eels upstream past the project.

We also note that within the past seven years, USFWS has received two petitions to list the American eel under the ESA. The first petition was received on November 18, 2004. On July 6, 2005 the USFWS issued a substantial 90-day finding on the petition and initiated a 12-month status review that concluded on February 2, 2007 with a finding that listing was not warranted. The second petition was filed on April 30, 2010 by the Council for Endangered Species Act Reliability (CESAR). On September 29, 2011 the USFWS issued a substantial 90-day finding and initiated a 12-month status review. The USFWS is still accepting new American eel information for the ongoing status review. Although the date for completion of the USFWS 12-month finding on the latest petition is uncertain, it is likely that it will be made before any new licenses are issued for the projects.

Project Nexus

The project generates hydropower on the head created by the Turners Falls dam. This dam creates a barrier to upstream migrating eels. While some eels are able to pass dams, some are not, and the passability of a given dam depends on factors such as its height, hydraulics, presence of climbable surfaces, presence of predators, risk of exposure to heat or drying while climbing a dam, etc. The Turners Falls dam is high (35 feet above bedrock), and the majority of the dam face is dry during most of the upstream eel passage season. Design of the dam is not currently amenable to passage of eels by climbing. While flow is released to the bypass reach via a bascule gate (typically the one closest to the gatehouse), this would not facilitate eel passage, as bascule gates open outward and downward (i.e., requiring the eels to essentially swim nearly upside down to get over the gate). As mentioned earlier, the existing anadromous passage facilities are not designed to pass eels, and even if some eels are able to ascend the ladders, they may incur delays (in attraction or passage rates), be size-selective (e.g. velocity barrier for small eels presented by ~8 ft/sec flow through weirs and orifices), present a potential predation risk (predators in or near the fishways), and are not operated throughout the upstream eel passage season.

Proposed Methodology

Objective 1: Systematic Surveys

Surveys of eel presence and relative abundance should be conducted at regular intervals throughout the eel upstream migratory season (~1 May to ~15 October, or when river temperatures exceed 10 C). Surveys should consist of visual inspection and trapping in likely areas where eels may concentrate as they attempt to climb structures wetted by significant spill or leakage flow in the Turners Falls dam complex area. These locations include: Cabot Station downstream bypass outfall, Cabot Station spillway (including attraction water stilling basin), Cabot Fishway (dewatered state), USGS Conte Lab flume outfall, Number One Station outfall, various small turbine and process water outfalls from the Cabot Canal, Spillway Fishway attraction water stilling basin, and leakage points along the downstream face of Turners Falls Dam (bascule and taintor gates). Methods should include visual surveys (on foot, from a boat, or snorkeling) and trapping using small mesh (< 1/8" clear opening) baited eel pots. Visual surveys must be performed once per week, at night, preferentially during precipitation events. Trap sets must be performed once per week, with an overnight soak time. Recorded data must include location, observation of eels (presence, absence, relative numbers, relative sizes, behaviors, time/date of observation), and survey method.

Objective 2: Trap/Pass Collections

Areas identified from Systematic Surveys as having significant number of eels present must be targeted as potential areas for permanent eel trap/passes, and must be initially assessed using temporary/portable trap passes. At a minimum (regardless of survey results), temporary trap passes must be installed at the following locations: Cabot Fishway attraction flow stilling basin (during dewatered fishway period), Number One Station outfall, and Spillway Fishway attraction flow stilling basin (during watered and dewatered fishway period), as these locations may be supplemented with additional attraction flow and have high potential for being concentration points for upstream migrant eels. Temporary trap/passes must be purpose-designed and built for each location, and operated throughout the eel upstream migratory season (~1May to 15 October, or when river temperatures exceed 10 C). Ramp-type traps with supplementary attraction flow are preferred temporary trap/pass designs. Traps must operate daily, with catches quantified every 2-3 days. Recorded data must include location, trapping interval, absolute numbers of eels trapped, relative eel sizes, and hydraulic and environmental conditions during the trapping period.

All collected eels from surveys should be released at their point of capture; those eels collected from trap/pass collections should be transported to and released above the dam in the Turners Falls Pool.

These methodologies are consistent with accepted practice.

Level of Effort and Cost

The level of cost and effort for the survey component of the study would be low; a minimal number of personnel may be able to conduct the weekly surveys. The trap/pass component would require low to moderate cost and effort.

In the PAD, the applicant has identified the need to assess issues related to upstream passage for American eels at the project, but indicates that it intends to rely on information from previously conducted studies and ongoing studies. We are not aware of any previously conducted or ongoing studies related to upstream eel passage.

6.10 Requested Study #10: Downstream American Eel Passage Assessment at Turners Falls and Northfield Mountain

Adult eels spend the majority of their lives in freshwater rivers. The age at which migrate out to sea and head towards their spawning grounds varies. Adult eels that embark on this migration can exceed two feet in length. Eel that pass hydro-electric projects are subjected to harsh or lethal conditions as they pass through the turbines. Currently, our understanding of the impacts and level of mortality on migrating adult eels is not well understood.

Goals and Objectives

The goal of this study is to determine the impact of two hydroelectric projects on the outmigration of silver eels in the Connecticut River. Entrainment of eels at the Northfield

Mountain Pumped Storage Station (NFMPS) removes eels from the river, prohibits a timely migration effectively extirpating them from the population. Entrainment at the conventional turbines at Station 1 and Cabot Station of the Turners Falls Project can result in mortality or injury. It is important to understand the passage routes at each project and the potential for mortality to assess alternative management options to increase survival.

The objectives of this study are:

1. Quantify the movement rates (including delays) and relative proportion of eels passing via various routes at the projects; i.e. for NFMPS, the proportion entrained into the intakes; for Turners Falls Dam, the proportion entrained into the power canal and spilled via bascule and taintor gates; for the Cabot Canal, proportion of fish passing via spillways, turbines, and the downstream bypass.
2. Evaluate instantaneous and latent mortality and injury of eels passed via the Turners Falls Dam routes, including bascule and taintor gates, spillways, turbines, and the downstream bypass.

Resource Management Goals

The goals of the ASMFC management plan for American eel (2000) include: (1) protect and enhance American eel abundance in all watershed where eel now occur; and (2) where practical, restore American eel to those waters where they had historical abundance but may now be absent by providing access to inland waters for glass eel, elvers, and yellow eel and adequate escapement to the ocean for pre-spawning adult eel. Addendum II contains specific recommendations for improving upstream and downstream passage of American eel, including requesting that member states and jurisdictions seek special consideration for American eel in the FERC relicensing process.

In addition, the CRASC developed A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin in 2005. The goal of the plan is "to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem…" Management objectives in the plan include the following:

1. Protect and enhance eel populations where they currently exist;
2. Where practical, restore populations to waters where they had historical abundance;
3. Provide effective upstream and downstream fish passage around dams and other barriers within the species' range in the basin; and
4. Comply with all requirements of the Fishery Management Plan of the ASMFC.

Based on these plans, we seek to accomplish a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to downstream passage of American eel, our goals are:

1. Minimize current and potential negative project operation effects that could hinder management goals and objectives.

2. Minimize project-related sources of downstream passage delay, injury, stress, and mortality in order to maximize the number of silver eels migrating to the spawning grounds.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to our mandates described in Section 4 above.

Public Interest

The requester, NMFS, is a federal resource agency.

Existing Information

The PAD contains information on the biology, life history, and regulatory status of American eel. It also discusses 2-D and 3-D telemetry studies that were conducted at Cabot Station in 1996, 1997, 2002 and 2003. Results of those studies indicate that a significant proportion of eels entering the Cabot forebay become entrained (90% in 2002, 100% in 2003; (Brown *et al.* 2009). The PAD notes that the study done in 2003 determined that 15 of the 29 test eels were detected at the Hadley Falls Station. However, that study was not designed to assess turbine mortality.

To date, no directed studies of eel mortality at Cabot Station or eel entrainment or mortality at either Station 1 or the NFMPS facility have been conducted. Information from the requested study is needed to assess the relative and cumulative impact of project operations on outmigrating eels and develop adequate passage and protection measures to meet management goals and objectives.

Project Nexus

The Turners Falls Project operates as a peaking facility, except during periods when inflow exceeds the hydraulic capacity of Cabot Station and Station 1. Silver eels outmigrate during the mid- summer through late fall, a time of year when flows are generally near the maximum operating capacity of the stations. Therefore, the project would be expected to spill infrequently during the silver eel outmigration beyond the nominal amount required in the bypass reach.

Racks at Cabot Station, Station 1, and NFMPS facility are not designed to protect eels from entrainment. At Cabot, the racks have one-inch clear spacing on the top 11-feet, with five-inch clear spacing on the bottom 20 feet of racks. The approach velocity at the racks is approximately 2.0 feet per second at maximum hydraulic capacity. At Station 1, the racks have 2.6-inch clear spacing and an approach velocity of 1.2 feet per second. Eels can readily pass through a 2.6-inch clear space. NFMPS has 48-foot-deep trashracks with six-inch clear spacing over the intake and an approach velocity of 3.5 feet per second at full pumping capacity (15,000 cfs).

As mentioned above, previous studies conducted at Cabot Station documented eel entrainment. Cabot Station has existing downstream passage facilities designed for anadromous species, but studies have documented few eels utilizing the surface bypass (likely because Cabot has a relatively deep, wide intake area). Station 1 has no passage and protection facilities. NFMPS has a seasonally-deployed barrier net to minimize entrainment of Atlantic salmon smolts, but it is only operated from April through June 15 annually. While no studies have been conducted at Station 1 or NFMPS facility, the rack spacing is wide enough to allow for entrainment.

Proposed Methodology

In order to understand the movements of outmigrating silver eels as they relate to operations at the Northfield Mountain Pump Storage Facility, Station 1, and Cabot Station, radio telemetry technology should be utilized. Radio telemetry is an accepted technology that has been used for a number of studies associated with hydropower projects, including at the Muddy Run Project (FERC No. 2355).

Studies should be designed to investigate route selection (i.e., entrainment vs. spill) independently from estimation of mortality/injury, because these metrics require different telemetric methodologies. Studies will also likely benefit from data from several seasons (especially route selection studies, which may be more significantly affected by environmental conditions during a given season that mortality/injury studies). It is also envisioned that results from route selection studies can guide design of turbine mortality studies. Therefore, it is proposed, at a minimum, that route selection studies be conducted in multiple years, but mortality/injury studies may be conducted after the first year of route selection studies have been completed.

Objective 1: Route Selection

This study will involve systematic releases of radio-tagged silver phase eels at strategic points above areas of interest, to assess general routes of passage (i.e., via spill, bypass, or turbines). Active downstream migrants should be collected within-basin if possible (i. e., Cabot or Holyoke bypass samplers), but fish sourced from out of basin may be acceptable to meet sample size demands. Experimental fish must meet morphometric (e.g. eye diameter relative to body size) criteria to ensure they are migrant silver phase. Collections should be made within the migratory season (late Aug to mid Oct), and eels should be tagged and released within 7 days of collection.

We request consultation with the resource agencies to determine the number of tagged fish that would be necessary and where receivers should be placed for this requested study in order to better understand route selection at NMPS and throughout the Turners Falls project. The route selection portion of this study should occur in both study years.

Objective 2: Spill, Bypass, and Turbine Mortality/Injury Studies

Spill, bypass, and turbine mortality will be assessed using a radio-telemetric balloon tag method. As with the route selection study, we request consultation with the resource agencies in order to determine the number of fish required for this study and to determine where receivers should be placed. This study would also incorporate the usage of balloon tags which should be held for 48 hours.

For spill mortality sites (dam bascule gate, dam taintor gate, Cabot spillway, Cabot Station bypass), tagged eels will be injected or released into spill flow at points where water velocity exceeds 10 ft/sec, to minimize the possibility of eels swimming upstream into the headpond or canal. Passed balloon-tagged eels will be recovered below areas of spill and held for 48 hours in isolated tanks for observation of injury and latent mortality; unrecovered balloon-tagged eels will be censored from the data. In addition, mobile tracking of fish via boat should also be incorporated into this study.

The turbine mortality component of the study should occur in Study Year 2.

Data analyses of route selection and turbine mortality (instantaneous and latent) will follow standard methodology.

Project operation (flows, levels, gate openings, number of units operating and operation level) and environmental conditions (river flow, temperature, turbidity, air temperature, precipitation) will be monitored regularly (hourly measurements if possible) throughout the duration of the studies.

These methodologies are consistent with accepted practice.

Level of Effort and Cost

The level of cost and effort for the downstream eel passage study would be moderate to high; silver eels would need to be collected, tagged, and released in several locations over the course of the migration season. Antennas and receivers would need to be installed at the intakes to all stations as well as at the Turners Falls dam spillway and Cabot Station bypass, and monitored regularly. Data would need to be retrieved periodically and subsequently analyzed. A multi-site route selection study conducted by the USGS Conte Lab on the Shetucket River in Connecticut cost approximately $75,000 for the first year of study. Costs are estimated at $100,000 per year for the Route Selection studies and $75,000 per year for the Spill, Bypass, and Turbine Mortality/Injury Studies (personal communication Alex Haro, USGS).

The applicant did not propose any studies to meet this need in the PAD. No alternate studies were proposed.

6.11 Requested Study #11: Assessment of adult sea lamprey spawning within the Turners Falls and Northfield Mountain Pump Storage Project Area

Sea lamprey could potentially find suitable spawning habitat within the Turners Falls project reach. Currently, our understanding of how these fish utilize the existing habitat within the project reach is not well understood.

Goals and Objectives

Our goal is to determine the impacts that the Turners Falls and Northfield Mountain Pump Storage Project's operations have on this species' spawning activity and spawning success. Such an understanding can guide us as we consult with the licensee on developing solutions to mitigate impacts to sea lamprey.

The objectives for this study include:

1. Assessing the level of spawning activity by adult sea lamprey in the Turners Falls and Northfield Mountain Pump Storage Project area (downstream extent of Turners Project operation influence and upstream extent of influence of both Projects) and determine whether the operations of the Projects are affecting the success of this activity to occur.
2. Identifying areas within the Project area where suitable spawning habitat may exist for adult sea lamprey.
3. Conducting a telemetry study of sea lamprey during their upstream migration period in the spring, focusing on areas of suitable spawning habitat, and areas of known spawning events.
4. Conducting a spawning ground surveys to observe the utilization of this habitat for spawning purposes, and hence, confirm suitability.

5. Obtaining data on redd characteristics including location, size, substrate, depth and velocity.
6. Determining if the operations at Turners Falls project (dam, Station 1, and Cabot Station), downstream reaches, and Northfield Mountain Pump Storage (upstream reaches) are adversely affecting these spawning areas (i.e. if flow alterations are causing dewatering and scouring of lamprey redds).

If it is determined that the Project operations are adversely affecting the spawning success of sea lamprey, identify operational regimes that will reduce and minimize impacts to sea lamprey spawning habitat and spawning success, within the project area.

Resource Management Goals

Sea lamprey are a trust resource. As such, we are charged with protecting this species and reducing the threats this species faces in order to maintain its population.

The sea lamprey *Petromyzon marinus*, within the Connecticut River drainage, is one of New Hampshire's and Vermont's Species of Greatest Conservation Need (SGCN). Examples of threats identified in the Vermont Wildlife Action Plan (2005) include degraded spawning habitat, and habitat fragmentation.

As outlined in Vermont's Wildlife Action Plan (2005), research and monitoring needs for SGCN include monitoring and assessing populations and habitats for current conditions and future changes, and identifying and monitoring problems for species and their habitats.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act and the Federal Power Act.

Public Interest

The requestor, NMFS, is a federal resource agency.

Existing Information

In 2012, a total of 14,089 sea lamprey passed upstream of the Holyoke Dam. The number of adult sea lamprey passed upstream of Holyoke has ranged from 14,089 to 100,000 since 1975, when counting for that species first began. The number of sea lamprey passed upstream of Turners Falls Dam was 4,503 in 2012, with the highest reported lamprey passage count 32,035 occurring in 2008. Annual count data, when available, are provide in the PAD, but it should be noted that lamprey pass at night as well and only in recent years has the digital imaging system been in place at the Project to more accurately determine this count.

Sea lamprey are known to utilize both main stem and accessible tributary habitat consisting of larger gravel to small cobble substrate in areas with flowing water (e.g., upstream of impounded areas or in areas within impoundment that provide favorable hydraulic conditions) from which they construct their nests or redds. Sea lamprey pairs or groups (multiple fish may form an aggregate nest) can be observed building redds, or nearby recently completed redds, generally in late June, from the Sunderland Route 116 bridge upstream to the base of the Cabot Station in shallow water habitats with the preferred substrate types, where water velocities are increased due to a variety of river physical characteristics (e.g., shifts in depth contours, channel turns, islands).

The Connecticut River Coordinator (Ken Sprankle, USFWS) has observed that sea lamprey also spawn in the Connecticut River main stem upstream of the Turners Falls Dam within close proximity of the Vernon Dam (habitat adjacent to Stebbins Island, both sides of island). This species is known to utilize lower sections of tributaries, such as the Ashuelot River, Hinsdale, New Hampshire and main stem gravel bar and shallow water habitats within the Turners Falls impoundment (e.g., Massachusetts State Line).

To date no studies have been conducted that aim to identify spawning habitat and activity of sea lamprey, and corresponding water level fluctuation impacts from Project operations downstream of Turners Falls Dam as well as upstream of Turners Falls Dam and Northfield Mountain Pump Storage operation impacts.

Power company studies conducted in the late spring and summer of 2012, examined habitat conditions downstream of Turners Falls Dam, including substrate composition and select area water elevation measures (24 hour basis). The study documented in low flow conditions, Cabot Station project operations produced fluctuations in water level elevations that can range over 4 feet in magnitude (daily operation) at the USGS Montague Gage Station, to lower values of 2 to 3 feet at the Route 116 Bridge, Sunderland, MA (PAD). Similarly, water elevation measures were obtained at two sites in the upper portion of the Turners Falls impoundment where sub-daily, Project operations (Northfield Mountain Pump Storage) also resulted in changes of several feet in magnitude.

Project Nexus

The Turners Falls and Northfield Mountain Pump Storage project operations have the potential to cause direct adverse effects to sea lamprey spawning activity, spawning success, and spawning habitat. If adult sea lamprey are actively spawning in the project area, it is important to assess whether Project operations are having any adverse effects (i.e. dewatering and scouring) to these spawning activities, their redds (spawning success), and spawning habitats.

Proposed Methodology

Although a relatively new practice, the tagging and tracking of adult Pacific lamprey to determine final destination, has been successfully conducted in the Columbia River. See Noyes *et al.* 2012.

As part of the Well Hydroelectric project (FERC No. 2149), Pacific lamprey spawning ground surveys were conducted to determine project effects on spawning success.

Level of Effort and Cost

The estimated level of effort and costs for this recommended study is expected to be moderate to high. FirstLight did not propose any alternative studies in its PAD to address this specific issue.

6.12 Requested Study #12: 3-dimensional computational fluid dynamics (CFD) modeling in the vicinity of fishway entrances and upstream of powerhouse forebays

Very complex flow fields occur in the vicinity of fishway entrances, powerhouse tailraces and upstream of the entrance to powerhouse intakes. In the case of fishway entrances it is important to ensure that adequate attraction water is present, that velocities are within an acceptable range, and that a certain amount of differential between the entrance pool and the river itself exists such that fish not only find the entrance but actually enter it. CFD modeling can greatly assist in determining to what extent favorable entrance conditions exist in front of a fishway. With respect to downstream passage, when a downstream bypass facility is present, it is important to understand the direction and magnitude of flow fields that are upstream of the turbine intakes such that some level of flow exists that can guide fish towards the bypass. Also, if excessive velocities occur in front of the turbine intakes, this can lead to entrainment and impingement problems for migrating fish.

Goals and Objectives

The goal of this study is to determine the flow field conditions that exist in and around the fishway entrances, and upstream of both Turners Falls powerhouses (Station 1 and Cabot). The information from this request is meant to be coupled with data from the telemetry study such that a comprehensive understanding of fish behavior is developed.

The objective of this study is to develop a series of maps that show velocity magnitude at discharges that have been agreed upon by the resource agencies and the licensee. With respect to upstream passage, the results will show approach velocities and orientation within the approach zone of the fish that may create a response in fish. This information can be coupled with telemetry data (Study Request #7, shad telemetry study) and passage counts to understand which conditions are optimal for guiding migrating fish to the fishway entrances and for stimulating fishway entry. With respect to downstream migration, the results will show velocities and orientations in front of each powerhouse. At Cabot Station, the results will indicate to what degree flow directs downstream migrating fish towards the surface bypass weir. At Station 1, the results should identify the magnitude of velocity in front of the turbine intakes.

Resource Management Goals

The management goals of this study request are to obtain information that will help assist in designing effective upstream fishways for upstream migrating trust species and to reduce impingement, entrainment and delay for downstream migrating fish. CFD models are a relatively cost effective way to analyze existing and future conditions. As such, changes in the amount of attraction water, changes in which turbines are operating and which spillway gates are releasing water can all be examined. As stated, the results from this study are meant to be used along with the data generated from the telemetry study. The combined analysis from these two data sources can help assess which flow conditions are most advantageous for migrating trust species to successfully pass the project in a safe, timely and effective manner current and proposed conditions.

As for downstream migration of adult and juvenile shad, and adult eel, the results from the models will reveal flow magnitude and direction in front of each powerhouse. Given the limited information that currently exist on survival through Cabot and Station 1, our management goal is to direct as many downstream migrating fish as possible towards the uniform acceleration weir and downstream bypass. With respect to upstream passage, we want to maximize the number of fish that find and enter the ladder entrances.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act and the Federal Power Act.

Public Interest

The requestor, NMFS, is a federal resource agency.

Existing Information and the Need for Additional Information

To date, no CFD modeled data exist in front of either fishway, nor do they exist in front of either powerhouse. Some preliminary modeling has been done downstream of the Gatehouse, but changes to the gatehouse entrances would require updated modeling. It is our understanding that the licensee has worked with the firm Alden to develop a CFD model of the upper power canal and that elevation survey data from the power canal also are available. Detailed 2-dimensional movement data on shad are available from observations made between 2003 to 2005 and 2010 to 2012. By coupling and analyzing these two data sets, flow and fish movement, we believe this will have substantial benefits to our management efforts.

When designing upstream passage structures, a site assessment is critical. The development of these models gives resource agencies valuable information into the hydraulic cues which may elicit a response from upstream migrants. For downstream passage, the USFWS has approach velocity guidelines; the output from these models would inform the resource agencies under what conditions appropriate approach velocities are being met and when they are being exceeded.

Project Nexus

The Turners Fall project has direct impacts to upstream and downstream migrating shad and eel. Our mandate from the Federal Power Act is that migrating fish have access to safe, timely and effective passage at hydro-electric facilities.

With respect to upstream migration, the auxiliary water system (AWS) plays a critical role in determining whether or not fish are attracted to the entrance. The results from this study would allow us to assess how well the AWS is performing and under what conditions it attracts the most fish.

With respect to downstream migration, as a general rule, fish tend to follow the flow. If flow fields are directing fish towards the turbine intakes, the results from this study will indicate that. The development of a CFD model under existing conditions also informs the design of future modifications. The development of a CFD model could be used to improve the survivability of downstream migrating shad and eel.

Proposed methodology

A 3-dimensional CFD model has become and increasing common standard of analysis at hydro-electric projects around the nation. Within the Northeast region, we have seen these types of models developed at the Holyoke (P-2004), Brunswick (P-2284), Shawmut (P-2322), Milford (P-2534) and Orono (P-2710). We would expect to engage with the licensee in terms of determining the appropriate area and flows to be modeled. We expect that the spatial extent of the model at each study site will vary. Given the large number of ways that output from these models can be presented and the near infinite number of flows that could potentially be modeled, we would expect to consult with the licensee to reach agreed upon modeling efforts and scenarios to be examined.

Level of Effort and Cost

The cost of developing, running and testing a CFD model can vary tremendously; one large variable to determining the cost is based on the amount of existing bathymetric data the applicant currently has access to. It has been estimated that the cost of each CFD model could run as high as $50,000 assuming no bathymetric data currently exists (personal communication Brett Towler, USFWS). Proactive communication with resource agencies will reduce the cost and iterative effort. The level of effort is commensurate with that of the other projects listed above and is warranted considering the long-term of the license renewal. FirstLight did not propose a study to address this issue and it did not propose an alternate study.

6.13 Requested Study #13: Entrainment of migratory fish from the Connecticut River into the Northfield Mountain Pump Storage Project

The turbines used to pump water into the Northfield Mountain Reservoir and used to generate power from water released from this reservoir have the potential to entrain fish migrating upstream and downstream along the Connecticut River. Currently, our understanding of this potential impact is not well understood.

Goals and Objectives

The goal of the study is to determine the impact of NFMPS Project during pumping on entrainment of juvenile American shad, adult shad, and adult American eel, including early life stages.

The objective of the study is to quantify the number of migratory fishes entrained at the NFMPS intake on an annual basis in order to evaluate potential impacts to Trust species in the Turners Falls pool and migrants moving through the project area. This should be done through a combination of hydroacoustic monitoring and netting using various gear types to quantify and identify species of different life stages.

Resource Management Goals

The CRASC developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.
2. Achieve annual passage of 40 to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem.
3. Maximize outmigrant survival for juvenile and spent adult shad.

Based on the CRASC plan, we seek the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.

2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

The ASMFC has developed two documents related to the management of American eel:

1. Interstate Fishery Management Plan for American Eel. April 2000. Atlantic States Marine Fisheries Commission.
2. Addendum II to the Fishery Management Plan for American Eel. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

Objectives of the management plan include: (1) protect and enhance American eel abundance in all watershed where eel now occur; and (2) where practical, restore American eel to those waters where they had historical abundance but may now be absent by providing access to inland waters for glass eel, elvers, and yellow eel and adequate escapement to the ocean for pre-spawning adult eel.

Addendum II contains specific recommendations for improving upstream and downstream passage of American eel, including requesting that member states and jurisdictions seek special consideration for American eel in the FERC relicensing process.

In addition, the CRASC developed A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin in 2005. The goal of the plan is "to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem…" Management objectives in the plan include the following:

1. Protect and enhance eel populations where they currently exist;
2. Where practical, restore populations to waters where they had historical abundance;
3. Provide effective upstream and downstream fish passage around dams and other barriers within the species' range in the basin; and
4. Comply with all requirements of the Fishery Management Plan of the ASMFC.

Specific to resident riverine and migratory fish entrainment, our goals are:

1. Minimize current and potential negative project operation effects such as turbine entrainment that could hinder management goals and objectives.
2. Minimize project-related sources of mortality to resident and migratory fishes in order to restore natural food web interactions and ecosystem functions and values.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), and the Federal Power Act (16 U.S.C. §791a, *et seq*.)

Public Interest

The requestor, NMFS, is a federal resource agency.

Existing Information and Need for Additional Information

Limited project specific information exists regarding entrainment of fish and aquatic organisms at the NFMPS facility. As part of a Memorandum of Agreement between then-owner NUSCO and regulatory agencies, NUSCO conducted studies to determine the impact of NFMPS station on anadromous fishes, including Atlantic salmon, American shad, and blueback herring. Results of a pilot study conducted in the fall of 1990 indicated that trap netting at the intake was ineffective at collecting fish. Gill netting and boat-shocking did result in collection of some juvenile shad, but further refinement in both methods was recommended to improve effectiveness. A total of 78 fish were collected at the intake (77 of which were American shad) by gill netting and 11 shad were collected by boat electrofishing. Hydroacoustic monitoring was deemed an effective method for monitoring entrained fish during pumpback operation. Hydroacoustic sampling over a two-week period (September 12-27, 1990) produced hourly entrainment estimates that cumulatively equaled 14,816 fish.

Based on the results of the pilot study, NUSCO developed a two-year plan to quantitatively determine the number of shad and salmon entrained at NFMPS station. In 1992, an entrainment study targeting juvenile American shad life stages was conducted in the lower (mainstem river) and upper reservoirs of NMPS. The study used several gear types to quantify egg through juvenile shad densities in different areas. Entrained juveniles were sampled using an upper reservoir net. Pumping operations were modified to only run three (77% of sample time) and sometimes two (23% of sample time) of the station's four units during the study and effort was limited to a total of 80 hours over a period spanning 9 August through 27 October (80 days). An estimated total of 1,175,900 shad eggs, 2,744,000 yolk-sac larvae, 10,525,600 post yolk-sac larvae, and 37,260 juveniles were reported entrained.

An additional study request seeks to obtain a more accurate documentation of all fish species inhabiting or utilizing the Turners Falls impoundment.

Project Nexus

Entrainment of fish and aquatic organisms associated with water withdrawal and hydroelectric operations has been documented to result in injury or death of entrained organisms. Migratory pass through the project area directly in front of the pump intakes. These organisms may be entrained and thus exposed to passage though the project pumps and reservoir supply tubes. How far these species and life stages may be drawn from, on a pumping cycle or over the course of time (repeated daily cycles of pumping and discharge), in relation to habitat and river conditions is unknown. Regardless of whether fish survive the pumping process, they are lost to the Connecticut River system. Depending on the species, life stages, and numbers entrained, this loss could impact the ecosystem productivity of the Turners Falls pool and may hinder restoration goals for diadromous fishes.

Previous entrainment studies have been conducted at the project. Those studies, which were done 20 years ago, documented entrainment of American shad and Atlantic salmon at the project, included over 13 million yolk sac and post yolk sac larvae of American shad. This level of entrainment is cause for concern, not only due to the resultant loss of potential adult returns, but for the important role early life history phases and juveniles play in their ecological contributions to the system (e.g., trophic interactions).

Since the previous studies were conducted, operations at the NFMPS facility have changed (e.g., the project increased the efficiency of its turbines, raising the pumping capacity from 12,000 cfs up to 15,000 cfs), as have river conditions (e.g., Vermont Yankee has increased its thermal discharge and the Vernon Project has increased its station capacity). Further, the PAD indicates that FirstLight will evaluate the feasibility of utilizing an additional 3,009 acre-feet of storage capacity to generate an additional 1,990 MWhs (this represents a 23% increase over existing storage and stored generation levels). While not specified in the PAD, increasing storage and generation would mean longer periods of both pumping and generation at NFMPS. In addition, anticipated improvements in fish passage at the Turners Falls project will result in increased juvenile production above the NFMPS. These factors, individually or cumulatively, could increase the potential for entrainment at NFMPS station. Evaluation of the fish behavior and potential for entrainment and impingement impacts is needed to inform a decision on the need for downstream fish passage and protection measures in the license and contribute to an administrative record for potential Section 18 fishway prescriptions.

Proposed Methodology

Previous studies used varying methodologies for determining entrainment. The 1990 study concluded that hydroacoustic monitoring at the intake was a viable method for determining entrainment of later life stages, but does not allow for identification of the species being entrained. While trap netting was ineffective at collecting fish near the intake, gill netting and boat shocking did capture some fish. Both may prove to be viable sampling methods; however it is likely that additional testing and gear refinement will be necessary.

The 1992 study used nets at the pump discharge location into the upper reservoir to collect entrained fish. Testing showed that this method was only 10% efficient. Plankton netting in the nearfield area of intake was used to estimate entrainment of ichthyofauna. It is likely that a combination of methods would provide the most reliable results (e.g., hydroacoustic monitoring at the racks during pumpback operations, variable gear sampling in the vicinity of the intake immediately prior to initiation of pumpback operations to determine species composition, and plankton netting in the nearfield area of the intake to obtain information on entrainment of ichthyofauna). As these methodologies have previously been utilized at the site, they are consistent with accepted practice.

Although a previous entrainment study was conducted, we believe it should be repeated, using a modified study design. The 1992 study only collected a total of 330 juvenile shad over a three-month period (resulting in an overall estimate of 37,260 juveniles entrained, after accounting for poor net efficiency); whereas the hydroacoustic study conducted in 1990 estimated nearly 15,000 fish in 15 days (while these fish were not identified, 77 of the 78 fish collected at the intake during the study were juvenile shad). It also should be noted that in the 1992 study, juvenile shad were collected on the first day of sampling, indicating that the sampling did not begin early enough, which would mean the results are an underestimate of the number of juvenile shad that were actually entrained. In 1990, 27,908 adult shad passed the Turners Falls gatehouse, while in 1992 over 60,000 shad passed gatehouse. The fact that the numbers entrained were so variable between study years argues for repeating the study, using a combination of previously-used methodologies.

The study will require deployment of at least five hydroacoustic transducers (one per rack face and one offshore). These transducers would be operated during every pumping cycle from April 15 through May 14 to assess riverine fish entrainment, from May 15 through July 15 for spent adult shad, and from July 16 through November 30 for entrainment of adult silver eels, juvenile American shad, and riverine fishes. Concurrent field sub-sampling at the intake to determine species composition would need to occur.

Level of Effort and Cost

We know of no other tool that will provide for this type of assessments for all fish species and organisms that may pass through the project. Cost is expected to be high. The study will require deployment of at least five hydroacoustic transducers (one per rack face and one offshore). These transducers would be operated during every pumping cycle from April 15 through May 14 to assess riverine fish entrainment, from May 15 through July 15 for spent adult shad, from July 16 through August 14 to assess riverine fish entrainment and from August 15 through November 30 for entrainment of adult silver eels and juvenile American shad. Concurrent field sub-sampling at the intake to determine species composition would need to occur. Data analysis would require moderate effort.

The applicant did not propose any studies to meet this need in the PAD.

6.14 Requested Study #14: Study of shoreline erosion caused by Northfield Mountain Pumped Storage (NMPS) operations

With approval for construction of the Northfield Mountain Project in 1968, and the use of the Turners Falls Impoundment as the lower impoundment for pumped storage operations, the Turners Falls Impoundment was enlarged to provide an additional 12,600 acre-feet of useable storage by raising the normal water surface elevation approximately 5.4 feet to elevation 185 feet mean sea level at the Turners Falls Dam. Operations began in 1972; since then all project operations have operated under this raised dam environment. The operation of NMPS causes alterations to the river as a direct feature of plant functionality. The alterations include: 1) daily fluctuating pond levels which at times in some places can exceed six feet (the license allows fluctuations up to 9 feet measured at an undisclosed location near and upstream of the Turners Falls dam), 2) altered flow and velocity profiles of river and 3) changes to the downstream hydrograph. Elevation data of the head pond in Appendix E of the PAD indicate that stage changes of 2 to 3 feet during the summer of 2012 were not uncommon. The additional 5.4 foot elevation increase in the headpond resulted in motorized boat traffic becoming more popular and makes the use of larger boats more possible. The presence of motorized recreational boats increases wake energy that can accelerate bank erosion rates.

Raising the level of the headpond can saturate bank soils. These same soils can quickly become dewatered when the headpond is lowered. Repeated saturation and dewatering of banks can lead to bank instability which in turn can lead to bank failure and eroded material entering the river. See Field (2007) for an extended discussion on bank erosion and failure mechanics. Elevated levels of turbidity and suspended solids in the water column can diminish rearing and migratory habitat for fish. When too much fine grain material is deposited on channel bed substrates, particularly those substrates used for spawning, spawning success of resident and migratory fish is compromised, potentially reducing recruitment and carrying capacity.

Goals and Objectives

The goals of this study request would be to determine the environmental effects of the presence and operation of the licensed facilities on river bank stability, shoreline habitat, agricultural farmland, wetland resources, bed substrate, and water quality in the Turners Falls impoundment. We recognize that data from other studies will be made available and we think that the data from these other studies could be used to help meet the objectives of this study request.

Objectives of the study include the following

1. Calculate the total volume of eroded material, calculate resulting nutrient loading of eroded material, and document and describe the three dimensional changes to the bank, including lateral bank recession, changes to bank slope, and the presence and subsequent inundation of pre-project beaches and shoreline since the Turners Falls Dam was raised and the Northfield Mountain Pumped Storage facility came on-line.

2. Document and describe the changes to banks upstream and downstream of riverbank restoration projects, including bank recession.
3. Identify the changes that have occurred to bed substrate as a result of fine grain material being eroded from the banks and being deposited on the channel bed.

Relevant Resource Management Goals

Our management goal is to ensure high quality habitat for migratory diadromous fish. Shortnose sturgeon, American shad and American eel all require suitable spawning, rearing, migratory and foraging habitat. Eroding banks and subsequent increases in turbidity and deposition of fine grained material onto bed substrates in the Turner's Falls headpond, the bypass reach and downstream of the Turner's Falls project reduces the quality of habitat for these species. Elevated levels of suspended sediment are associated with a diminution in water quality which also affects the quality of habitat encountered by trust resource species.

In addition to habitat effects, soil erosion contributes to nutrient loading. In 2001, the U.S. EPA approved New York and Connecticut's Long Island Sound (LIS) dissolved oxygen Total Maximum Daily Load. As a result, the New England Interstate Water Pollution Control Commission (NEIWPCC) established the Connecticut River Workgroup and the Connecticut River Nitrogen Project. This project is a cooperative effort involving staff from NEIWPCC, the states of Connecticut, Massachusetts, New Hampshire, and Vermont, and EPA's Region 1 and Long Island Sound (LIS) offices. All are working together to develop scientifically-defensible nitrogen load allocations, as well as an implementation strategy, for the Connecticut River Basin in Massachusetts, New Hampshire, and Vermont, which are consistent with Total Maximum Daily Load allocations established for LIS. Since its inception, the Connecticut River Workgroup has participated in a number of projects to better understand nitrogen loading, transport, and reductions in erosion.

Public Interest

The requestor, NMFS, is a federal resource agency.

Existing Information and Need for Additional Information

The PAD makes reference to several studies in section 4.2.4 including the Erosion Control Plan (Simons & Associates, 1999), previous Full River Reconnaissance studies (1998, 2001 – maps but no report generated, 2004, and 2008), Field Geology Services' 2007 fluvial geomorphic investigation of the Turners Fall headpond, and 2012 investigations by Simons & Associates.

Field Geology Services' 2007 investigation provided several good recommendations for future work in section 9.3 of this report which, if implemented, could provide for: a) an improved understanding of the causes of erosion; b) more accurate monitoring of erosion; and c) more successful bank stabilization efforts. This document is a good point of reference. Conversely, The Simons & Associates' (2012) documents are qualitative and based on several unstated assumptions that may not be valid. Full River Reconnaissance efforts have been undertaken using varying methodologies, making for difficult comparisons from one report to the other.

We believe that these existing studies do have data that can be useful if certain new analyses are undertaken. These analyses of existing data would help fill in our gaps of understanding of bank erosion in the Turners Fall headpond. We are also asking for some additional field collected data. With the existing information, it should be possible to better display what changes have occurred to streambanks over time. Current Geographic Information System (GIS) software allows for various types of data to be assembled into a map and into a database such that change over time analysis can be conducted fairly easily. The change over time analysis is a critical analysis that is needed, and was already started under Field (2007).

Photos that have been taken at or near the same location but at different times exist. For example, the last three Full River Reconnaissance efforts have included continuous videotaping of the river banks with locational information. With these data, "snapshots" of the bank at various locations could be extracted and compared over time. Field (2007) photo locations could be re-shot as well. This existing information should be presented such that it is easy to discern where the photo was taken and what changes have occurred over time. A comparison of the bank every 100 ft could be compared over the years.

Historic aerial photography for the Turners Fall headpond should be gathered and analyzed. Examples of good photographic datasets include the Field 2007 appendices and 1929 aerials. The location of the shoreline over time should be noted such that it is easy to discern where bank retreat has been most severe and where the river has been relatively stable since the earliest aerial photograph was taken.

Very little turbidity data for the Turner's Falls headpond, the bypass reach or stretches of the Connecticut River downstream of the Turner's Fall project exist. Thus far, implementation of the *Northfield Mountain Pumped Storage Project Sediment Management Plan* (revised February 15, 2012) has yielded few results, and many technological difficulties (see *2012 Sediment Management Plan – 2012 Summary of Annual Monitoring* dated November 30, 2012). Suspended sediment monitoring equipment is installed at the Route 10 Bridge upstream of the project and inside the powerhouse, theoretically taking readings representative of pumping and discharging through the turbines. An analysis of how turbidity might change relative to rapidly changing headpond levels would be very useful information.

Project Nexus

The construction of the NMPS project was contingent upon the Turner's Falls project raising the dam crest elevation by 5.9 feet. The NMPS project operations rely on the Turner's Falls headpond as the source of water to be pumped and to be discharged into. The importance of this river reach to the NMPS operation is made clear by FirstLight's reference to this portion of the river as the "lower reservoir." Daily pumping and discharging changes the ponded elevation of the Connecticut River which in turn leads to bank material that repeatedly becomes saturated and then dewatered. Weakened bank material can then become eroded and the fine grain material from the banks can enter the water column and be transported in suspension in the river and eventually settle onto bed material. The raising of the Turner's Falls headpond also made recreational boating more popular, including the introduction of large, high-horsepower powerboats that were not previously present. Because of the fluctuating water levels, boat wakes impact the shoreline to a much greater extent than would occur if levels were more constant, thus exacerbating both the effects of the wakes and the fluctuating levels. For these reasons, erosion caused or contributed by NMPS project operation can negatively affect spawning, rearing and migratory habitat for trust species and the endangered shortnose sturgeon. The requested study will help inform the Commission when contemplating mitigation measures and or operational modifications.

Proposed Methodology

1. This study should determine the net soil loss in cubic yards between 1970 and the present; a density estimate of the eroded material should also be provided. Provide an analysis of where the greatest loss has occurred, location of proximity to the tailrace, soil type, riparian land use, and vegetative cover in that area. Calculate nutrient loadings (nitrogen and phosphorus compounds) to the river system based on soil loss. Obtain copies of the original survey plans for the project, and complete a new survey using the same landmarks used previously. The Field (2007) report states on page 11 that the original survey plans of the river are still retained by Ainsworth and Associates, Inc. of Greenfield MA. Use pre-operation aerial photos and current aerial photos to complete a 10-foot topographic map of the section of river between Turners Falls Dam and Vernon Dam and the 200-foot buffer regulated under the Massachusetts Rivers Protection Act. The Field (2007) report on page 11 states that Eastern Topographics, Inc. determined that sufficient information is known about the 1961 aerial photos (e.g., height of airplane) to create a 10-foot topographic map of that time period, and that 1961 aerial photos could be accurately overlayed with recent aerial photos. Field (2007) states that this analysis would enable a more reliable determination of small-scale shifts in channel position and changes in bank height that may have resulted from the erosion of a low bench that previously existed along portions of the river. Among other things, create a single map showing areas of erosion and deposition, and also overlay the Field report's hydraulic modeling analysis of the river channel.
2. With respect to the January 22, 2013 submittal from FirstLight to FERC regarding its long term monitoring transects in the Turners Fall impoundment, we ask that any data errors (as discussed in Field, 2007) and problems that have occurred over the years at each site be mentioned. We also ask that that an analysis for each cross section extending to the top of the bank and including a portion of the floodplain be provided.
3. Take the information presented in Figure 4.2.3-1 "Soils in the vicinity of Turners Falls and Northfield Mountain projects" in the PAD and convert from 63 categories to just a few that are defined in a key that will allow readers to understand which soils are easily erodible, which aren't, and where there is bedrock along the banks.
4. Complete detailed surficial mapping (topographic map or LIDAR) to identify the various geomorphic surfaces, height of benches/terraces above the river level, and types of sediments underlaying the surfaces. This will allow one to determine how erosion varies with geomorphic conditions. One could then normalize the amount of erosion to a specific type of bank material/geomorphic surface/terrace.
5. Another information request covers the range of daily water level fluctuations. In this study request, we ask for an analysis on the degree to which boat wakes increase that fluctuation range. The task would be to observe boat wakes under a range of boat sizes and flow rates on the river. We recommend the 2007 Field report recommendation which states, "A more thorough study of boat waves is merited to better document how many boats use the Turners Falls Pool, how fast they travel, the type and size of waves they produce, and their impact on shoreline erosion."

A component of this study request is not necessarily for new data, but for existing data to be presented in a more clear, coherent and comprehensive manner. All existing photographs of banks that have been collected either by FirstLight, on behalf of FirstLight or on behalf of the Franklin Regional Council of Governments Streambank Erosion Committee should be georeferenced in such a way such that it is easy to discern where the photograph was taken and the date should be easily discernible as well. These photos should be presented in a manner that makes it easy to visually see how a particular section of bank has changed over time. Providing geographic context for photographic data of river banks and making these photos comparable over time should be standard practice. The 2007 Field report contains the following recommendation on page 47: “An attempt should be made to overlay the 1961 aerial photographs with a current flight and to create a topographic map from the 1961 flight. The feasibility of this effort has been confirmed by Eastern Topographics, Inc. This effort will identify the previous extent of the low bench and identify areas of the most significant bank recession the past 45 years.” Given that this statement was written in 2007, we request that that the analysis is extended to current conditions.

Given the complexity of this study request and the expertise necessary to implement it, we request that the resources agencies be involved with the selection of the hired consultant.

Level of Effort and Cost

The level of effort to compile existing information and to make the data available in a map and searching for existing bed substrate material data is a simple task that can be completed with little effort. The level of effort for the bed sampling work will vary based upon how much existing historic information exists. Much of the effort of this study request is essentially office work that compiles and better presents existing data. While an estimate on the amount of field time required is difficult to make, we estimate that up to two weeks of field work could be required and some of the data collection could be done while other field studies are occurring.

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Glenn Normandeau
Executive Director

February 27, 2013

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E., Room 1A
Washington, DC 20426

RE: Study Requests for FERC Hydroelectric Projects P-1889 (Turners Falls) and P-2485 (Northfield Mountain)

Dear Secretary Bose:

As the agency responsible for protecting fish and wildlife resources in New Hampshire, the New Hampshire Fish and Game Department (NHFGD) monitors and attempts to reduce the impacts of hydroelectric facilities on fish and wildlife species and their habitats. The mission of the NHFGD is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources. The NHFGD's 1998-2010 Strategic Plan contains four goals relevant to the relicensing process under the Federal Energy Regulatory Commission (FERC). These goals are to ensure that New Hampshire:

1) has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.

2) has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.

3) has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.

4) Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

Participation in the relicensing process for hydroelectric projects falls under one of the many strategies outlined in New Hampshire's Wildlife Action Plan. Wildlife Action Plans, completed in 2005, were required from each state by the United States Congress as a proactive strategy to "conserve wildlife and vital natural areas before they become more rare and more costly to protect". New Hampshire's Wildlife Action Plan contains three objectives relevant to the hydropower relicensing process.

Objective 507: Restore or maintain natural flow regimes.
Objective 508: Restore and maintain watershed continuity.
Objective 701: Protect riparian / shoreland habitat and other wildlife corridors.

In addition to these objectives, the New Hampshire Wildlife Action Plan identifies a number of fish and wildlife species of concern, which may be impacted by the projects under review. We hereby submit the New Hampshire Wildlife Action Plan to the FERC for consideration in determining whether it qualifies as comprehensive plans pursuant to Section 10(a)(2)(A) of the Federal Power Act. The complete New Hampshire Wildlife Action Plan is available online at: http://www.wildlife.state.nh.us/Wildlife/wildlife_plan.htm.

The NHFGD has reviewed the Preliminary Application Documents and Scoping Documents for the relicensing of the following hydropower projects owned by FirstLight Power Resources:

Northfield Mountain
FERC Project No. 2485

Turners Falls
FERC Project No. 1889

The NHFGD supports the following study requests submitted by other partners within the Connecticut River watershed. Although the two FirstLight projects (Turners Falls and Northfield Mountain) are not located in the New Hampshire portion of the Connecticut River, we feel it is prudent to comment on these projects and support study requests related to these projects because the FirstLight projects have the potential to impact fish migrating to and from New Hampshire waters. For example, American eel, American shad and sea lamprey all have to successfully migrate upstream past the FirstLight projects in order to reach New Hampshire waters. Additionally, fish that are reared (American shad and sea lamprey), spawn (American shad), and grow to maturity (American eel) in New Hampshire portions of the Connecticut River watershed all have to successfully migrate downstream past FirstLight projects in order to complete their life cycle. Finally, the influence of the Turners Falls Dam extends into New Hampshire portions of the Connecticut River.

The following formal study requests will expand on the information presented in each Pre-Application Document (PAD) and lead to informed management decisions intended to reduce impacts on fish and wildlife. It is understood that there is overlap between some of the requested studies, and where appropriate, the NHFGD supports the combination of studies to reduce cost and effort as long as the goals and objectives within each individual study proposal are still achieved.

Thank you for this opportunity to comment.

Sincerely,

Glenn Normandeau
Executive Director

Study Request 1: Telemetry Study of Upstream and Downstream Migrating Adult American Shad to Assess Passage Routes, Effectiveness, Delays, and Survival (Docket Number p-1889) (Docket Number p-2485)

Goals and Objectives

Assess behavior, approach routes, passage success, survival, and delay by adult American shad as they encounter the projects during both upstream and downstream migrations, under permitted project operations conditions, proposed operational conditions, and study treatment operational conditions at First Light Power's Turners Falls and Northfield Mountain Pumped Storage projects and TransCanada's Vernon Project. There are multiple fishways and issues related to both upstream and downstream passage success at the projects. Some of these issues at the Turners Falls Project are similar to and/or pertain directly to the Northfield Mountain and Vernon projects. Therefore, it is reasonable to address passage issues at all projects in a similar manner.

Telemetry Study - This requested study requires use of radio telemetry using both radio and Passive Integrated Transponder (PIT) tag types to provide information to address multiple upstream and downstream fish passage issues. The following objectives shall be addressed in these studies:

- Assessment of any migration delays resulting from the presence of the dam and peaking flow operations of the Turners Falls Project;
- Determine route selection and behavior of upstream migrating shad at the Turners Falls Project under various spill flow levels (e.g., movement to the dam, attraction to Cabot Station, attraction to Station 1 discharge, movement between locations, delay, timing, etc.). A plan and schedule for dam spill flow releases will need to be developed that provides sufficient periods of spill flow conditions, and various generating levels from Turners #1 Station coupled with Cabot Station generation flows (e.g., treatments will require multiple days of consistent discharge). Evaluated spill flows should include flows between 2,500 – 6,300 cfs, which relate to bypass flows identified as providing spawning opportunities for shortnose sturgeon in the lower bypass reach at the Rock Dam. (Kieffer and Kynard 2012). Sturgeon spawning and upstream shad passage occur concurrently;
- Assess near field, attraction to and entrance efficiency of the Spillway Ladder by shad reaching the dam spillway, under a range of spill conditions;
- Evaluate the internal efficiency of the Turners Falls Spillway Ladder;
- Continue data collection of Cabot Station Ladder and Gatehouse Ladder efficiency, to include rates of approach to fishway entrances, entry into fishways, and passage through them, under different operational conditions that occur in these areas;
- Evaluate modifications to the Cabot and/or Spillway fishways recommended by the Service if they are implemented;
- Assess upstream migration from Turners Falls to the Vernon Dam in relation to Northfield Mountain's pumping and generating operations and Vernon Project peaking generation operations. Typical existing and proposed project operation alterations should be evaluated;
- Assess near field, attraction to and entrance efficiency of the Vernon Dam Ladder;
- Assess internal efficiency of the Vernon Dam Ladder;
- Assess upstream passage past Vermont Yankee's thermal discharge (also located on the west bank of the river 0.45 mile upstream of fish ladder exit)
- Assess upstream migration from Vernon Dam in relation to the peaking generation operations of the Bellows Falls Project. Typical existing and proposed project operation alterations should be evaluated;

- Determine post-spawn downstream migration route selection, passage efficiency, delays and survival related to the Vernon Project, including evaluation of the impact of the Vermont Yankee heated water discharge plume on downstream passage route, migrant delay/timing, efficiency and survival;
- Assess impacts of Northfield Mountain operations on up- and downstream adult shad migration, including delays, entrainment, and behavioral changes and migration direction shifts under existing and proposed project operations;
- Determine downstream passage route selection, timing/delay, and survival under varied project operational flows into the power canal and spill flows at Turners Falls Dam;
- Determine downstream passage route selection, timing/delay in the canal, Cabot Station fish bypass facility effectiveness, and survival of Cabot-bypassed adult shad that enter the Turners Falls Canal system;
- Compare rates and or measures of delay, movement and survival etc., among project areas or routes utilized (e.g., spill at dam vs. power canal) under the range of permitted and proposed conditions; and
- Utilize available data sets and further analyze raw data (e.g., 2003- 2012 Conte Lab Studies) where possible to address these questions and inform power analyses and experimental design.

Information to address all of these questions would rely on the tagging of upstream migrating adult shad at Holyoke Dam and releasing them to migrate naturally from Holyoke through the Turners Falls and Vernon projects and back downstream after spawning. Additional tagged individuals would likely need to be released farther upstream (Turners Falls Canal, upstream of Turners Falls Dam, and upstream of Vernon Dam), to ensure that enough tagged individuals encounter project dams on both upstream and downstream migrations, that these individuals are exposed to a sufficient range of turbine and operational conditions to test for project effects, and to provide adequate samples sizes for statistically valid data analyses to address the many objectives listed. This study will require two years of field data collection to attempt to account for inter-annual variability in river discharge and water temperatures.

Evaluation of Past Study Data- In addition to collection and analysis of new telemetry data, substantial data has already been collected at Turners Falls from multiple years of passage assessments conducted for First Light by U.S. Geological Survey's Conte Anadromous Fish Research Center (Conte Lab) researchers and there are also data from the 2011 and 2012 full river study conducted by the Conte Lab that address Turners Falls, Northfield Mountain and Vernon project migration and passage questions that have not yet been analyzed. These data include several million records each year from more than 30 radio telemetry receivers deployed between Middletown, CT and Vernon Dam. This data will provide substantial information free from the field data collection costs and therefore should be analyzed as part of this study. This data analysis should be completed in 2013 to help inform the design of subsequent field studies.

Evaluation of Methods to Get Shad Past Cabot Station for Spillway Passage at the Turners Falls Dam – The poor passage efficiency of the Cabot Ladder, the first and most used fishway encountered by shad arriving at the Turners Falls Project, and at the entrance to the Gatehouse Ladder, which all Cabot fishway-passed fish must use, has resulted in very poor overall shad passage efficiency at the project. An alternative to passing fish at the Cabot Station is to install a fish lift at the dam that would put fish directly into the Turners Falls pool, thereby eliminating problems with the Cabot Fishways, and the Gatehouse Fishway entrance and the variable passage efficiency of the Gatehouse Fishways. For this to be effective, attraction of shad to the Cabot Station discharge and associated delays would need to be overcome. It is possible that spillway flow releases coupled with behavioral measures at Cabot Station that dissuade shad from that tailrace could achieve this end. In order to assess the possibilities, we recommend the following study:

1. A literature search and desk-top assessment of the possible behavioral measures that could be effective in getting shad to pass Cabot Station tailrace and continue upstream to the dam.

2. Based on results of the desk-top assessment, possible evaluation of behavioral measures that are likely to be effective.

3. Field evaluation of the effect of different levels of spill at the dam that would induce fish to move past the Cabot Station into the bypass reach and up to the dam (as noted in objectives).

Besides passage success and delays at passage facilities, these studies would assess the impacts of project operations on migration passage delay, route, timing, injury, mortality, and passage structure attraction, retention, and success. Of particular interest will be fish behavior during periods when flow releases from the project increase from the required minimum flows to peak generation flows and when flows subside from peak generation flows to minimum flows and the operation of NMPS in pumping and generation modes.

Resource Management Goals

The Connecticut River Atlantic Salmon Commission (CRASC) developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually. (Table 1)

2. Achieve annual passage of 40 to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem.

3. Maximize outmigrant survival for juvenile and spent adult shad.

The Atlantic States Marine Fisheries Commission, Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010 includes the following objective:

1. Maximize the number of juvenile recruits emigrating from freshwater stock complexes.

And recommendations:

Upstream Passage –
1. American shad must be able to locate, enter, and pass the passage facility with little effort and without stress.
2. Where appropriate, improve upstream fish passage effectiveness through operational or structural modifications at impediments to migration.
3. Fish that have ascended the passage facility should be guided/routed to an appropriate area so that they can continue upstream migration, and avoid being swept back downstream below the obstruction.

Downstream Passage –

1. To enhance survival at dams during emigration, evaluate survival of post spawning and juvenile fish passed via each route (e.g., turbines,, spillage, bypass facilities, or a combination of the three) at any given facility, and implement measures to pass fish via the route with the least delay and best survival rate.

Based on the CRASC plan, the Service seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to American shad movement and migration, the Service's goals are:

1. Minimize current and potential negative project operation effects such as migration delays, false attraction, turbine entrainment, survival of project passage routes, and trashrack impingement that could hinder management goals and objectives.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), Silvio O. Conte National Fish and Wildlife Refuge Act (P.L. 102-212; H.R. 794), the Federal Power Act (16 U.S.C. §791a, *et seq*.), the Atlantic States Marine Fisheries Compact (P.L. 539, 77th Congress, as amended by P.L. 721, 81st Congress), and the Atlantic Coastal Fisheries Cooperative Management Act (16 U.S.C. 5107)..

Public Interest

The requestor is a federal natural resource agency. Migratory species of fish are a trust resource for the Service due to their interjuristictional movements. Protection and restoration of these fish is a key objective for the Service.

Existing Information

Passage of adult shad at the Turners Falls fishway complex has been the subject of intense study by the Conte Lab since before 1999. These studies have clearly demonstrated that passage through the existing fishways at Cabot and Spillway is poor (<10% in many years). Passage through the Gatehouse fishway is better, but still rarely exceeds 80%, despite the short length of this ladder. In addition to poor passage for fish entering the ladders, shad that ascend the Cabot Fishway experience extensive delays before entry into the Gatehouse Fishway. Shad that ascend Spillway frequently fall back into the canal and are also subject to these upstream delays. A new entrance to the Gatehouse Fishway installed in 2007 led to dramatic improvements in passage out of the canal (from 5% to over 50% in 2011), but passage still falls well short of management goals. In addition, shad spend considerable time (up to several weeks) attempting to pass. These delays likely influence spawning success and survival. Adult shad, unable to pass Gatehouse, experience similar delays in downstream passage, even after they have stopped trying to pass Gatehouse. Without spill, all outmigrating shad that have passed Gatehouse must enter the canal at the Gatehouse and may be subject to delays exiting the canal.

During the course of these studies a very large dataset has been compiled that could yield useful information for further improving passage of shad out of the canal in both the upstream and downstream directions. A unique feature of these data is a 2-dimensional array covering the canal just downstream of Gatehouse, documenting fine scale movements and occupancy of this zone. These data should be combined with computational fluid dynamics (CFD) and real-time hydraulic data to determine how canal hydraulics influence the ability of shad to locate and enter the fishway, and to identify modifications that are likely to lead to improvements in approach and entry rates. A separate CFD modeling study is requested that includes modeling of the Gatehouse Fishway entrance are at the head of the power canal.

In addition, whole-river shad telemetry studies performed in 2011 and 2012 will likely provide useful information and should be analyzed. These data should allow quantification of delay below Turners Falls, and could help guide studies requested above. Preliminary analyses of data through 2011 have been made available to FirstLight and the resource agencies (Castro-Santos and Haro 2005; Castro-Santos and Haro 2010).

The whole-river studies have also shown that, at least in 2011, most shad that pass Turners Falls rapidly progress upstream to Vernon Dam where extensive delays also occur. Data from the 2012 study were not available at this time, but Dr. Castro-Santos stated similar patterns were noted in the data between the years on the topic of upstream delay (personal communication, Dr. Theodore Castro-Santos). Similarly, concerns relative to the downstream passage of spent shad also remain relative to delays, with existing unpublished USGS telemetry data sets suggesting this is an issue within the Turners Falls canal.

Since the first year of operation of the Turners Falls upstream fishways (1980), the percent passage of American shad annually passed upstream of Turners Falls Dam compared to the number passed at the Holyoke Fish Lift has averaged 3.6% (1980-2012 data). The highest values for this metric has not exceed 11% and are well below the noted CRASC Management Plan target range for this objective noted earlier as 40-60% on a five year running average.

Since the first year of operation of the Vernon Dam upstream fish ladder (1981), the percent passage of American shad annually passed at Vernon compared to the number passed upstream of Turners Falls Dam (Gatehouse counts) has averaged 39.4%, ranging from 0.42% to 116.4% (> 100% due to counting error at one or both facilities, unknown).

Nexus to Project Operations and Effects

Existing project operations (peaking power generation) and limited bypass flows have a direct impact on instream flow and zones of passage (migration corridors). Project flow releases affect passage route selection, entry into fishways, and create delays to upstream migration. Inefficient downstream bypasses can result in migration delays and increased turbine passage. Mortality of adult shad passing through these turbines is expected to be high (Bell and Kynard 1985), additional stresses associated with passage and delay may cause mortality as shad are unable to return to salt water in a timely manner. The project's upstream and downstream passage facilities need to be designed and operated to provide timely and effective upstream and downstream fish passage to meet restoration goals of passage to upstream habitat and maximize post-spawn survival. These factors are all critically important to the success of restoration efforts.

Methodology

Use of radio including passive-integrated transponder (PIT) telemetry is widely accepted as the best method to assess fish migratory behavior and passage success and has been used extensively to assess migration and passage issues at Turners Falls as well as other Connecticut River projects. These studies include one conducted in 2011 and 2012 by the Service and U.S. Geological Survey's Conte Anadromous Fish Research Center, which has provided substantial information related to some of the issues identified here. The requested study will build and expand on the information collected over the past two years.

The study design must specify sample sizes, tag configurations and receiver configurations, to ensure that rates of entry and exit to the tailraces, fishways, downstream bypasses, and the bypassed reach can be calculated with sufficient precision to determine effectiveness of flow and ensonification treatments (separate Study Request). For project assessments at Turners Falls (e.g., Cabot, Spillway and Gatehouse ladder attraction and entry, route selection, operational effects), double tagged (radio and PIT) shad will be required for release from Holyoke Dam. Additional shad must be released directly into the Turners Falls Canal to support assessment of the various operational and structural conditions in effect, to be modified in this period, and proposed conditions within the Turners Falls power canal relative to entrances to the Gatehouse fishway. A related request on CFD modeling in the Cabot Station tailrace, the upper power canal near Gatehouse, and in the area around the entrance of the Spillway Ladder will address related project operational effects that will also address identified objectives in this telemetry request. Shad captured at Holyoke and tagged and release upstream of Turners Falls Dam, or tagged out of Gatehouse Ladder, would help to ensure an adequate sample size for evaluations in the vicinity of NMPS and to the Vernon Dam and the ability to address identified study objectives in those project areas. Additional tagged shad are expected to be required for release upstream of the Vernon Dam, which should ensure adequate sample for a separate study request, where shad spawn upstream of Vernon Dam as well as ensuring there is an adequate number of outmigrating spent adults to address related study objectives for adult outmigrants. The required number of tagged fish to address study objectives may be adjusted accordingly from area to area depending on target numbers (i.e., best information on resultant viable tagged fish and power analyses to detect effects) to account for typical passage rates, survival rates, and handling effects as examples.

Existing information on captured, handled, tagged fish performance (e.g., percent that drop back, unsuitable for tracking) and factors such as timing of tagging and potentially transport, must all be carefully considered to ensure an adequate sample size of healthy (e.g., viable to characterize behavior, survival, etc.) tagged fish is available to address the many questions identified in this request (as supported by a statistical power analysis). Additionally, ensuring adequate downstream adult fish sample sizes (to address project effect questions above) requires close consideration as expected losses of healthy tagged fish during upstream passage, natural mortality rates, and tagging related effects, are expected to reduce sample sizes on downstream passage objectives/questions as the season progresses. The use of single PIT tagged fish can help improve sample sizes, but will be of limited use to answer some of the passage questions we have identified.

Due to environmental variability, two years of study work will be necessary. A large array of stationary monitoring stations (radio and PIT) will be needed to address the issues identified among the project areas. A sufficient level of radio receiver and PIT reader coverage will be required, to provide an appropriate level of resolution, for data analyses, to answer these questions on project operational effects. The study will provide information on a variety of structural and operational aspects of fish migration, relative to route selection, timing, survival, and up and downstream passage attraction, retention, delay, efficiency, survival as some examples at three projects (Turners Falls, NMPS, and Vernon). The use of video monitoring may also be utilized for specific study areas such as the Spillway Ladder, to provide additional information on shad entrance activity, with the understanding of some data limitations associated with this approach (fish identification, water visibility). This study will be coordinated with the proposed study request to evaluate ensonification as a shad behavioral deterrent at the Cabot Station tailrace which will be an additional treatment of the telemetry study.

In addition to the tagging studies, use of video monitoring of the Spillway Fishway would provide additional overall data on Spillway Fishway efficiency as all shad attempting to pass could be monitored versus just those shad that have been tagged.

Level of Effort/Cost, and Why Alternative Studies will not suffice

The requested study is extensive and will require a substantial effort and cost to capture, PIT tag, and radio tag a sufficient number of shad at Holyoke to release at upstream locations. We are not aware of any other study technique that would provide project specific fish behavior and migration information to adequately assess existing project operations and provide insight in possible alternative operations and measures needed to address observed negative impacts to fish migration success. Cost for the entire multi-project tagging, tracking and data analysis are expected to range from $400,000 to $500,000 based on past Turners Falls' studies and the 2011 and 2012 shad telemetry studies. Video monitoring of the Spillway fishway would add a modest cost to this study.

Due to the fact tagged shad will move throughout the larger five project area, to varying degrees, there will be expected cost savings (e.g., radio tags) to both owner/operators, provided cooperation in study planning and implementation occurs.

Literature Cited

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Study Request 2: Evaluation of Timing of Downstream Migratory Movements of American Eels on the Mainstem Connecticut River (Docket Number p-1889) (Docket Number p-2485)

Goals and Objectives

The goal of this study is to better understand migration timing of adult, silver-phase American eels as it relates to environmental factors and operations of mainstem hydropower projects on the Connecticut River.

The objectives of this study are:

1. Quantify and characterize the general migratory timing and presence of adult, silver-phase American eels in the Connecticut River relative to environmental factors and operations of mainstem river hydroelectric projects

Resource Management Goals

The Atlantic States Marine Fisheries Commission has developed two documents related to the management of American eel:

1. Interstate Fishery Management Plan for American Eel. April 2000. Atlantic States Marine Fisheries Commission.
2. Addendum II to the Fishery Management Plan for American Eel. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

Objectives of the management plan include: (1) protect and enhance American eel abundance in all watershed where eel now occur; and (2) where practical, restore American eel to those waters where they had historical abundance but may now be absent by providing access to inland waters for glass eel, elvers, and yellow eel and adequate escapement to the ocean for pre-spawning adult eel.

Addendum II contains specific recommendations for improving upstream and downstream passage of American eel, including requesting that member states and jurisdictions seek special consideration for American eel in the FERC relicensing process.

In addition, the Connecticut River Atlantic Salmon Commission (CRASC) developed A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin in 2005. The goal of the plan is "to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem…" Management objectives in the plan include the following:

1. Protect and enhance eel populations where they currently exist;
2. Where practical, restore populations to waters where they had historical abundance;
3. Provide effective upstream and downstream fish passage around dams and other barriers within the species' range in the basin; and
4. Comply with all requirements of the Fishery Management Plan of the ASMFC.

Based on these plans, the Service seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to downstream passage of American eel, the Service's goals are:

1. Minimize current and potential negative project operation effects that could hinder management goals and objectives.
2. Minimize project-related sources of downstream passage delay, injury, stress, and mortality in order to maximize the number of silver eels migrating to the spawning grounds.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), and the Federal Power Act (16 U.S.C. §791a, *et seq*.).

Public Interest
The requester is a resource agency.

Existing Information
Data on timing of downstream migratory movements and rates of American eels in the mainstem Connecticut River are sparse and relatively incomplete. Preliminary data on presence of "eel-sized" acoustic targets have been collected (Haro et al. 1998) within the Turners Falls Project's Cabot Station forebay that were somewhat confirmed by video monitoring at the Cabot Station downstream fish bypass; however, these were short-term studies, with acoustic monitoring only performed from 17 September to 5 October and video monitoring only conducted between 18 September to 22 October.

Some daily monitoring of the downstream bypass at the Holyoke Dam (canal louver array) was performed in 2004 and 2005 (Kleinschmidt, Inc. 2005, 2006, Normandeau Associates 2007); these studies also were of relatively short duration (spanning from October 5 to November 10 in 2004 and September 9 to November 11 in 2005) and the sampler was only operated at night.

To date, no other directed studies of eel migratory movements have been conducted at any location on the Connecticut River mainstem. This information gap needs to be filled, as it relates directly to when downstream passage and protection measures need to be operated.

We also note that within the past seven years, the Service has received two petitions to list the American eel under the Endangered Species Act. The first petition was received on November 18, 2004. On July 6, 2005 the Service issued a substantial 90-day finding on the petition and initiated a 12-month status review that concluded on February 2, 2007 with a finding that listing was not warranted. The second petition was filed on April 30, 2010 by the Council for Endangered Species Act Reliability. On September 29, 2011 the Service issued a substantial 90-day finding and initiated a 12-month status review. The Service is still accepting new American eel information for the ongoing status review. The Service also is currently in settlement negotiations with CESAR on their legal complaint that the Service failed to complete the 12-month finding within the statutory timeframe. Although the date for completion of the Service's 12-month finding on the latest petition is uncertain, it is likely that it will be made before any new licenses are issued for the projects.
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Nexus to Project Operations and Effects
The timing of downstream migration of adult eels is poorly defined for the Connecticut River; therefore the general effects of hydroelectric project operations on eel survival to the ocean are unknown. Although separate study requests have been submitted to address project-specific downstream passage route selection, delays, and mortality of eels, general

characteristics of river flow and environmental conditions may have significant relationships with project operation and eel migratory success and survival. For example, eels may tend to move immediately before or during periods of significant precipitation (or consequently river flow); times at which projects may be generating at maximum capacity or spilling, which may (or may not) present a higher passage risk to eels. Conversely, periods of low flow may be associated with a significant proportion of total river flow passing through turbine units, which present additional (or different) passage risk to eels. If discrete conditions which promote eel downstream migration are known, it may be possible to take actions with respect to project operations which reduce or minimize passage risk; i.e., operation of a bypass, reduction of intake approach velocities, directed spillage through a "safe" route, etc. These studies should provide baseline information on river-specific downstream migration to predict when silver-phase eels are expected to be migrating in the mainstem Connecticut River, from which project operations could be modified to minimize passage risks.

The studies are proposed for a single or multiple sites; the results will be relevant to all sites on the Connecticut River mainstem.

Methodology Consistent with Accepted Practice

Quantification of downstream movements of American eels in river systems requires systematic sampling of migrants throughout the migratory season. This can be accomplished with traditional active trapping methods; i.e., fyke or stow net sampling, weirs, or eel racks, but these methods are technically challenging on larger mainstem rivers, due to the scale of flows that need to be sampled, difficulties in operation throughout all flow conditions, and high debris loading during fall flows. Passive monitoring of migrant eels using hydroacoustic methods offers an alternative to active trapping. However, passive monitoring requires verification of potential acoustic targets with some level of active (collection) or visual (traditional optical or acoustic video) sampling.

Two potential locations offer opportunities to conduct simultaneous passive and active sampling: the Cabot Station (Turners Falls project) canal/forebay and the Holyoke Dam forebay and canal louver/bypass system. Each location possesses a route of downstream passage which conducts a significant proportion of river flow (Cabot canal and Holyoke forebay or canal), and each has a proximal bypass equipped with a sampler so that fish can be concentrated/collected from the passage route and identified to species. Project operations do influence the relative proportion of flow (and thus numbers of downstream migrant eels) in each passage route, so numbers of eels sampled in each route represent only a proportion of the total number of eels migrating downstream within the entire river. Because the absolute proportion of eels using a specific route at any one time is unknown, numbers of eels quantified within a route must serve as a relative index of the degree of migratory movement.

This study shall quantify eel movements in either one, or preferably both, locations for two consecutive years (since environmental conditions strongly influence migratory timing of eels, which can vary significantly from year to year; Haro 2003). Eels will be quantified using methods similar to Haro et al. (1999), by continuously monitoring a fixed location at the projects with hydroacoustics. Because eels tend to concentrate in areas of dominant flow (Brown et al. 2009, EPRI 2001), the zone to be monitored should pass a dominant proportion of project flow throughout most periods of operation (i.e., forebay intake area). Hydroacoustic monitoring shall encompass the entire potential migratory season, beginning in mid-August and ending in mid-December, and shall operate 24 hours per day. Data will be recorded for later processing and archiving.

Systematic active quantification of eels at downstream bypass samplers shall be performed simultaneously with passive hydroacoustic monitoring, to verify presence of eels and relative abundance of eel-sized hydroacoustic targets from the hydroacoustic data. Although daily operation of the bypass sampler could be performed, a more comprehensive technique is to monitor eels entering the bypass with an acoustic camera (i.e. DIDSON, BlueView, etc.). The acoustic camera will afford positive visual identification of eels as they enter the bypass, which is a concentration point for migrating eels. Acoustic camera monitoring will also allow monitoring to be performed 24 hours a day, and will be relatively unaffected by water turbidity (which influences effectiveness of traditional optical video monitoring). The acoustic camera system will be operated during the same time period as acoustic monitoring, and images will be recorded for later processing and archiving.

Data analyses of hydroacoustic, acoustic camera, bypass sampling, and environmental/ operational data will follow standard methodology.

Project operation (flows, levels, gate openings, number of units operating and operation level) and environmental conditions (river flow, temperature, turbidity, air temperature, precipitation) will be monitored regularly (hourly measurements if possible) throughout the duration of the studies.

These methodologies are consistent with accepted practice.

Level of Effort/Cost, and Why Alternative Studies will not suffice

The level of cost and effort for the downstream migrant eel migratory timing study would be moderate, given the level of cost for instrumentation, deployment, and data review/analysis. Cost is estimated at $50,000 per year for the study.

The applicant did not propose any studies to meet this need in the PAD.

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Study Request 3: Impact of Project Operations on Shad Spawning, Spawning Habitat, and Egg Deposition in the Project Areas of the Turners Falls, Northfield Mountain Pumped Storage and Vernon Project Areas and downstream from Bellow Falls Dam . (Docket Number p-1889) (Docket Number p-2485)

Conduct a field study of spawning by American shad in the Connecticut River mainstem downstream of Turners Falls Dam, in the Turners Falls Dam impoundment, in the Vernon Dam Project area, and downstream of Bellows Falls Dam to determine if project operations (including operations of the Northfield Mountain Pump Storage) negatively impact shad spawning behavior, spawning habitat use, areal extent and quality of those spawning areas, and spawning activity in terms of egg deposition in those areas.

Goals and Objectives

Determine if project operations (under the permitted and proposed operational ranges) affect American shad spawning site use and availability, spawning habitat quantity and quality, and spawning activity in the river reaches downstream from Cabot Station and in the project bypass reach of Turners Falls Dam, in the Turners Falls Dam impoundment and in relation to Northfield Mountain Pump Storage operations, downstream and upstream of the Vernon Dam, and in the project area downstream of Bellows Falls Dam. The following objectives will address this request:

- Determine areas utilized by American shad for spawning by conducting night-time visual observation of spawning activity, identify and define areas geospatially, and obtain data on physical habitat conditions effected by project operations (e.g., water depth, velocity, discharge, substrate, exposure and inundation of habitats);
- Determine project operation effects on observed spawning activity, under a range of permitted or proposed project operation conditions;
- Quantify effects (e.g., water velocity, depths, inundation, exposure of habitats) of project operation on identified spawning areas for a range of conditions, over the complete period of spawning activity;
- Quantify spawning activity as measured by night-time spawning/splash surveys and egg collection in areas of spawning activity, and downstream of these areas, to further determine project operation effects (location extent of exposure from changing water levels and flows and on associated habitats from project operations).

If it is determined that the Project operations are adversely affecting the spawning activity of American shad and impacting spawning area habitat, identify operational regimes that will reduce and minimize impacts spawning habitat and spawning success, within the project area. This study will require two years of field data to capture inter-annual variability to river discharge and water temperatures and to allow for evaluation of alternative flow regimes if year one studies determine that the present peaking regime negatively affects spawning.

Resource Management Goals

The Connecticut River Atlantic Salmon Commission developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following:

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.

2. Achieve annual passage of 40% to 60% of the spawning run (based on a 5-year running

average) at each successive upstream barrier on the Connecticut River mainstem.

The Atlantic States Marine Fisheries Commission, Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010 includes the following objective:

1. Maximize the number of juvenile recruits emigrating from freshwater stock complexes and recommendations:
2. To mitigate hydrological changes from dams, consider operational changes such as turbine venting, aerating reservoirs upstream of hydroelectric plants, aerating flows downstream, and adjusting in-stream flows.
3. Natural river discharge should be taken into account when instream flow alterations are being made to a river (flow regulation) because river flow plays an important role in the migration of diadromous fish.
4. Ensure that decisions on river flow allocation (e.g., irrigation, evaporative loss, out of basin water transport, hydroelectric operations) take into account instream flow needs for American shad migration, spawning, and nursery use, and minimize deviation from natural flow regimes.
5. When considering options for restoring alosine habitat, include study of impacts and possible alteration of dam-related operations to enhance river habitat.

The Service seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:
1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to American shad, the Service's goals are:
1. Minimize current and potential negative project operation effects on American shad spawning and recruitment.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), Silvio O. Conte National Fish and Wildlife Refuge Act (P.L. 102-212; H.R. 794),The Federal Power Act (16 U.S.C. §791a, *et seq*.), The Atlantic States Marine Fisheries Compact (P.L. 539, 77th Congress, as amended by P.L. 721, 81st Congress), and the Atlantic Coastal Fisheries Cooperative Management Act (16 U.S.C. 5107).

Public Interest
The requestor is a resource agency.

Existing Information
Since the construction of the first fish lift facility at Holyoke Dam in 1967, American shad have had access to spawning and rearing habitat upstream from Holyoke Dam. A number of improvements to the Holyoke fishway have occurred since that time, but while the numbers of shad lifted at Holyoke have reached as much as 721,764 and the overall shad population to the river exceeded 1.6 million shad in 1992 (CRASC 1992), total shad population, and numbers of shad passing Turners Falls and Vernon Dam have not met CRASC management plan objectives. Population number and passage numbers past Holyoke have declined substantially from those totals in recent years, with average Holyoke passage numbers over the last 10 years of 211,850. Since historically approximately half of the returning population

of shad to the river passed upstream of Holyoke, recent returns are far below management goals. Effective upstream and downstream passage and successful in-river spawning and juvenile production are necessary to help achieve shad management goals for the Connecticut River.

American shad broadcast spawn in congregations over shallow flats and rocky or sandy substrates (Davis et al, 1970, Mansuetti and Kolb 1953), at depths less than 10 feet and often far shallower with spawning fish swimming vigorously near the surface in a closely packed circle (Marcy 1972, Mackenzie et al 1985). Fertilized eggs drift downstream until hatching (Mackenzie et al 1985).

American shad are known to spawn downstream from the Turners Falls Project. Layzer (1974) identified 6 spawning sites from an area below the mouth of the Deerfield River (river mile 191.9) to river mile 161.7 below the Mill River in Hatfield, MA. Kuzmeskus (1977) verified 16 different spawning sites ranging from downstream of the Cabot tailrace to just upstream of the Holyoke dam (river mile 87.1). The only parameter that all spawning sites had in common was current (Kuzmeskus 1977). The Service is not aware of any more recent studies that document whether these 16 sites are still viable spawning locations for shad. We are not aware of any studies that have determined American shad spawning habitat or spawning sites upstream of Vernon Dam to Bellows Fall Dam (historic extent of upstream range).

First Light Power conducted studies in the late spring and summer of 2012, examined habitat conditions downstream of the Turners Falls Dam. The study documented that in low flow conditions, Cabot Station project operations produced fluctuations in water level elevations that can range over 4 feet in magnitude (daily operation) at the USGS Montague Gage Station, to lower values of 2 to 3 feet at the Route 116 Bridge, Sunderland, MA (PAD). Similar short-term, limited monitoring in the upper Turners Falls Dam impoundment identified water level changes due to project operations that d cyclically varied several feet on a sub-daily frequency.

Nexus to Project Operations and Effects
American shad are known to spawn at five locations downstream from the Turners Falls Project from an area below the mouth of the Deerfield River (river mile 191.9) and ten other locations downstream to river mile 161.7 below the Mill River in Hatfield (Layzer 1974, Kuzmeskus 1977).

Shad spawning is likely influenced by river flow, which fluctuates greatly due to the project's peaking mode of operation. These fluctuations may impact shad spawning activity by altering current velocities and water depth at the spawning sites. Effects on spawning behavior could include suspension of spawning activity, poor fertilization, flushing of eggs into unsuitable habitat due to higher peaking discharges, eggs dropping out into unsuitable substrate and being covered by sediment deposition and/or eggs becoming stranded on dewatered shoal areas as peak flows subside.

While a number of shad spawning and egg deposition studies were conducted in the 1970s, that research was aimed at assessing the potential impact of developing a nuclear power station in the Montague Plains section of the Connecticut River. The Service is not aware of any studies being conducted specifically designed to determine if a relationship between spawning behavior, habitat use, and egg deposition and project operations effects of the Turners Falls, Northfield Mountain Pump Storage and Vernon projects and downstream of Bellows Falls Dam..

The Service is concerned that peaking operations may be altering spawning behavior and contributing to the failure of the Connecticut River shad population to meet management targets.

Methodology

The first year of study should examine known spawning areas downstream of the Turners Falls Dam project, to determine operation effects on shad spawning behavior, activity, and success. In areas upstream of Turners Falls Dam to the Bellow Falls Dam tailrace, the study should identify areas utilized for spawning by American shad. In the second year, should results from year one determine project operations affected spawning activity, access to habitat, or success, downstream of Turners Falls Dam, then an identical more detailed assessment (identified objectives) should be conducted in spawning areas upstream of Turners Falls Dam to the Bellows Falls Dam tailwater. Measures to reduce or eliminate any documented project operation impacts should be explored and evaluated in year two, downstream of Turners Falls Dam.

The impacts to spawning behavior would best be studied by night-time observations of actual in-river spawning behavior (Ross et al. 1993). Project discharge increases or decreases during actual observed spawning activity will provide empirical evidence of change in behaviors. The observational methodology should follow the protocol specified in Layzer (1974) and/or as described in Ross et al. (1993). The analysis should utilize the observational field data in conjunction with operational data from the projects (station generation and spill on a sub-hourly basis). To assess the impacts of changes in generation flows, the study should include scheduled changes in project operation to ensure that routine generation changes that occur during the nighttime spawning period affect downstream spawning habitats selected for study while shad are spawning. Stier and Crance (1985) provide optimal water velocities during spawning to range between 1 to 3 ft/sec.

In areas used for spawning, the characteristics of those areas (e.g., location, depth, flow, substrate) should be recorded. The effect of project operations (discharge, water velocity, inundation and exposure) should be assessed. Drift nets will be used to collect eggs to quantify egg production before and after flow changes at the spawning site.

In the reaches above the Turners Falls dam, night time observations of splashing associated with shad spawning should be done in each reach as sufficient numbers of shad are passed above each dam. Observations should be done regularly until the end of the spawning season. The use of radio-tagged adult shad from a separate Study Request will aid in this effort. An estimate of the total area used for spawning and an index of spawning activity should be recorded for each site.

Level of Effort/Cost, and Why Alternative Studies will not suffice

Neither First Light or TransCanada propose any studies to meet this need. Estimated cost for the study is expected to be moderate (up to $40,000) for each owner, with the majority of costs associated with fieldwork labor.

REFERENCES:

Atlantic States Marine Fisheries Commission. 2010. Amendment #3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management). Washington, D.C.

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Layzer, J.B. 1974. Spawning Sites and Behavior of American Shad, *Alosa sapidissima* (Wilson), in the Connecticut River Between Holyoke and Turners Falls, Massachusetts, 1972. Master of Science Thesis. University of Massachusetts, Amherst, Massachusetts.

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Stier, D. J. and J. H. Crance. 1985. Habitat suitability index models and instream flow suitability curves: American shad. U. S. Fish and Wildlife Service Biological Report No. 82(10.88), Washington, D.C.

Study Request 4: Downstream American Eel Passage Assessment at Turners Falls Dam and Northfield Mountain (Docket Number p-1889) (Docket Number p-2485)

Goals and Objectives

The goal of this study is to determine the impact of two hydroelectric projects on the outmigration of silver eels in the Connecticut River. Entrainment of eels at the Northfield Mountain Pumped Storage Station (NFMPS) removes eels from the river, effectively extirpating them from the population. Entrainment at the conventional turbines at Station 1 and Cabot Station of the Turners Falls Project can result in mortality or injury. It is important to understand the passage routes at each project and the potential for mortality to assess alternative management options to increase survival.

The objectives of this study are:

1. Quantify the movement rates (including delays) and relative proportion of eels passing via various routes at the projects; i.e. for NFMPS, the proportion entrained into the intake; for Turners Falls Dam, the proportion entrained into the power canal and spilled via bascule and taintor gates; for the Cabot Canal, proportion of fish passing via spillways, turbines, and the downstream bypass.
2. Evaluate instantaneous and latent mortality and injury of eels passed via the Turners Falls Dam routes, including bascule and taintor gates, spillways, turbines, and the downstream bypass.

Resource Management Goals

The Atlantic States Marine Fisheries Commission has developed two documents related to the management of American eel:

1. Interstate Fishery Management Plan for American Eel. April 2000. Atlantic States Marine Fisheries Commission.
2. Addendum II to the Fishery Management Plan for American Eel. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

Objectives of the management plan include: (1) protect and enhance American eel abundance in all watershed where eel now occur; and (2) where practical, restore American eel to those waters where they had historical abundance but may now be absent by providing access to inland waters for glass eel, elvers, and yellow eel and adequate escapement to the ocean for pre-spawning adult eel.

Addendum II contains specific recommendations for improving upstream and downstream passage of American eel, including requesting that member states and jurisdictions seek special consideration for American eel in the FERC relicensing process.

In addition, the Connecticut River Atlantic Salmon Commission (CRASC) developed A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin in 2005. The goal of the plan is "to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem…" Management objectives in the plan include the following:

1. Protect and enhance eel populations where they currently exist;
2. Where practical, restore populations to waters where they had historical abundance;
3. Provide effective upstream and downstream fish passage around dams and other barriers within the species' range in the basin; and
4. Comply with all requirements of the Fishery Management Plan of the ASMFC.

Based on these plans, the Service seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to downstream passage of American eel, the Service's goals are:

1. Minimize current and potential negative project operation effects that could hinder management goals and objectives.
2. Minimize project-related sources of downstream passage delay, injury, stress, and mortality in order to maximize the number of silver eels migrating to the spawning grounds.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), and the Federal Power Act (16 U.S.C. §791a, *et seq.*).

Public Interest

The requester is a resource agency.

Existing Information

The PAD contains information on the biology, life history, and regulatory status of American eel. It also discusses 2-D and 3-D telemetry studies that were conducted at Cabot Station in 1996, 1997, 2002 and 2003. Results of those studies indicate that a significant proportion of eels entering the Cabot forebay become entrained (90% in 2002, 100% in 2003; Brown 2005, Brown et al. 2009). The PAD notes that the study done in 2003 determined that 15 of the 29 test eels were detected at the Hadley Falls Station. However, that study was not designed to assess turbine mortality.

To date, no directed studies of eel mortality at Cabot Station or eel entrainment or mortality at either Station 1 or the NFMPS facility have been conducted. These information gaps need to be filled so resource agencies can assess the relative and cumulative impact of project operations on outmigrating eels and develop adequate passage and protection measures to meet management goals and objectives.

We also note that within the past seven years, the Service has received two petitions to list the American eel under the Endangered Species Act. The first petition was received on November 18, 2004. On July 6, 2005 the Service issued a substantial 90-day finding on the petition and initiated a 12-month status review that concluded on February 2, 2007 with a finding that listing was not warranted. The second petition was filed on April 30, 2010 by the Council for Endangered Species Act Reliability (CESAR). On September 29, 2011 the Service issued a substantial 90-day finding and initiated a 12-month status review. The Service is still accepting new American eel information for the ongoing status review. The Service also is currently in settlement negotiations with CESAR on their legal complaint that the Service failed to complete the 12-month finding within the statutory timeframe. Although the date for completion of the Service's 12-month finding on the latest petition is uncertain, it is likely that it will be made prior to any new licenses are issued for the projects.

Nexus to Project Operations and Effects

The Turners Falls Project operates as a peaking facility, except during periods when inflow exceeds the hydraulic capacity of Cabot Station and Station 1. Silver eels outmigrate during the mid- summer through late fall, a time of year when flows are generally near the maximum operating capacity of the stations. Therefore, the project would be expected to spill infrequently during the silver eel outmigration beyond the nominal amount required in the bypass reach.

Racks at Cabot Station, Station 1, and NFMPS facility are not designed to protect eels from entrainment. At Cabot, the racks have one-inch clear spacing on the top 11-feet, with five-inch clear spacing on the bottom 20 feet of racks. The approach velocity at the racks is approximately 2.0 feet per second at maximum hydraulic capacity. At Station 1, the racks have 2.6-inch clear spacing and an approach velocity of 1.2 feet per second. Eels can readily pass through a 2.6-inch clear space. NFMPS has 48-foot-deep trashracks with six-inch clear spacing over the intake and an approach velocity of 3.5 feet per second at full pumping capacity (15,000 cfs).

As mentioned above, previous studies conducted at Cabot Station documented eel entrainment. Cabot Station has existing downstream passage facilities designed for anadromous species, but studies have documented few eels utilizing the surface bypass (likely because Cabot has a relatively deep, wide intake area). Station 1 has no passage and protection facilities. NFMPS has a seasonally-deployed barrier net to minimize entrainment of Atlantic salmon smolts, but it is only operated from April through June 15 annually. While no studies have been conducted at Station 1 or NFMPS facility, the rack spacing is wide enough to allow for entrainment.

Methodology Consistent with Accepted Practice

In order to understand the movements of outmigrating silver eels as they relate to operations at the Northfield Mountain Pump Storage Facility, Station 1, and Cabot Station, radio telemetry technology should be utilized. Radio telemetry is an accepted technology that has been used for a number of studies associated with hydropower projects, including at the Muddy Run Project (FERC No. 2355).

Studies should be designed to investigate route selection (i.e., entrainment vs. spill) independently from estimation of mortality/injury, because these metrics require different telemetric methodologies. Studies also will likely benefit from data from several seasons (especially route selection studies, which may be more significantly affected by environmental conditions during a given season that mortality/injury studies). It is also envisioned that results from route selection studies can guide design of turbine mortality studies. Therefore, it is proposed, at a minimum, that route selection studies be conducted in multiple years, but mortality/injury studies may be conducted after the first year of route selection studies have been completed.

1. Objective 1: Route Selection

   This study will involve systematic releases of radio-tagged silver phase eels at strategic points above areas of interest, to assess general routes of passage (i.e., via spill, bypass, or turbines). Active downstream migrants should be collected within-basin if possible (i.e., Cabot or Holyoke bypass samplers), but fish sourced from out of basin may be acceptable to meet sample size demands. Experimental fish must meet morphometric (e.g. eye diameter relative to body size) criteria to ensure they are migrant silver phase. Collections should be made within the migratory season (late Aug to mid Oct), and eels should be tagged and released within 7 days of collection.

   NFMPS Route Selection Study:

   A minimum number of 50 telemetered eels (e.g., 5 separate groups of approximately 10 eels each) will be required to maximize the data return. Eels will be released at least 5 km upstream of the NFMPS project; releases should be timed so that there is a significant probability that migrating eels will encounter NFMPS during the pumping stage. Radio telemetry antennas will be strategically placed to determine times eels are present within the river reach in the vicinity of the NFMPS intakes, within the intakes themselves, and whether they are entrained into the upper reservoir.

   Turners Falls Dam Route Selection Study:

   A minimum number of 50 telemetered eels (e.g., 5 separate groups of approximately 10 eels each) will be required to maximize the data return. Groups of eels should be released during spill and non-spill periods if possible. Tagged eels will be released at least 3 km upstream of the Turners Falls dam but several km below the intake to NFMPS. Telemetry receivers and antennas will be located above and below the dam to assess passage via the following potential routes: entrainment into power canal; passage via spill over the bascule gates; passage via spill through the taintor gates.

   Eels from the NFMPS route study not entrained into the NFMPS intake and migrating to the Turners Falls Dam may be used to supplement (but not serve in lieu of) these release groups.

   Turners Falls Project – Canal Route Selection Study:

   A minimum number of 50 telemetered eels (e.g., 5 separate groups of approximately 10 eels each) will be required to maximize the data return. Groups of eels should be released during periods of low, moderate, and high generation conditions if possible.

Eels will be released in the upper canal (ideally just downstream of the Gatehouse), and allowed to volitionally descend through the canal. Telemetry receivers and antennas will be located within the canal, bypass, channel, and mainstem below Cabot Station to assess passage via the following potential routes: Spillway Fishway attraction water intake (if operational); Station 1 turbines; Cabot Station spillway; Cabot Station bypass; Cabot Station turbines

Eels from the NFMPS and Turners Falls Dam Route Studies not entrained into the NFMPS intake and migrating into the Turners Falls Canal may be used to supplement (but not serve in lieu of) these release groups.

Mobile tracking (i.e., via boat) in river reaches between release sites and several km downstream of Cabot Station will be performed at regular intervals during and after releases to confirm routes and fates of passed fish, or fish lost to follow-up.

Movement rates (time between release and passage) of eels passing the projects by various routes will also be quantified.

The route selection portion of this study should occur in both study years.

2. Objective 2: Spill, Bypass, and Turbine Mortality/Injury Studies

Spill, bypass, and turbine mortality will be assessed using a radio-telemetric balloon tag method. A minimum number of 50 tagged eels (e.g., 5 separate groups of approximately 10 eels each) will be required at each location (dam bascule gate, dam taintor gate, Cabot Station spillway, Cabot Station bypass, Station 1 and Cabot Station) to maximize the data return. Turbine mortality studies are not required at NFMPS because it is assumed that all entrained fish (including eels) are lost to the Connecticut River system.

For spill mortality sites (dam bascule gate, dam taintor gate, Cabot spillway, Cabot Station bypass), tagged eels will be injected or released into spill flow at points where water velocity exceeds 10 ft/sec, to minimize the possibility of eels swimming upstream into the headpond or canal. Passed balloon-tagged eels will be recovered below areas of spill and held for 48 hours in isolated tanks for observation of injury and latent mortality; unrecovered balloon-tagged eels will be censored from the data.

For turbine mortality sites (Station 1 and Cabot Station), tagged eels will be injected into intakes of units operating at or near full generation at points where intake water velocity exceeds 10 ft/sec, to minimize the possibility of eels swimming back upstream through the intakes. Passed balloon-tagged eels will be recovered in the tailrace and held for 48 hours in isolated tanks for observation of injury and latent mortality; unrecovered balloon-tagged eels will be censored from the data.

Mobile tracking (i.e., via boat) in river reaches between release sites and several km downstream of Cabot Station will be performed at regular intervals after releases to confirm routes and fates of passed fish, or fish lost to follow-up.

The turbine mortality component of the study should occur in Study Year 2.

Data analyses of route selection and turbine mortality (instantaneous and latent) will follow standard methodology.

Project operation (flows, levels, gate openings, number of units operating and operation level) and environmental conditions (river flow, temperature, turbidity, air temperature, precipitation) will be monitored regularly (hourly measurements if possible) throughout the duration of the studies.

These methodologies are consistent with accepted practice.

Level of Effort/Cost, and Why Alternative Studies will not suffice

The level of cost and effort for the downstream eel passage study would be moderate to high; silver eels would need to be collected, tagged, and released in several locations over the course of the migration season. Antennas and receivers would need to be installed at the intakes to all stations as well as at the Turners Falls dam spillway and Cabot Station bypass, and monitored regularly. Data would need to be retrieved periodically, then analyzed. A multi-site route selection study conducted by the USGS Conte Lab on the Shetucket River in Connecticut cost approximately $75,000 for the first year of study. Cost are estimated at $100,000 per year for the Route Selection studies and $75,000 per year for the Spill, Bypass, and Turbine Mortality/Injury Studies.

In the PAD, the applicant has identified the need to assess issues related to downstream passage for American eels at the project, but indicates that it intends to rely on information from previously conducted studies and ongoing studies. The Service is not aware of any previously conducted or ongoing studies related to downstream eel passage.

References:

Brown, L.S. 2005. Characterizing the downstream passage behavior of silver phase American eels at a small hydroelectric facility. M.Sc. Thesis, Department of Natural Resource Conservation, University of Massachusetts, Amherst, Massachusetts. 110 pp.

Brown, L., A. Haro, and T. Castro-Santos. 2009. Three-dimensional movement of silver-phase American eels in the forebay of a small hydroelectric facility. Pages 277-291in: J. Casselman et al. editors. Eels at the Edge: Science, Status, and Conservation Concerns. American Fisheries Society, Bethesda, MD.

EPRI (Electric Power Research Institute). 2001. Review and documentation of research and technologies on passage and protection of downstream migrating catadromous eels at hydroelectric facilities. EPRI Technical Report No. 1000730, Palo Alto, California 270 pp.

Study Request 5: Impacts of the Turners Falls and Northfield Mountain Pumped Storage Project Operations on Tributary and Backwater Area Access and Habitats (Docket Number p-1889) (Docket Number p-2485)

Goals and Objectives

One goal of this study is to determine if water level fluctuations from the Turners Falls and Northfield Mountain Pumped Storage projects result in a barrier(s) to fish movement in and out of tributaries and backwaters to the impoundments and riverine reaches below dams.

A second goal is to determine if water level fluctuations in the Turners Falls and Northfield Mountain Pumped Storage project impoundments impact water levels, available fish habitat and water quality in tributaries and backwaters to the impoundments and riverine reaches below dams, and if impacts are found, to ascertain how spatially far reaching they are and develop mitigation measures.

Results of this study may also be used to help determine the adequacy of existing downstream minimum flow requirements.

Specific objectives include:
1) Conduct a field study of tributaries and backwaters, including water velocity and habitat data where appropriate, to evaluate potential impacts of impoundment fluctuation on fish access to tributaries and backwater areas. The study should also evaluate if changes in impoundment fluctuation range would mitigate for any identified impacts and if other mitigative measures would improve access.

2) Conduct a field study to examine potential impacts of impoundment fluctuations on water levels, available habitat and water quality in tributaries and backwaters. The evaluation should also evaluate if changes in impoundment fluctuation range would mitigate for identified impacts and if other mitigative measures would lessen these impacts.

Resource Management Goals

This requested study will help promote tributary and backwater access and protect valuable fish habitat and maintain appropriate water quality conditions for diadromous and riverine fish species in project-affected areas. Maintaining connectivity between the mainstem of the Connecticut River and tributaries and backwaters is vital to the fish populations in these systems, as many fish species utilize these areas for spawning, rearing, refuge, and feeding.

Public Interest

The requestor are natural resource agency.

Existing Information

To our knowledge, limited information exists related to this requested study.

Nexus to Project Operations and Effects

Project operations have the potential to impact fish species life history requirements, biological interactions, and habitat quantity and quality. For example, water level changes due to project operations could create conditions that could impede free movement of fish between tributaries/backwaters and the mainstem of the Connecticut River, thus limiting access to spawning habitat and/or growth opportunities. Additionally, water level changes could also alter tributary and backwater fish habitat quality, quantity, and also water quality, thus decreasing productivity and available habitat.

Methodology Consistent with Accepted Practice

Common tools to evaluate water level impacts would be used including: bathymetric mapping, substrate, depth and velocity measurements, and water quality information (dissolved oxygen, temperature, turbidity, and pH). Studies should be conducted throughout the year.

The study area for tributary and backwater fish sampling should cover all tributaries and backwaters within the project-affected areas of the Turners Falls and Northfield Mountain

Pumped Storage projects. A second year of study may be required if first year data collection is limited due to environmental or other conditions, or if river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period.

Level of Effort/Cost, and Why Alternative Studies will not suffice

First Light does not propose any studies to meet this need. Estimated cost for the study is moderate.

Study Request 6: Northfield Mountain/Turners Falls Operations Impact on Sedimentation and Sediment Transport (Docket Number p-1889) (Docket Number p-2485)

Goals and Objectives

Conduct hydraulic and sediment transport modeling of both the intake and discharge conditions (current and proposed) at Northfield Mountain. The results of the study should provide information sufficient to enable staff to understand current and proposed effects on water level fluctuations and relate to potential increase in sedimentation to the Connecticut River. Staff should be able to identify techniques that could be used to mitigate the effects of project operations or other mitigation techniques that could be developed to reduce riverbank erosion within the impoundment. In addition, an assessment of means to minimize the sediment load passing through the Turners Falls Canal during and after maintenance drawdowns should be conducted.

The specific objectives of this study are as follows:

- Assess hydraulic and sediment dynamics in the Connecticut River from Vernon Dam to Turners Falls Dam, the upper reservoir at Northfield Mountain, and downstream of the Turners Falls Dam.

- Identify management measures to minimize erosion and sedimentation.

- Determine areas of sediment deposition and beach formation in the Project Area and 1 km downstream of Cabot Station and describe habitat features of these areas, recreational uses and effects on invasive species, if any. Habitat areas include but are not limited to coves (e.g. Barton Cove), back channels, islands, wetland habitats, shorelines, shoals, deep water areas and channels.

- Identify management measures to mitigate for substrate (habitat) impacts and recreational impacts in sediment-starved areas below the dam and sediment accumulation areas upstream of the dam.

Resource Management Goals

In order to meet the objectives of the federal Clean Water Act, MADEP adopted the Massachusetts Surface Water Quality Standards, 314 CMR 4.00.The Standards classify each body of water; designate the most sensitive uses to be enhanced, maintained and protected for each class; prescribe minimum water quality criteria required to sustain the designated uses; and contain regulations necessary to achieve the designated uses and maintain existing water quality including, where appropriate, the prohibition of discharges into waters of the Commonwealth.

MADEP has designated the Connecticut River as a Class B river for its entire length in Massachusetts, 314 CMR 4.06(5). Class B rivers are assigned the designated uses of habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation, 314 CMR 4.05(3)(b). Class B waters must also have consistently good aesthetic value and meet minimum criteria for numerous water quality indicators to achieve compliance with the standards set forth in the regulations. The anti-degradation provisions of 314 CMR 4.04 require protection of all existing and designated uses of water bodies, and maintenance of the level of water quality needed to protect those uses.

Public Interest

The requestor is a state natural resource agency.

Existing Information

The PAD provides a summary of the numerous studies that have been conducted to characterize streambank conditions of the Turners Falls Impoundment, to understand the causes of erosion, and to identify the most appropriate approaches for bank stabilization. The *Erosion Control Plan for the Turners Falls Pool of the Connecticut River* (Simons & Associates, Inc. dated June 15, 1999) was completed in order to comply with license articles 19 and 20, and contained a list of 20 priority streambank stabilization project sites. By the end of the current license, work at all sites will have been completed, although some require further repair work. The Erosion Control Plan (ECP) will need to be updated based on current science of fluvial geomorphology, and stakeholders will need to decide the direction additional future projects may take. The next Full River Reconnaissance is scheduled in 2013. Some of the goals and objectives of that effort is contained within this study request.

Implementation of the *Northfield Mountain Pumped Storage Project Sediment Management Plan* (revised February 15, 2012) was begun in 2011 and is scheduled to end in 2014.

Nexus to Project Operations and Effects

Turners Falls and the Northfield Mountain Pumped Storage Project operate in a peaking mode, with allowable headpond fluctuations of up to 9 feet, with proposals to continue as such. It is proposed to evaluate increasing the volume of flow from the Northfield Mountain Pumped Storage Project through increased use of the upper reservoir which is expected to result in additional water level fluctuations. Upstream hydroelectric facilities also operate in a peaking mode of operation. Periodically, the upper reservoir at Northfield Mountain and the power canal at the Turners Falls dam need to be dewatered for maintenance purposes. Historically, both procedures have resulted in the discharge of large quantities of sediment.

Sediment from shoreline erosion and riverbank failure is one of the major contributors that negatively affect water quality and habitat by increasing the turbidity and sedimentation, smothering aquatic habitat. Repetitive water level fluctuations and flow alterations caused by hydroelectric peaking operations are known to be a major contributor to shoreline erosion.

The Proposed Massachusetts Year 2012 Integrated List of Waters shows two river segments, from the VT/NH state line to the Turners Falls dam (MA34-01 & MA34-02) impaired and considered a “Water Requiring a TMDL” due to “Other flow regime alterations”, “Alteration in stream-side or littoral vegetative covers” and “PCB in Fish Tissue”. In addition, the segment below the Turners Falls dam to the confluence with the Deerfield River (MA34-03) is impaired by these causes as well as total suspended solids.

Methodology Consistent with Accepted Practice

The MA Department of Environmental Protection recommends:

Assess hydraulic and sediment dynamics

- FirstLight continue implementing the Northfield Mountain Pumped Storage Project Sedimentation Management Plan over the full range of river flows and pumping/generating cycles. An unfulfilled task in the Plan is to develop a correlation over the full range of flow conditions between the overall suspended sediment transport through the entire cross section of the river compared to the continuous sampling at the single fixed location. Environmental Protection Agency approval of a Quality Assurance Project Plan is required for valid data acquisition.
- Provide data on the daily water level fluctuation changes from the past five years from stations listed in the PAD, and estimate fluctuations within Turners Pool assuming proposed operations and hydraulic conditions.
- Identify the most appropriate techniques for bank stabilization given the existing and proposed hydraulic conditions.

Determine areas of sediment deposition in the Project Area

- Field (2007) conducted a bathymetric study as part of his report. Use previous bathymetric data, if available (Field 2007 recommends putting additional effort into finding a bathymetric survey from 1913 that was partially shown in Reid 1990), and current bathymetric information to look at areas of sediment accumulation. Determine areas of sediment deposition in the Project Area and 1 km downstream of Cabot Station and describe habitat features of these areas. Habitat areas include but are not limited to coves (e.g., Barton Cove), back channels, islands, wetland habitats, shorelines, shoals, deep water areas and channels.
- Identify recreational uses and impacts in areas known to be impacted by accumulated sediment, such as Barton Cove.
- Identify invasive species (plant or animal) present in the reaches and determine if erosion and sedimentation in any way contributes to the establishment and/or proliferation of these species.
- Investigate the formation of beaches using remote sensing, LIDAR at low pool levels or some other mapping technique to understand the processes of beach deposition the distribution of beaches in the pool, the impact of beach deposition on habitat and species, and how can this be related to operation of NMPS.
- Evaluate management strategies to address the release of accumulated sediment through Northfield Mountain Project works during upper reservoir drawdown or dewatering activities. FirstLight should specifically evaluate the feasibility of the installation of a physical barrier across the bottom of the intake channel designed to prevent the migration of sediment during future drawdowns of the upper reservoir
- Evaluate management strategies to minimize flow fluctuations within Turners Pool including coordination with upstream users.
- Evaluate management strategies to minimize sediment released through spillway gates and the log sluice located near the bottom of the forebay adjacent to the Cabot Powerhouse during canal dewatering activities.

- Identify a prioritized list of locations for bank stabilization projects in the Project Area
- Develop a map of land owned by FirstLight within 200 feet of the Connecticut River with an overlay of land use and vegetation cover. Provide land use options aimed at reducing bank erosion.

<u>Management measures to change sediment flow below and above the dam.</u>

- Any historic information of existing bed substrate material in the Turner's Falls headpond, bypass reach or downstream of the project should be collected and assembled. To the extent possible, the location of each sample should be made available on a map. The request for new data would stem from being able to make any valid comparison to changes in bed substrate at a given location, assuming the historic data exist.
- Identify measures that could be taken to mitigate impacts to recreational use, habitat, or invasive species from sedimentation.
- Identify measures that could be taken to change or mitigate sediment starved reaches below the Turners Falls dam.

Level of Effort/Cost, and Why Alternative Studies will not suffice

Many erosion studies have already been conducted and the cost of expanding the scope of some should be reasonable. A Full River Reconnaissance under the *Erosion Control Plan for the Turners Falls Pool of the Connecticut River* (Simons & Associates, Inc. dated June 15, 1999) is scheduled for 2013 and should accomplish many of the objectives listed above.

Study Request 7: Model flows in the Northfield Mountain Pumped Storage Project discharge tailrace and Connecticut River 1 kilometer upstream and downstream of the discharge using two-dimensional Computational Fluid Dynamics (CFD) model techniques. **(Docket Number p-2485)**

Goals and Objectives

The goal of this study is to determine the potential impacts (both project-specific and cumulative) of the Northfield Mountain Pump Storage Project operations (pumping and generating) on the zone of passage for migratory fish near the Northfield Mountain turbine discharge/pump intake, on natural flow regimes in the area of the Connecticut River immediately upstream and downstream of the project, on the potential for entrainment during pumping operations, on the potential for creating flow reversals in Connecticut River during pumping cycles that may confuse migratory fish attempting to pass the project, and on bank erosion on both sides of the river in the vicinity of the tailrace.

Specific objectives of the study include:

- Develop a 2-dimensional CFD modeling capability for the area of the Northfield Mountain discharge and tailrace, along with the full width of the Connecticut River 1km upstream and 1 km downstream of the discharge.

- Model flow characteristics upstream and downstream of the project under existing project operations (pumping and generating) and at several representative river flow levels, as well as proposed operations such as those proposed in section 3.4.4 of the

PAD, and any other modifications under consideration, to assess potential impacts to fish and wildlife resources, recreational use, agricultural resources, and historical resources.

- Assess velocities at and in proximity to the Northfield Mountain intake/discharge structure, when pumping or generating and their potential to interfere with fish migration.

- Assess the potential for velocity barriers in the mainstem river resulting from pumping and generation flows at the project, alone or in combination with generation flows from the upstream Vernon Project.

- Assess potential for Northfield Mountain project operations to create undesirable attraction flows to the intake/discharge that may result in entrainment or delay of migratory fish.

- Assess the potential of a mainstem instream local flow reversal associated with pumping operations to impact migrating fish. The Connecticut River in the area of the Northfield Mountain tailrace has been said to flow upstream potentially confusing migratory fish keying in to flow as a directional aid to upstream or downstream migration, causing delay and additional "fish" energy expense and possible entrainment.

- Model and then evaluate flow characteristics under alternative project operations with potential measures to avoid, minimize, or mitigate impacts to fish and wildlife resources.

- Assess the potential for unnatural flows and eddies in the main-stem associated with pumping or generation at the Northfield Mountain Project to impact bank erosion and recreational use.

Resource Management Goals

The mission of the U.S. Fish and Wildlife Service (Service) is to work with others to protect, conserve and enhance fish, wildlife, plants and their habitats for the continuing benefit of the American public. Service trust resources include wetlands, endangered species, and migratory species, all of which have been documented to occur in the project area. The Service is also working with a number of federal, state, local, non-governmental organizations, and the public to restore and enhance trust resources in the Connecticut River Basin through comprehensive management plans and cooperative agreements. Instream flow is an important riverine habitat characteristic that can have a great impact on aquatic habitat for fish, wildlife, and plants. Flow is an important directional guidance cue for instream navigation and attraction to fishway entrances for migratory fish.

Public Interest

The requestor is a federal natural resource agency.

Existing Information

No project specific information exists that will allow for a comprehensive assessment of existing project operations (pumping and generating flows) on Connecticut River flows and on fish and aquatic organisms in the project area upstream and downstream of the project in the Connecticut River. Preliminary results from an ongoing study of radio-tagged American shad by the USFWS and USGS Conte lab indicate that shad are exposed to the intakes and some individuals spend substantial amounts of time in the vicinity of the intakes. The PAD does not contain any information or tool that will allow for predictions of impacts of alternative project operations, or potential mitigation measures to protect or enhance aquatic fish and wildlife resources.

As part of Field (2007; see appendix 4), a "Connecticut River Hydraulic Analysis – Vernon Dam to Turners Falls Dam" was completed by Woodlot Alternatives in July 2007. For this analysis, a 2-dimensional flow model was developed for the entire Turners Falls impoundment. This study was geared towards looking at shear stresses from high-flow events, and did not focus in detail around the tailrace or examine how pumping and generation may affect flows in the vicinity of the tailrace under a variety of flows.

As a result of the hydraulic analysis, Field (2007) on page 20 states that "While erosion does occur where high flow velocities and shear stresses approach near the bank, significant amounts of erosion also occur where flow velocities near the bank are low." No specific examination was done in the report on the ±1 km area near the tailrace and existing erosion sites. Banks immediately upstream and downstream and across river have all required bank stabilization projects over the last 15 years, in some cases needing several repairs.

Nexus to Project Operations and Effects

Existing project operations have a direct impact on instream flow and aquatic habitat in the pump/discharge area of the Connecticut River. The PAD in section 3.2.2 says that the velocity at the trash racks when operating at full capacity is 20,000 cfs and maximum pumping conditions are 15,200 cfs. Annual flow duration curves shown for below the Vernon Dam submitted in the PAD section 4.3.1.2 (for years 1944-1973; recent and near project flows are not available; see p. 459) indicate that river flows are ≤ 20,000 cfs more than 85% of the time. Flows released from the project must therefore influence flow patterns and velocities in the Connecticut River, particularly at flows below some unknown threshold level.

Recreational users of the Connecticut River in the Turners Falls impoundment have anecdotally described flow reversals in the mainstem river. Discharges from the project could potentially be larger than river flows or at least act like a major tributary to the Connecticut River. Project flows may influence the availability and extent of upstream and downstream migration zones, or may confuse fish and delay migration. Project flows may also impact stream banks in ways that natural river flow (or flows affected by upstream hydropower facilities) does not, and may also impact recreational use of the river.

Proposed Methodology

CFD modeling is consistent with generally accepted practice, and has been used to assess proposed modifications to the Holyoke Dam fish passage facilities, upstream of the intakes and downstream of the dam, as well as at hydroelectric projects on the Susquehanna River to assess existing and proposed project operations, and develop mitigation measures for fish and wildlife resources.

Level of Effort/Cost, and Why Alternative Studies will not suffice

This study will require a detailed elevation map of the study area upstream and downstream of the Northfield Mountain project. Information already exists in historic construction files for the project, the hydraulic analysis included in Appendix 4 of Field (2007), and possibly in conjunction with work done after the 2010 maintenance procedures that resulted a portion of the river being dredged after a large sediment dump) that are in the possession of the applicant. Additional elevation data will likely need to be collected in the field using standard survey techniques. Elevation data will then need to be entered into a CFD modeling program.

The CFD computer program will need to simulate existing project operations that include all potential variations of pumping and generating, and static operation. No project specific instream flow analysis tool has been developed for the Northfield Mountain project that will allow for assessment of existing operations and alternative operational impacts on instream flow and aquatic habitat for fish and wildlife resources. The computer model, once built, can be used to simulate flow conditions in the vicinity of the project during migratory fish passage and can be used together with behavior studies (i.e., telemetry studies and entrainment studies requested herein) to assess the impacts of varying project operations or potential mitigation operations and measures on fish migration and aquatic habitat. We know of no other tool that will provide for these types of assessments. Cost is expected to be moderate to high.

Study Request 8: Entrainment of Migratory and Riverine Fish from the Connecticut River into the Northfield Mountain Pump Storage Project. (Docket Number p-2485)

Goals and Objectives

The goal of the study is to determine the impact of Northfield Mountain Pump Storage Project (NFMPS) during the pumping cycle on entrainment of juvenile American shad, adult shad, adult American eel, and riverine fish, including early life stages.

The objective of the study is to quantify the number of resident and migratory fishes entrained at the NFMPS intake on an annual basis in order to evaluate potential impacts to riverine fish populations in the Turners Falls pool and diadromous fish migrants moving through the project area. This will be accomplished through a combination of hydroacoustic monitoring and netting using various gear types to quantify and identify species of different life stages.

Resource Management Goals

The Connecticut River Atlantic Salmon Commission (CRASC) developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually. (Table 1)
2. Achieve annual passage of 40 to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem.
3. Maximize outmigrant survival for juvenile and spent adult shad.

Based on the CRASC plan, the Service seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

The Atlantic States Marine Fisheries Commission has developed two documents related to the management of American eel:

1. Interstate Fishery Management Plan for American Eel. April 2000. Atlantic States Marine Fisheries Commission.
2. Addendum II to the Fishery Management Plan for American Eel. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

Objectives of the management plan include: (1) protect and enhance American eel abundance in all watershed where eel now occur; and (2) where practical, restore American eel to those waters where they had historical abundance but may now be absent by providing access to inland waters for glass eel, elvers, and yellow eel and adequate escapement to the ocean for pre-spawning adult eel.

Addendum II contains specific recommendations for improving upstream and downstream passage of American eel, including requesting that member states and jurisdictions seek special consideration for American eel in the FERC relicensing process.

In addition, the Connecticut River Atlantic Salmon Commission (CRASC) developed A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin in 2005. The goal of the plan is "to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem…" Management objectives in the plan include the following:

1. Protect and enhance eel populations where they currently exist;
2. Where practical, restore populations to waters where they had historical abundance;
3. Provide effective upstream and downstream fish passage around dams and other barriers within the species' range in the basin; and
4. Comply with all requirements of the Fishery Management Plan of the ASMFC.

Specific to resident riverine and migratory fish entrainment, the Service's goals are:

1. Minimize current and potential negative project operation effects such as turbine entrainment that could hinder management goals and objectives.

2. Minimize project-related sources of mortality to resident and migratory fishes in order to restore natural food web interactions and ecosystem functions and values.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), and the Federal Power Act (16 U.S.C. §791a, *et seq.*).

Public Interest

The requestor is a resource agency.

Existing Information

Limited project-specific information exists regarding entrainment of fish and aquatic organisms at the NFMPS. As part of a Memorandum of Agreement between then-owner Northeast Utilities Service Company (NUSCO) and regulatory agencies (including the Service), NUSCO conducted studies to determine the impact of NFMPS on anadromous fishes, including Atlantic salmon, American shad, and blueback herring. Results of a pilot study conducted in the fall of 1990 indicated that trap netting at the intake was ineffective at collecting fish. Gill netting and boat-shocking did result in collection of some juvenile shad, but further refinement in both methods was recommended to improve effectiveness. A total of

78 fish were collected at the intake (77 of which were American shad) by gill netting and 11 shad were collected by boat electrofishing. Hydroacoustic monitoring was deemed an effective method for monitoring entrained fish during pumpback operation. Hydroacoustic sampling over a two-week period (September 12-27, 1990) produced hourly entrainment estimates that cumulatively equaled 14,816 fish.

Based on the results of the pilot study, NUSCO developed a two-year plan to quantitatively determine the number of shad and salmon entrained at NFMPS station. In 1992, an entrainment study targeting juvenile American shad life stages was conducted in the lower (mainstem river) and upper reservoirs of NMPS. The study used several gear types to quantify egg through juvenile shad densities in different areas. Entrained juveniles were sampled using an upper reservoir net. Pumping operations were modified to only run three (77% of sample time) and sometimes two (23% of sample time) of the station's four units during the study and effort was limited to a total of 80 hours over a period spanning 9 August through 27 October (80 days). An estimated total of 1,175,900 shad eggs, 2,744,000 yolk-sac larvae, 10,525,600 post yolk-sac larvae, and 37,260 juveniles were reported entrained.

There are no reliable data on the timing, magnitude and duration of entrainment of larval riverine fishes in the NFMPS area. Unlike anadromous shad and river herring, , riverine species occurrence and susceptibility relative to space and time exposure windows to NFMPS pumping, are undocumented. The complete lack of any long-term fish population monitoring data for riverine species in the Turners Falls impoundment leaves questions unanswered on the types and extent of impacts to these populations that may be linked to the near daily cycling of river water up and down through the NFMPS operations system. As a starting point, it is necessary to obtain baseline data on project operation impacts for all species potentially impacted by NFMPS. An additional study request seeks to obtain a more accurate documentation of all fish species inhabiting or utilizing the Turners Falls impoundment.

Nexus to Project Operations and Effects

Entrainment of fish and aquatic organisms associated with water withdrawal and hydroelectric operations has been documented to result in injury or death of entrained organisms. Migratory and resident fish pass through the project area directly in front of the pump intakes. These organisms may be entrained and thus exposed to passage though the project pumps and reservoir supply tubes. How far from the intake these species and life stages may be drawn into the intake on a pumping cycle or how susceptible they are to the repeated daily cycles of pumping and discharge, and how these factors vary in relation to habitat and river conditions are unknown. Survival of fish subjected to entrainment on the pumping cycle is unknown, but regardless of whether fish survive the pumping process, they are lost to the Connecticut River system. Depending on the species, life stages, and numbers entrained, this loss could impact the ecosystem productivity of the Turners Falls pool and may hinder restoration goals for diadromous fishes.

Previous entrainment studies have been conducted at the project. Those studies, which were done 20 years ago, documented entrainment of American shad and Atlantic salmon at the project, including over 13 million yolk sac and post-yolk sac larvae of American shad. This level of entrainment is cause for concern, not only due to the resultant loss of potential adult returns, but for the important role early life history phases and juveniles play in their ecological contributions to the river system (e.g., trophic interactions).

No entrainment studies for other species of fish have been conducted at the project. The unknown extent of other riverine species ichthyoplankton entrained by the NFMPS requires evaluation. Studies conducted in 1969 and 1970 at the Muddy Run Pumped Storage Station documented significant entrainment of eggs and larval fish. In June and July of 1970, 5.3 million eggs and 56.6 million larvae were entrained (Snyder 1975). Muddy Run and NFMPS are of a similar size and both use a river as the lower reservoir. It is anticipated that a considerable number of eggs and larvae will be entrained by the NFMPS.

Since the previous studies were conducted, operations at the NFMPS facility have changed (e.g., the project increased the efficiency of its turbines, and raised the pumping capacity from 12,000 cfs up to 15,000 cfs), as have river conditions (e.g., Vermont Yankee has increased its thermal discharge and the Vernon Project has increased its station capacity). Further, the PAD indicates that FirstLight will evaluate the feasibility of utilizing an additional 3,009 acre-feet of storage capacity to generate an additional 1,990 MWhs (this represents a 23% increase over existing storage and stored generation levels). While not specified in the PAD, increasing storage and generation would mean longer periods of both pumping and generation at NFMPS. In addition, anticipated improvements in fish passage at the Turners Falls Project will result in increased juvenile production above the NFMPS. These factors, individually or cumulatively, could increase the potential for entrainment at NFMPS station.

Methodology Consistent with Accepted Practice

Previous studies used varying methodologies for determining entrainment. The 1990 study concluded that hydroacoustic monitoring at the intake was a viable method for determining entrainment of later life stages, but does not allow for identification of the species being entrained. While trap netting was ineffective at collecting fish near the intake, gill netting and boat shocking did capture some fish. Both may prove to be viable sampling methods; however it is likely that additional testing and gear refinement will be necessary.

The 1992 study used nets at the pump discharge location into the upper reservoir to collect entrained fish. Testing showed that this method was only 10% efficient. Plankton netting in the nearfield area of intake was used to estimate entrainment of ichthyofauna. It is likely that a combination of methods would provide the most reliable results (e.g., hydroacoustic monitoring at the racks during pumpback operations, variable gear sampling in the vicinity of the intake immediately prior to initiation of pumpback operations to determine species composition, and plankton netting in the nearfield area of the intake to obtain information on entrainment of ichthyofauna). As these methodologies have previously been utilized at the site, they are consistent with accepted practice.

Although a previous entrainment study was conducted, the Service believes it should be repeated, using a modified study design. The 1992 study only collected a total of 330 juvenile shad over a three-month period (resulting in an overall estimate of 37,260 juveniles entrained, after accounting for poor net efficiency); whereas the hydroacoustic study conducted in 1990 estimated nearly 15,000 fish in 15 days (while these fish were not identified, 77 of the 78 fish collected at the intake during the study were juvenile shad). It also should be noted that in the 1992 study, juvenile shad were collected on the first day of sampling, indicating that the sampling did not begin early enough, which would mean the results are an underestimate of the number of juvenile shad that were actually entrained. In 1990, 27,908 adult shad passed the Turners Falls gatehouse, while in 1992 over 60,000 shad passed gatehouse. The fact that the numbers entrained were so variable between study years argues for repeating the study, using a combination of previously-used methodologies.

The study will require deployment of at least five hydroacoustic transducers (one per rack face and one offshore). These transducers would be operated during every pumping cycle from April 15 through May 14 to assess riverine fish entrainment, from May 15 through July 15 for spent adult shad, and from July 16 through November 30 for entrainment of adult silver eels, juvenile American shad, and riverine fishes. Concurrent field sub-sampling at the intake to determine species composition would need to occur.

Sampling for planktonic fish larvae should capture early spring spawning species (white suckers) through later season centrarchid species (bass and sunfish). Active plankton trawl surveys should utilize a sampling design that adequately captures temporal and spatial changes in water pumping cycle (i.e., early start-up is local water, later cycle pumping is drawn in from both upstream and downstream habitat areas).

Level of Effort/Cost, and Why Alternative Studies will not suffice
We know of no other tool that will provide for this type of assessments for all fish species and organisms that may pass through the project. Cost and effort are expected to be high.

The applicant did not propose any studies to meet this need in the PAD.

References

CRASC. 1992. A Management Plan for American Shad in the Connecticut River.

Harza Engineering Company. 1991. Draft Northfield Mountain Pumped Storage Project 1990 Field Sampling Program. February 1991. Northeast Utilities Service Company, Berlin, CT.

Lawler, Matusky and Skelly Engineers (LMS). 1993. Northfield Mountain Pumped-Storage Facility – 1992 American Shad Studies. February 1993. Northeast Utilities Service Company, Berlin, CT.

Memorandum of Agreement NUSCO. July 1990.

Snyder, D.E. 1975. Passage of fish eggs and young through a pumped storage generation station. J. Fish Res. Board Canada. 32: 1259-1266.

Study Request 9: Study of shoreline erosion caused by Northfield Mountain Pumped Storage (NMPS) operations (Docket Number p-2485)

Development of the current configuration of the Northfield Mountain Pumped Storage project included raising the dam height at Turners Falls by 5.9 feet in 1970 in preparation for NMPS operations. Operations began in 1972; since then all project operations have operated under this raised dam environment. The operation of NMPS causes alterations to the river as a direct feature of plant functionality. The alterations include: 1) daily fluctuating pond levels which at times in some places can exceed six feet (the license allows fluctuations up to 9 feet measured at an undisclosed location near and upstream of the Turners Falls dam), 2) altered flow and velocity profiles of river and 3) changes to the downstream hydrograph. Elevation data of the head pond in Appendix E of the PAD indicate that stage changes of 2 to 3 feet during the summer of 2012 were not uncommon. The additional 5.9 foot elevation increase in the headpond resulted in motorized boat traffic becoming more popular and makes the use of larger boats more possible. The presence of motorized recreational boats increases wake energy that can accelerate bank erosion rates.

Raising the level of the headpond can saturate bank soils. These same soils can quickly become dewatered when the headpond is lowered. Repeated saturation and dewatering of banks can lead to bank instability which in turn can lead to bank failure and eroded material entering the river. See Field (2007) for an extended discussion on bank erosion and failure mechanics. Elevated levels of turbidity and suspended solids in the water column can diminish rearing and migratory habitat for fish. When too much fine grain material is deposited on channel bed substrates, particularly those substrates used for spawning, spawning success of resident and migratory fish is compromised, potentially reducing recruitment and carrying capacity.

Goals and Objectives

The goals of this study request would be to determine the environmental effects of the presence and operation of the licensed facilities on river bank stability, shoreline habitat, agricultural farmland, wetland resources, bed substrate, and water quality in the Turners Falls impoundment. We recognize that data from other studies will be made available and we think that the data from these other studies could be used to help meet the objectives of this study request.

Objectives of the study include the following

1. Calculate the total volume of eroded material, calculate resulting nutrient loading of eroded material, and document and describe the three dimensional changes to the bank, including lateral bank recession, changes to bank slope, and the presence and subsequent inundation of pre-project beaches and shoreline since the Turners Falls Dam was raised and the Northfield Mountain Pumped Storage facility came on-line.
2. Document and describe the changes to banks upstream and downstream of riverbank restoration projects, including bank recession.
3. Identify the changes that have occurred to bed substrate as a result of fine grain material being eroded from the banks and being deposited on the channel bed.

Relevant Resource Management Goals and Public Interest Considerations

Our management goal is to ensure high quality habitat for migratory diadromous fish. Shortnose sturgeon, American shad and American eel all require suitable spawning, rearing, migratory and foraging habitat. Eroding banks and subsequent increases in turbidity and deposition of fine grained material onto bed substrates in the Turner’s Falls headpond, the bypass reach and downstream of the Turner’s Falls project reduces the quality of habitat for these species. Elevated levels of suspended sediment are associated with a diminution in water quality which also affects the quality of habitat encountered by trust resource species. In addition to habitat effects, soil erosion contributes to nutrient loading. In 2001, the U.S. EPA 2001 approved New York and Connecticut’s Long Island Sound (LIS) dissolved oxygen TMDL. As a result, the New England Interstate Water Pollution Control Commission (NEIWPCC) established the Connecticut River Workgroup and the Connecticut River Nitrogen Project. This project is a cooperative effort involving staff from NEIWPCC, the states of Connecticut, Massachusetts, New Hampshire, and Vermont, and EPA's Region 1 and Long Island Sound (LIS) offices. All are working together to develop scientifically-defensible nitrogen load allocations, as well as an implementation strategy, for the Connecticut River Basin in Massachusetts, New Hampshire, and Vermont, which are consistent with TMDL allocations established for LIS. Since its inception, the Connecticut River Workgroup has participated in a number of projects to better understand nitrogen loading, transport, and reductions in erosion.

Public Interest

The National Marine Fisheries Service is a Federal agency.

Existing Information and Need for Additional Information

The PAD makes reference to several studies in section 4.2.4 including the Erosion Control Plan (Simons & Associates, 1999), previous Full River Reconnaissance studies (1998, 2001 – maps but no report generated, 2004, and 2008), Field Geology Services' 2007 fluvial geomorphic investigation of the Turners Fall headpond, and 2012 investigations by Simons & Associates.

Field Geology Services' 2007 investigation provided several good recommendations for future work in section 9.3 of his report which, if implemented, could provide for: a) an improved understanding of the causes of erosion; b) more accurate monitoring of erosion; and c) more successful bank stabilization efforts. This document is a good point of reference. The Simons & Associates' (2012) documents are qualitative and based on several unstated assumptions that may not be valid. Full River Reconnaissance efforts have been undertaken using varying methodologies, making for difficult comparisons from one report to the other.

We believe that these existing studies do have data that can be useful if certain new analyses are undertaken. These analyses of existing data would help fill in our gaps of understanding of bank erosion in the Turners Fall headpond. We are also asking for some additional field collected data. With the existing information, it should be possible to better display what changes have occurred to streambanks over time. Current Geographic Information System (GIS) software allows for various types of data to be assembled into a map and into a database such that change over time analysis can be conducted fairly easily. The change over time analysis is a critical analysis that is needed, and was already started under Field (2007).

Photos that have been taken at or near the same location but at different times exist. For example, the last three Full River Reconnaissance efforts have included continuous videotaping of the river banks with locational information. With these data, "snapshots" of the bank at various locations could be extracted and compared over time. Field (2007) photo locations could be re-shot as well. This existing information should be presented such that it is easy to discern where the photo was taken and what changes have occurred over time. A comparison of the bank every 100 ft could be compared over the years.

Historic aerial photography for the Turners Fall headpond should be gathered and analyzed. Examples of good photographic datasets include the Field 2007 appendices and 1929 aerials. The location of the shoreline over time should be noted such that it is easy to discern where bank retreat has been most severe and where the river has been relatively stable since the earliest aerial photograph was taken.

Very little turbidity data for the Turner's Falls headpond, the bypass reach or stretches of the Connecticut River downstream of the Turner's Fall project exist. Thus far, implementation of the *Northfield Mountain Pumped Storage Project Sediment Management Plan* (revised February 15, 2012) has yielded few results, and many technological difficulties (see *2012 Sediment Management Plan – 2012 Summary of Annual Monitoring* dated November 30, 2012). Suspended sediment monitoring equipment is installed at the Route 10 Bridge upstream of the project and inside the powerhouse, theoretically taking readings representative of pumping and discharging through the turbines. An analysis of how turbidity might change relative to rapidly changing headpond levels would be very useful information.

Project Nexus

The construction of the NMPS project was contingent upon the Turner's Falls project raising the dam crest elevation by 5.9 feet. The NMPS project operations rely on the Turner's Falls headpond as the source of water to be pumped and to be discharged into. The importance of this river reach to the NMPS operation is made clear by Firstlight's reference to this portion of the river as the "lower reservoir." Daily pumping and discharging changes the ponded elevation of the Connecticut River which in turn leads to bank material that repeatedly becomes saturated and then dewatered. Weakened bank material can then become eroded and the fine grain material from the banks can enter the water column and be transported in suspension in the river and eventually settle onto bed material. The raising of the Turner's Falls headpond also made recreational boating more popular, including the introduction of large, high-horsepower powerboats that were not previously present. Because of the fluctuating water levels, boat wakes impact the shoreline to a much greater extent than would occur if levels were more constant, thus exacerbating both the effects of the wakes and the fluctuating levels. For these reasons, erosion caused or contributed by NMPS project operation can negatively affect spawning, rearing and migratory habitat for trust species and the endangered shortnose sturgeon. The requested study will help inform the Commission when contemplating mitigation measures and or operational modifications.

Proposed Methodology

1. This study should determine the net soil loss in cubic yards between 1970 and the present; a density estimate of the eroded material should also be provided. Provide an analysis of where the greatest loss has occurred, location of proximity to the tailrace, soil type, riparian land use, and vegetative cover in that area. Calculate nutrient loadings (nitrogen and phosphorus compounds) to the river system based on soil loss.
   Obtain copies of the original survey plans for the project, and complete a new survey using the same landmarks used previously. The Field (2007) report states on page 11 that the original survey plans of the river are still retained by Ainsworth and Associates, Inc. of Greenfield MA. Use pre-operation aerial photos and current aerial photos to complete a 10-foot topographic map of the section of river between Turners Falls Dam and Vernon Dam and the 200-foot buffer regulated under the Massachusetts Rivers Protection Act. The Field (2007) report on page 11 states that Eastern Topographics, Inc. determined that sufficient information is known about the 1961 aerial photos (e.g., height of airplane) to create a 10-foot topographic map of that time period, and that 1961 aerial photos could be accurately overlayed with recent aerial photos. Field (2007) states that this analysis would enable a more reliable determination of small-scale shifts in channel position and changes in bank height that may have resulted from the erosion of a low bench that previously existed along portions of the river. Among other things, create a single map showing areas of erosion and deposition, and also overlay the Field report's hydraulic modeling analysis of the river channel.
2. With respect to the January 22, 2013 submittal from FirstLight to FERC regarding its long term monitoring transects in the Turners Fall impoundment, we ask that any data errors (as discussed in Field, 2007) and problems that have occurred over the years at each site be mentioned. We also ask that that an analysis for each cross section extending to the top of the bank and including a portion of the floodplain be provided.
3. Take the information presented in Figure 4.2.3-1 "Soils in the vicinity of Turners Falls and Northfield Mountain projects" in the PAD and convert from 63 categories to just a few that are defined in a key that will allow readers to understand which soils are easily erodible, which aren't, and where there is bedrock along the banks.

4. Complete detailed surficial mapping (topographic map or LIDAR) to identify the various geomorphic surfaces, height of benches/terraces above the river level, and types of sediments underlaying the surfaces. This will allow one to determine how erosion varies with geomorphic conditions. One could then normalize the amount of erosion to a specific type of bank material/geomorphic surface/terrace.
5. Another information request covers the range of daily water level fluctuations. In this study request, we ask for an analysis on the degree to which boat wakes increase that fluctuation range. The task would be to observe boat wakes under a range of boat sizes and flow rates on the river. We recommend the 2007 Field report recommendation which states, "A more thorough study of boat waves is merited to better document how many boats use the Turners Falls Pool, how fast they travel, the type and size of waves they produce, and their impact on shoreline erosion."

A component of this study request is not necessarily for new data, but for existing data to be presented in a more clear, coherent and comprehensive manner. All existing photographs of banks that have been collected either by Firstlight, on behalf of Firstlight or on behalf of the FRCOG Streambank Erosion Committee should be georeferenced in such a way such that it is easy to discern where the photograph was taken and the date should be easily discernible as well. These photos should be presented in a manner that makes it easy to visually see how a particular section of bank has changed over time. Providing geographic context for photographic data of river banks and making these photos comparable over time should be standard practice. The 2007 Field report contains the following recommendation on page 47: "An attempt should be made to overlay the 1961 aerial photographs with a current flight and to create a topographic map from the 1961 flight. The feasibility of this effort has been confirmed by Eastern Topographics, Inc. This effort will identify the previous extent of the low bench and identify areas of the most significant bank recession the past 45 years." Given that this statement was written in 2007, we request that that the analysis is extended to current conditions.

Given the complexity of this study request and the expertise necessary to implement it, we request that the resources agencies be involved with the selection of the hired consultant.

Level of Effort and Cost

The level of effort to compile existing information and to make the data available in a map and searching for existing bed substrate material data should not take more than a few days. The level of effort for the bed sampling work will vary based upon how much existing historic information exists. Much of the effort of this study request is essentially office work that compiles and better presents existing data. While an estimate on the amount of field time required is difficult to make, we estimate that up to two weeks of field work could be required and some of the data collection could be done while other field studies are occurring.

Study Request 10: Shad Population Model for the Connecticut River (Docket Number p-1889) (Docket Number p-2485)

Develop an American shad annual step, mathematical simulation population model for the Connecticut River to quantify how project operations and potential restoration/mitigation measures impact the population of shad in the Connecticut River.

Goals and Objectives

The goal of the model is to assess impacts of both upstream and downstream passage at each of the Connecticut River projects and potential management options for increasing returns to the river.

Specific objectives include:

- Annual projections of returns to the Connecticut River;
- A deterministic and stochastic option for model runs
- Life history inputs of Connecticut River shad
- Understanding the effect of upstream and downstream passage delay at projects
- Calibration of the model with existing data
- Analysis of the sensitivity of model inputs
- Analysis of sensitivity to different levels of up- and downstream passage efficiencies at all projects
- Multiple output formats including a spreadsheet with yearly outputs for each input and output parameter

Resource Management Goals

The Connecticut River Atlantic Salmon Commission (CRASC) developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following:

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.

2. Achieve annual passage of 40 to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem.

3. Maximize outmigrant survival for juvenile and spent adult shad.

The Service seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

3. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
4. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to American shad, the Service's goals are:

1. Minimize current and potential negative project operation effects on American shad spawning and recruitment.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), and the Federal Power Act (16 U.S.C. §791a, *et seq*.).

Public Interest

The requestor is a resource agency.

Existing Information

Since the construction of the first fish lift facility at Holyoke Dam in 1967, American shad have had access to spawning and rearing habitat upstream from Holyoke Dam. A number of improvements to the Holyoke fishway have occurred since that time, but while the numbers of shad lifted at Holyoke have reached as much as 721,764 and the overall shad population to the river exceeded 1.6 million shad in 1992 (CRASC 1992), total shad populations, and numbers of shad passing Holyoke, Turners Falls and Vernon Dam have not met CRASC management goals.

Population and passage numbers past Holyoke have declined substantially from those totals in recent years, with average Holyoke passage numbers since 2000 of 229,876. Whole river population estimates have shown that approximately half of the returning population of shad pass upstream of Holyoke. Recent returns to Holyoke are far below management goals. Average passage efficiency of shad at Turners Falls (Gatehouse counts) and Vernon since 2000 has been 3.1 and 20.4 % respectively. These too are well below the CRASC management goals.

Safe, timely and effective up- and downstream passage along with successful spawning and juvenile production are necessary to help achieve shad management goals for the Connecticut River.

Nexus to Project Operations and Effects

Existing project operations and fish ladder efficiencies have a direct effect on shad populations in the Connecticut River. Poor upstream passage efficiencies and delays restrict river access to returning shad. Fish unable to reach upriver spawning grounds may not spawn or have reduced fitness or survival of young. Poor downstream passage survival and downstream passage delays affect outmigration and consequently repeat spawning, an important ecological aspect of the iteroparous Connecticut River shad population (Limberg et al. 2003).

The Service is concerned that poor passage efficiencies and delays at projects may be limiting access to upstream reaches of the river, altering spawning behavior, decreasing outmigration survival and contributing to the failure of the Connecticut River shad population to meet management targets (Castro-Santos and Letcher 2010).

Development of a population model will allow an assessment of individual project impacts on the population as well as the cumulative impacts of multiple projects. The model will allow managers to direct their efforts in the most efficient manner toward remedying the conditions that most impact the shad population.

Methodology

Population models are commonly used to assess anthropomorphic and natural impacts and are consistent with accepted practice. A model similar to this request was constructed for the Susquehanna River by Exelon (FERC #405, RSP 3.4). The model is constructed in Microsoft Access

Specific parameters that would be included in the model:

- Upstream passage efficiency at Holyoke, Turners Falls (Cabot, Gatehouse and Spillway Ladders), Vernon fishways, and any impacts associated with Northfield Mountain.
- Distribution of shad approaching the Turners Falls project between the Cabot Ladder and the spillway at the dam
- Downstream passage efficiencies at Vernon, Northfield Mountain, Turners Falls, and Holyoke projects for juveniles and adults
- Entrainment at Mount Tom and Vermont Yankee
- Sex ratio of returning adults

- The proportion of virgin female adults returning at 4, 5, 6, and 7 years
- The proportion of repeat spawning females at 5, 6 and 7 years
- Spawning success of females in each reach
- Fecundity
- Percent egg deposition
- Fertilization success
- Larval and juvenile in-river survival
- Calibration factor to account for unknown parameters such as at sea survival
- Options for fry stocking and trucking as enhancement measures
- Start year and model run years
- Start population
- Rates of movement to and between barriers
- Temperature, river discharge, and other variable of influence to migration and other life history events

The model should be adaptable to allow the input of new data and other inputs.

Level of Effort/Cost, and Why Alternative Studies will not suffice

Neither First Light nor TransCanada have proposed any study to meet this need. Estimated cost for the study is expected to be low to moderate. As the model describes the impacts of multiple projects and two owners, both project owners would share the cost of model development.

Literature cited:

CRASC (Connecticut River Atlantic Salmon Commission). 1992. A management plan for American shad in the Connecticut River basin. Sunderland, MA

Castro-Santos, T and B. H. Letcher. 2010. Modeling migratory bioenergetics of Connecticut River American shad (*Alosa sapidissima*): implications for the conservation of an iteroparous anadromous fish. Can.J.Fish.Aquat.Sci. 67: 806-830

Limberg, K. E., K. A. Hattala, and A. Kahne. 2003. American shad in its native range. Pages125-140 in K. E. Limberg and J. R. Waldman, editors. Biodiveristy, status and conservation of the world's shads. American Fisheries Society, Symposium 35, Bethesda, Maryland

Study Request 11: Upstream American Eel Passage Assessment at Turners Falls Dam (Docket Number p-1889)

Goals and Objectives

This study has two objectives:

1. Conduct systematic surveys of eel presence/abundance at Cabot Station discharge, Station #1 discharge, canal discharges, and Turners Falls Dam to identify areas of concentration of eels staging in pools or attempting to ascend wetted structures that would potentially establish the most effective locations to place upstream eel passage facilities.
2. Collect eels with temporary trap/pass devices from areas identified from surveys as potential locations of eel concentration to assess whether eels can be collected/passed in substantial numbers, and whether locations are viable sites for permanent eel trap/pass structures.

Resource Management Goals

The Atlantic States Marine Fisheries Commission has developed two documents related to the management of American eel:

1. Interstate Fishery Management Plan for American Eel. April 2000. Atlantic States Marine Fisheries Commission.
2. Addendum II to the Fishery Management Plan for American Eel. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

In addition, the Connecticut River Atlantic Salmon Commission (CRASC) developed A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin in 2005. The goal of the plan is "to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem…" Management objectives in the plan include the following:

1. Protect and enhance eel populations where they currently exist;
2. Where practical, restore populations to waters where they had historical abundance;
3. Provide effective upstream and downstream fish passage around dams and other barriers within the species' range in the basin; and
4. Comply with all requirements of the Fishery Management Plan of the ASMFC.

Based on these plans, the Service seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to upstream passage of American eel, the Service's goals are:

1. Minimize current and potential negative project operation effects that could hinder management goals and objectives.
2. Minimize project-related sources of upstream passage delay, injury, and stress in order to facilitate access to historical rearing habitat.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), and the Federal Power Act (16 U.S.C. §791a, *et seq*.).

Public Interest

The requester is a resource agency.

Existing Information

The PAD contains no information relative to areas where eels seeking to move upstream concentrate downstream of the dam, or annual numbers of eels attempting to ascend past Turners Falls Dam. While eels have been known to ascend the Cabot Station ladder (A. Haro, U.S. Geological Survey, pers. comm.), its efficiency is unknown, and it is only operated during the American shad passage season (from April 1 through July 15). Eels are currently able to pass the Turners Falls Dam complex (as evidenced by documented presence of eels upstream), but the total number of eels attempting to pass Turners Falls and the proportion successfully passing the project is unknown (but suspected to be low). The downstream Holyoke Project has operated upstream eel passage facilities since 2004. Last year these facilities passed over 40,000 juvenile eels. While there is rearing habitat in between the Holyoke and Turners Falls dams, some eels will attempt to continue upstream, and passage needs to be provided so these fish can access historical habitat.

These information gaps need to be filled so resource agencies can determine the best locations to site upstream eel passage facilities and assess whether operating the existing anadromous ladders would be an effective mechanism to move juvenile eels upstream past the project.

We also note that within the past seven years, the Service has received two petitions to list the American eel under the Endangered Species Act. The first petition was received on November 18, 2004. On July 6, 2005 the Service issued a substantial 90-day finding on the petition and initiated a 12-month status review that concluded on February 2, 2007 with a finding that listing was not warranted. The second petition was filed on April 30, 2010 by the Council for Endangered Species Act Reliability (CESAR). On September 29, 2011 the Service issued a substantial 90-day finding and initiated a 12-month status review. The Service is still accepting new American eel information for the ongoing status review. The Service also is currently in settlement negotiations with CESAR on their legal complaint that the Service failed to complete the 12-month finding within the statutory timeframe. Although the date for completion of the Service's 12-month finding on the latest petition is uncertain, it is likely that it will be made before any new licenses are issued for the projects.

Nexus to Project Operations and Effects

The project generates hydropower on the head created by the Turners Falls dam. This dam creates a barrier to upstream migrating eels. While some eels are able to pass dams, some are not, and the passability of a given dam depends on factors such as its height, hydraulics, presence of climbable surfaces, presence of predators, risk of exposure to heat or drying while climbing a dam, etc. The Turners Falls dam is high (35 feet above bedrock), and the majority of the dam face is dry during most of the upstream eel passage season. Design of the dam is not currently amenable to passage of eels by climbing. While flow is released to the bypass reach via a bascule gate (typically the one closest to the gatehouse), this would not facilitate eel passage, as bascule gates open outward and downward (i.e., requiring the eels to essentially swim nearly upside down to get over the gate). As mentioned earlier, the existing anadromous passage facilities are not designed to pass eels, and even if some eels are able to ascend the ladders, they may incur delays (in attraction or passage rates), be size-selective (e.g. velocity barrier for small eels presented by ~8 ft/sec flow through weirs and orifices), present a potential predation risk (predators in or near the fishways), and are not operated throughout the upstream eel passage season.

Methodology Consistent with Accepted Practice

1. Objective 1: Systematic Surveys
   Surveys of eel presence and relative abundance should be conducted at regular intervals throughout the eel upstream migratory season (~1 May to ~15 October, or when river temperatures exceed 10 C). Surveys should consist of visual inspection and trapping in likely areas where eels may concentrate as they attempt to climb structures wetted by significant spill or leakage flow in the Turners Falls dam complex area. These locations include: Cabot Station downstream bypass outfall, Cabot Station spillway (including attraction water stilling basin), Cabot Fishway (dewatered state), USGS Conte Lab flume outfall, Number One Station outfall, various small turbine and process water outfalls from the Cabot Canal, Spillway Fishway attraction water stilling basin, and leakage points along the downstream face of Turners Falls Dam (bascule and taintor gates). Methods should include visual surveys (on foot, from a boat, or snorkeling) and trapping using small mesh (< 1/8” clear opening) baited eel

pots. Visual surveys should be performed once per week, at night, preferentially during precipitation events. Trap sets should be performed once per week, with an overnight soak time. Recorded data should include location, observation of eels (presence, absence, relative numbers, relative sizes, behaviors, time/date of observation), and survey method.

2. Objective 2: Trap/Pass Collections
   Areas identified from Systematic Surveys as having significant number of eels present should be targeted as potential areas for permanent eel trap/passes, and should be initially assessed using temporary/portable trap passes. At a minimum (regardless of survey results), temporary trap passes should be installed at the following locations: Cabot Fishway attraction flow stilling basin (during dewatered fishway period), Number One Station outfall, and Spillway Fishway attraction flow stilling basin (during watered and dewatered fishway period), as these locations may be supplemented with additional attraction flow and have high potential for being concentration points for upstream migrant eels. Temporary trap/passes should be purpose-designed and built for each location, and operated throughout the eel upstream migratory season (~1May to 15 October, or when river temperatures exceed 10 C). Ramp-type traps with supplementary attraction flow are preferred temporary trap/pass designs. Traps should operate daily, with catches quantified every 2-3 days. Recorded data should include location, trapping interval, absolute numbers of eels trapped, relative eel sizes, and hydraulic and environmental conditions during the trapping period.

All collected eels from surveys should be released at their point of capture; those eels collected from trap/pass collections should be transported to and released above the dam in the Turners Falls Pool.

These methodologies are consistent with accepted practice.

Level of Effort/Cost, and Why Alternative Studies will not suffice

The level of cost and effort for the survey component of the study would be low; a minimal number of personnel may be able to conduct the weekly surveys. The trap/pass component would require low to moderate cost (estimated at $40,000) and effort.

In the PAD, the applicant has identified the need to assess issues related to upstream passage for American eels at the project, but indicates that it intends to rely on information from previously conducted studies and ongoing studies. The Service is not aware of any previously conducted or ongoing studies related to upstream eel passage.

Study Request 12: Impacts of Turners Falls Canal Drawdown on Fish Migration and Aquatic Organism Populations (Docket Number p-1889)

Conduct a study to quantify impacts of the annual Turners Falls Canal drawdown on emigrating and resident fishes, freshwater mussels and mudpuppies in the canal.

Goals and Objectives

Quantitatively assess the effects of the Turners Falls Canal drawdown on diadromous fishes and other aquatic organisms known to be present in the canal during the annual drawdown. Objectives of this study request include:

1. Determine whether juvenile shad and American eel abundance in the canal increases leading up to the time of its closure, due to delays in downstream passage (e.g., is fish accumulation occurring?)
2. Determine level of mortality for juvenile sea lamprey from exposure of burrow habitats;
3. Conduct surveys to determine aquatic organisms (fishes, freshwater mussels, and mudpuppies) present in the canal during the drawdown, their densities, status (stranded, dead, alive), and locations (mapping to document habitat, substrate type, wetted , at complete drawdown);
4. Evaluate measures to minimize aquatic organism population impacts of the canal drawdown.

Other submitted Study Requests compliment or directly relate to this project activity and assessing project effects, including the resultant effects of all river flow being passed over the Turners Falls Dam as spill (e.g., downstream juvenile shad study request and American eel movement and survival request).

Resource Management Goals

The Connecticut River Atlantic Salmon Commission developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following:

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.

2. Maximize outmigrant survival for juvenile and spent adult shad.

The Atlantic States Marine Fisheries Commission Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010, has the stated goal of *"Protect, enhance, and restore Atlantic coast migratory stocks and critical habitat of American shad in order to achieve levels of spawning stock biomass that are sustainable, can produce a harvestable surplus, and are robust enough to withstand unforeseen threats,"* and includes the following objective:

1. Maximize the number of juvenile recruits emigrating from freshwater stock complexes.

And recommendation:

2. To enhance survival at dams during emigration, evaluate survival of post spawning and juvenile fish passed via each route (e.g., turbines, spillage, bypass facilities, or a combination of the three) at any given facility, and implement measures to pass fish via the route with the best survival rate.

The Service seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to diadromous fishes, the Service's goals are:

1. Minimize current and potential negative project operation effects on diadromous fishes, including juvenile shad, adult silver eels, and sea lamprey ammocetes.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), Silvio O. Conte National Fish and Wildlife Refuge Act (P.L. 102-212; H.R. 794), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), and the Federal Power Act (16 U.S.C. §791a, *et seq*.).

Public Interest

The requestor is a resource agency.

Existing Information

Existing information in the PAD does not provide data on the population size or survival rates of juvenile American shad, American eels, or juvenile sea lamprey located in the power canal during the de-watering process. The power canal is dewatered in early September of each year for over a one week period to perform facility maintenance, inspections, and repairs including substantial silt removal and bank repairs. Historically, the canal drawdown occurred in July, but approximately five years ago it was moved to September, where it has occurred annually since then, with the exception of 2010. The agencies were informed in a letter by FLP that the shift to September was at the request of the Independent System Operator –New England (ISO-NE) to avoid peak load months of June through August. Studies conducted by the previous operator, Northeast Utilities Service Company (NUSCO), to assess downstream clupeid survival and use (1991 and 1994 studies at Cabot Station) support the contention that juvenile shad out-migration is occurring within the current drawdown time frame. There are no data to suggest that out-migration would occur earlier than 1 August, but likely does begin in the month of August (O'Donnell and Letcher 2008). Based on these data, CRASC altered its Fish Passage Notification Letter for Downstream Passage Operations for juvenile shad and herring to require the Cabot Station downstream bypass to begin operating on 15 August in 2010 and then moved the date to 1 August in 2011

It is unknown, whether the power canal may, through potential mechanism(s) of delay due to its configuration or operation, cause out-migrating juvenile shad to accumulate in the canal. This information gap leads to concerns that migrant numbers may be elevated beyond simple extrapolations of surface area comparison in the canal to main stem habitat. In the PAD, FLP indicates that the Cabot Station forebay in the vicinity of the intake has a maximum depth of 60 feet, while the existing near-surface downstream bypass structure at the Cabot Station is designed to operate only within a depth of six feet of the surface. As a result, the downstream bypass only operates effectively for a short period during the drawdown period (timing of this is unknown). The only points of egress, once the bypass becomes unavailable, are through the turbines at Cabot as well as at Station 1, and eventually at the Keith Street gate lacted well upstream from the Cabot Station intakes. It is unknown what the survival rates are for these passage routes, what proportion of fish are using each route, what number may become stranded and their survival rates, and how many fish are subjected to this situation. The related Study Requests on downstream juvenile shad outmigration and American eel outmigration outline objectives that would address some of these information gaps.

There is also a paucity of information relative to the disposition of fish moving downstream in the impoundment during the canal drawdown. Once the Turners Falls Gatehouse closes its gates, all inflow passes over the dam; a situation unique to this brief one week annual time period. Survival rates for outmigrating juvenile American shad and adult American eel moving past the project during the period of spill are not known.

Lastly, there exists an information gap regarding the fate of juvenile sea-lamprey (known as ammocetes) that reside in the soft substrate materials located in much of the lower or downstream end of the canal (personal communication, Boyd Kynard). In previous drawdowns, thousands to tens of thousands of desiccated ammocetes have been observed (Matt O'Donnell, personal communication, USGS Conte Lab). However, the distribution and abundance of ammocetes in the canal as well as mortality rates for ammocetes during the drawdown period has not been quantitatively determined.

Nexus to Project Operations and Effects

Previous studies at Cabot Station have documented that juvenile American shad and American eel migrate through the project area during the canal drawdown period. During normal operations (where canal water level elevations are stable), downstream migrants are able to utilize the Cabot bypass facility; however, as the canal water level is drawn down, the bypass is no longer available, and the only routes of egress are through the turbines at Cabot Station and Station 1, unless the Cabot Station spill gates are utilized (the spill gates have a canal depth limitation of approximately 16 feet). Turbine entrainment at hydropower projects has been shown to cause injury and mortality to fishes.

The annual canal drawdown was formerly conducted in July. In response to ISO-NE's request that FL conduct the drawdown outside of the June through August period, FL moved the drawdown to a period of time when diadromous fishes are known to be moving through the project area.

Once the canal has been drawn down, isolated shallow pools are left standing until the canal is refilled. During this period, fish (including lamprey ammocetes), amphibians, and benthic invertebrates are prone to desiccation, predation or other sources of mortality or impact.

Methodology Consistent with Accepted Practice

The methods presented here are consistent with the study requests addressing downstream juvenile American shad passage and downstream American eel passage, with an emphasis on addressing survival and movement immediately prior to and during the canal draw down. Hydroacoustic monitoring immediately upstream of the Turners Falls Gatehouse, as well as upstream of opened dam gates for spill, will provide data on the timing, frequency and magnitude of natural wild juvenile shad movement into these areas, particularly the power canal. The abundance of juvenile shad moving into the canal can be derived and compared with similar data obtained with hydroacoustic equipment monitoring upstream of the Cabot Station intake and bypass, for comparisons. Juvenile shad will be PIT tagged, released, and monitored in the canal, for movements, timing and location including Station 1 canal and forebay. PIT tagged fish will be detected at the Cabot Bypass Sluice sampler. Juvenile fish should be specifically targeted for release immediately prior to drawdown to assess survival and movement in and through the canal. Surveys of sea lamprey ammocetes should be conducted by a stratified sampling design based upon substrate.

Lamprey density surveys, immediately after drawdown and in a subsequent later survey, may derive rates of change in observed densities and their status (live, moribund, dead); appropriate methods would need to be discussed. Surveys of remaining ponded water should be conducted immediately following drawdown and at later intervals (mid- week and end of week) to compare species occurrence and densities (relative abundance) which will be used to develop catch-curve analyses that can inform rates of mortality to the observed populations.

Assessments of freshwater mussels should also be conducted to quantify drawdown impacts. As with lamprey, the assessment can be based on sampling identified habitats in a stratified, random design, over the three time periods noted (initial drawdown, mid week, and end of week), tracking changes in densities and status of observed individuals among areas. Sub-sampling, with sufficient repeated measures to determine variability and acceptable level of precision of data will inform the required sampling intensity that will be needed. This sampling intensity will be determined as the study occurs and may vary among identified species. Comparisons among the three time periods for measures of density and status will inform the evaluation of project effects for juvenile shad, sea lamprey ammocetes, freshwater mussels and mudpuppies

The canal drawdown mitigation assessment involves evaluating alternative drawdown protocols to minimize impacts to resident and migratory fish, mussels and amphibians inhabiting the canal. Alternatives should include: (1) moving the drawdown to a time of year outside of migration seasons; (2) keeping or moving the timing of the drawdown, but utilize technologies to keep the majority of the canal wetted during the drawdown (e.g., portadams in the forebay immediately upstream of the trashracks and at other canal intakes in need of maintenance); and (3) in combination with alternative #2, assess whether other existing infrastructure within the forebay could be used to pass fish safely out of the canal (e.g., low level outlets, deep gates, side spillway boards, etc.). The assessment should compare the merits and drawbacks of each alternative and provide an order of magnitude cost estimate for implementation.

Level of Effort/Cost, and Why Alternative Studies will not suffice
This Study Request has many elements that overlap directly with a larger scale downstream juvenile American shad passage and downstream American eel passage study requests. With equipment costs principally covered in those requests, many components of what has already been proposed will be used in this study. However this request does include some specific elements not specified in the other two larger requests. The study cost and effort are expected to be low to moderate. Some additional radio tags and balloon tags with additive days of field work to accurately assess impacts specific to the drawdown period will be required. Surveys for identified aquatic organisms will take several days during the drawdown period as well.

The canal drawdown mitigation assessment should require a low to moderate level of effort and cost. One staff person would evaluate alternative drawdown protocols. This should take less than one week to complete.

The applicant did not propose any studies to meet this need in the PAD.

Literature Cited:

O'Donnell, M and B. H. Letcher. 2008. Size and age distributions of juvenile Connecticut River American shad above Hadley Falls: influence on outmigration representation and timing. River Research Applications #24: 929-940.

Study Request 13: Three-dimensional Computational Fluid Dynamics (CFD) Modeling in the Vicinity of Fishway Entrances and Powerhouse Forebays (Docket Number p-1889)

Goals and Objectives

The goal of this study is to determine the flow field conditions that exist in and around the fishway entrances, and upstream of both Turners Falls powerhouses (Station 1 and Cabot). The information from this request is meant to be coupled with data from the telemetry study such that a comprehensive understanding of fish behavior is developed.
The objective of this study is to develop a series of maps that show color contour maps of velocity magnitude at discharges that have been agreed upon by the resource agencies and the licensee. With respect to upstream passage, the results will show approach velocities and orientation within the approach zone of the fish that may create a response in fish. This information can be coupled with telemetry data (from the requested shad telemetry study) and passage counts to understand which conditions are optimal for guiding migrating fish to the fishway entrances and for stimulating fishway entry. With respect to downstream migration, the results will show velocities and orientations in front of each powerhouse. At Cabot Station, the results will indicate to what degree, if any, flow directs downstream migrating fish towards the surface bypass weir. At Station 1, we will have an improved understanding of the magnitude of velocity in front of the turbine intakes.

Resource Management Goals

The management goals of this study request are to obtain information that will help assist in designing effective upstream fishways for upstream migrating trust species and to reduce impingement, entrainment and delay for downstream migrating fish. CFD models are a relatively cost effective way to analyze existing and future conditions. As such, changes in the amount of attraction water, changes in which turbines are operating and which spillway gates are releasing water can all be examined. As stated, the results from this study are meant to be used along with the data generated from the telemetry study. The combined analysis from these two data sources can help assess which flow conditions are most advantageous for migrating trust species to enter the fishway under current and proposed conditions.
As for downstream migration of adult and juvenile shad, and adult eel, the results from the models will reveal flow magnitude and direction in front of each powerhouse. Given the limited information that currently exist on survival through Cabot and Station 1, our management goal is to direct as many downstream migrating fish as possible towards the uniform acceleration weir and downstream bypass. With respect to upstream passage, we want to maximize the number of fish that find and enter the fishway entrances.
Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), and the Federal Power Act (16 U.S.C. §791a, *et seq*.).

Public Interest

The requestor, NMFS, is a federal resource agency.

Existing Information and the Need for Additional Information

To date, no CFD modeled data exist in front of either fish ladder, nor do they exist in front of either powerhouse. Some preliminary modeling has been done downstream of the Gatehouse, but changes to the gatehouse entrances would require updated modeling . It is our understanding that the licensee has worked with the firm Alden to develop a CFD model of the upper power canal and that elevation survey data from the power canal also are available. Detailed 2-dimensional movement data on shad are available from observations made between 2003 to 2005 and 2010 to 2012. By coupling and analyzing these two data sets, flow and fish movement, we believe this will have substantial benefits to our management efforts.

When designing upstream passage structures, a site assessment is critical. The development of these models gives resource agencies valuable information into the hydraulic cues which may elicit a response from upstream migrants. For downstream passage, the U.S. Fish and Wildlife Service has approach velocity guidelines; the output from these models would inform the resource agencies under what conditions appropriate approach velocities are being met and when they are being exceeded.

Project Nexus

The Turners Fall Project has direct impacts to upstream and downstream migrating shad and eel. With respect to upstream migration, the auxiliary water system (AWS) plays a critical role in determining whether or not fish are attracted to the entrance. The results from this study would allow us to assess how well the AWS is performing and under what conditions it attracts the most fish.

With respect to downstream migration, as a general rule, fish tend to follow the flow. If flow fields are directing fish towards the turbine intakes, the results from this study will indicate that. The development of a CFD model under existing conditions also informs the design of future modifications. The development of a CFD model could be used to improve the survivability of downstream migrating shad and eel.

Proposed methodology

A 3-dimensional CFD model has become and increasing common standard of analysis at hydro-electric projects around the nation. Within the Northeast region, we have seen these types of models developed at the Holyoke (P-2004), Brunswick (P-2284), Shawmut (P-2322), Milford (P-2534) and Orono (P-2710). We would expect to engage with the licensee in terms of determining the appropriate area and flows to be modeled. We expect that the spatial extent of the model at each study site will vary. Given the large number of ways that output from these models can be presented and the near infinite number of flows that could potentially be modeled, we would expect to consult with the licensee to reach agreed upon modeling efforts and scenarios to be examined.

Level of Effort and Cost

The cost of developing, running and testing a CFD model can vary tremendously; one large variable is determining the cost is based on the amount of existing bathymetric data the applicant currently has access to. We roughly estimate the cost of each CFD model could run as high as $50,000 assuming no bathymetric data currently exists. Proactive communication with resource agencies will reduce the cost and iterative effort. Given the above mentioned projects where this level of effort has occurred for other projects that have proposed to amend their license for various reasons, we see the level of effort as commensurate with the other projects given that the applicant is requesting a renewal of its existing license.

Study Request 14: Evaluate the frequency and impact of: 1) emergency water control gate discharge events and: 2) bypass flume spill events, on

shortnose sturgeon spawning and rearing habitat in the tailrace and downstream from Cabot Station (Docket Number p-1889)

This evaluation should directly address the impact of sediment disturbance and excessive velocities on habitat in Cabot Station tailrace and downstream resulting from emergency water control gate discharge events and bypass spill events and effects of spill from the downstream fish bypass sluice on shortnose sturgeon spawning and incubation.

Goals and Objectives

The goal of this study is to determine appropriate scenarios for operation of the emergency water control gates and bypass flume that will be sufficiently protective of shortnose spawning and rearing below Cabot Station from excessive water velocities and exposure to abrasive sediments dislodged and transported across spawning and rearing areas. Furthermore, avoidance or minimization of rapid fluctuations in flow is also a goal of this study applicable to the operations of the emergency water control gates and bypass flume.

The objective of the study will be to determine how often the emergency water control gates are operated to discharge large quantities of water and evaluate the impact of these events on sediment transport and bottom velocities within known shortnose sturgeon spawning and rearing habitat below Cabot Station. Another objective is to understand the operation of the bypass flume that result in bypass flume spill events and evaluate the impacts of these spill events on sediment transport and bottom velocities within known shortnose sturgeon spawning and rearing habitat below Cabot station. Even when bottom velocities fall within the range optimum for shortnose sturgeon spawning, rapid fluctuations may result in sediment transport having a harmful impact on developing eggs and embryos.

Specific Objectives include:

a. Emergency water control gate discharge events
    i. Field verification during operation of the emergency water control gates during a range of spill and discharge conditions is necessary during years 2014 and 2015 if emergency water control gates will continue to be operated during shortnose sturgeon spawning and rearing (April 15th –June 22nd).
        1. Collection of sedimentation and bottom velocity data during 2014 and 2015 is necessary to verify proposed alternative operation scenarios for the emergency water control gates that will avoid or minimize negative impacts to spawning and rearing habitat.

b. Bypass flume spill events
    i. Field verification during bypass flume spill events under a range of spill and discharge conditions is necessary during years 2014 and 2015 if bypass flume spill events continue to be a part of future project operations and will occur during shortnose sturgeon spawning and rearing (April 15th and June 22nd).
        1. Collection of sedimentation and bottom velocity data during 2014 and 2015 is necessary to verify proposed alternative operation scenarios for the bypass flume that will avoid or minimize negative impacts to spawning and rearing habitat.

Resource Management Goals

NMFS seeks to understand current emergency water control gate bypass flume operations and associated impacts to determine potential operation scenarios that avoid or minimize negative effects on shortnose sturgeon spawning a rearing.

Public Interest

The requestor is a natural resource agency.

Existing Information

The emergency water control gates are used to spill large amounts of water and Cabot Station also spills water from the bypass flume (Kynard et al. 2012, chapter 3, Kieffer and Kynard 2007). These large spill events created a plume of turbid turbulent flow, which caused some females to leave the area (Kynard et al. 2012, chapter 3, Kieffer and Kynard 2007). Additional spill events create a scour effect on the bottom and the scoured sediments are then pushed downstream over, or deposited on spawning and rearing shoals where an entire years class of ELS may be destroyed (Kynard et al. 2012, chapter 3, Kieffer and Kynard 2007). Information included in the PAD does not address operation of the emergency water control gates or bypass flume and impacts on shortnose sturgeon spawning and rearing.

Nexus to Project Operations and Effects

The large and rapid changes in flow releases from hydropower dams are known to cause adverse effects on habitat and biota downstream of the project [insert citations]. One of the two critical shortnose sturgeon spawning and rearing areas in the Connecticut River is located within the Cabot Station tailrace and impacted by the project's discharges, including spill from the emergency water control gates and bypass flume. This section of the Connecticut River also contains habitat that supports important spawning and rearing areas for migratory fish such as American shad and American eel. Current operations of the emergency water control gates and bypass flume create flow dynamics that are not sufficiently protective of shortnose sturgeon spawning and rearing. Results of this study will be used by the Service to determine recommendations for operation of the emergency water control gates and bypass flume that will avoid or minimize sedimentation and improve bottom velocities that are sufficiently protective of shortnose sturgeon spawning and rearing.

Methodology Consistent with Accepted Practice

River hydrology modeling is commonly employed at hydroelectric projects to assess implications of project operations on the river environment. It is assumed that the planned hydrologic modeling can incorporate emergency water control gate operations and associated impacts. Thus, an additional model would not be required for this request.

Field assessment will be needed to collect sedimentation and bottom velocity data at the emergency water control gates and fish bypass sluice discharge areas to determine what operational scenarios of those structures avoid or minimize impacts to shortnose sturgeon spawning and rearing. Velocity gauges will be employed to collect data on bottom velocities associated with project operations at Cabot Station. Coordination of gauge placement for this request with the field measurements for the instream flow study should help minimize the number of necessary gauges. Field assessment of sedimentation may be collected using a variety of techniques. One potential method of collection of sedimentation data would be to set fine-mesh nets similar to shortnose sturgeon larval collection nets; these nets may show changes in the amount of dislodged substrate material that travels along the spawning site as a result of powerful releases at both the Cabot spillway and bypass flume.

Level of Effort/Cost, and Why Alternative Studies will not suffice

Field verification for this study request will likely be coordinated with other field work for related study requests. It is not expected that the required field work for this request will result in significant additional cost and effort beyond what is expected for field work related to the instream flow study request. Post-fieldwork data analysis would be a moderate cost and effort. We anticipate that the level of effort and costs will be comparable to that experienced on similar FERC relicensing projects of this size (e.g., the Conowingo Project, FERC No. 405).

Study Request 15: Determine the Fish Assemblage in the Turners Falls and Northfield Mountain Pumped Storage Project-Affected Areas (Docket Number p-1889) (Docket Number p-2485)

Goals and Objectives

The goal of this request is to determine the occurrence, distribution, and relative abundance of fish species present in the Project affected areas of the Turners Falls and Northfield Mountain Project Areas, which potentially includes Species of Greatest Conservation Need (SGCN) for Massachusetts, New Hampshire, and Vermont.

Specific objectives include:
1) Document fish species occurrence, distribution and abundance within the project affected area along spatial and temporal gradients.

2) Compare historical records of fish species occurrence in the project affected area to results of this study.

Resource Management Goals
The Massachusetts Division of Fisheries and Wildlife, New Hampshire Fish and Game Department and the Vermont Fish and Wildlife Department each have as a mission the protection and conservation of fish and their habitats. Riverine fish species are an important component of the river's ecology and are the basis for the sport fishery. Furthermore, several of the states' SGCN have been documented in the project-affected area.

Determining species occurrence, distribution, and abundance will better clarify what species occur in the project area both spatially and temporally, relative to habitats which may be affected by project operations of the Turners Falls or Northfield Mountain Pump Storage projects. This information will better inform other results from other study requests that will be examining project operation effects on various aquatic habitats, water quality and other related concerns such as entrainment concerns at NFMPS. This information will be used to make recommendations and provide full consideration for all species, including those that might not otherwise be known to occur in the project-affected area and impacts that may affect their population status through direct or indirect effects of the projects.

Public Interest
The requestor is a natural resource agency.

Existing Information

A thorough and comprehensive assessment of the fish assemblage present in the project-affected areas of the Turners Falls and NFMPS projects is lacking. The PAD for these projects sites notes resident fish surveys conducted by the State of Massachusetts in the early to mid 1970s and a limited 2008 sampling effort by Midwest Biodiversity Inst. (contracted by EPA). The PAD identifies a total of 22 fish species in the project area which omits, as an example of its limited information basis, northern pike, tessellated darter, burbot, eastern silvery minnow, and channel catfish (Ken Sprankle, USFWS, and Jessie Leddick, MADFW, personal communication). It is unknown how many other species may inhabit or utilize aquatic habitats in the projects area, potentially including species of greatest conservation need.

The most relevant recent fish survey study related to the project affected areas is a Connecticut River electrofishing survey conducted in 2008 (Yoder et al., 2009). While some sampling was conducted in both project areas during the 2008 survey, this survey did not have the same goals and objectives as those outlined above. Due to the design of the study limitations in geographic/habitat type coverage both spatially and temporally, and the use of a single gear type, limits the use of these data and that synthesized data may not be a full representation of species occurrence in the project affected areas. It follows that since information is limited regarding the composition of the fish community and their use of habitats in the project-affected area, project impacts on fish species are also unknown.

Nexus to Project Operations and Effects

Project operations have the potential to directly impact fish species life history requirements, biological interactions, and habitat quantity and quality. For example, headpond and tailwater water level fluctuations could dewater important spawning areas, or affect habitat availability, thus limiting productivity of fish species by direct impacts to their spawning success or indirectly by limiting the spawning success of forage fish species. Accordingly, a thorough understanding of the current fish assemblage structure and associated metrics are needed in order to examine any potential project-related impacts. A Study Request to examine project effects on aquatic habitats, as well as impacts to spawning habitats (e.g., sea lamprey and black bass) has been submitted and will compliment this request.

Methodology Consistent with Accepted Practice

An accepted and robust field sampling design (e.g., as described in Pollock et al. 2002 or MacKenzie et al. 2006) and accepted methods for collecting fish species likely to be present in the project-affected areas (Bonar et al. 2009) should be used to conduct field surveys. Randomly sampling multiple habitat types using a multi-gear approach will be required to ensure that all fish species present are sampled. The spatial scope of the study will be from the headwaters of the Turners Falls pool downstream to Sunderland, Massachusetts, and will omit the upper reservoir of Northfield Mountain Pump Storage Project. Sampling should occur at each selected site across multiple seasons (spring, summer, and fall). Digital photographs should be taken to avoid misidentification of certain species such as Cyprinids.

The sampling design should include replicate samples for estimation of species detection probability. Sample replicates may be gathered temporally, using different methods, by independent observers, or by randomly sampled spatial replicates (MacKenzie et al. 2006). For each replicate sample, data that may be important for describing variation in species occurrence and presence/absence should be collected and recorded, such as gear type, mesohabitat type, depth, velocity, flow, water temperature, substrate, time of day, day of year, presence of cover, proportion of vegetation cover, size of individuals collected (juveniles may select different habitat), and/or other factors as determined by a qualified biologist. Species detection, occurrence, and/or abundance and related habitat measures on these parameters should be estimated using methods as described by Kery et al. (2005), MacKenzie et al. (2006), Wenger and Freeman (2008), or Zipkin et al. (2010).

This will be a one year study provided river discharge conditions fall within 25th to 75th percentile for weekly averages. Based upon this study's results, and the additional information obtained on requests to survey aquatic habitats and littoral zone fish spawning, an additional study may be required if evidence of project operation affects on population status or habitat for identified species.

Level of Effort/Cost, and Why Alternative Studies will not suffice
The cost of the study will be moderate to high as seasonal sampling with several types of gear will be required. However, cost will also be partially dependent on the number of sites sampled, the number of sample replicates, and the extent of the covariate data that are measured, all which may be flexible. Based on first year study results, a second year of sampling or specific studies examining impacts of project operations on specific fish species may be needed and requested. Provided the collected data are of high quality, analysis and synthesis should take approximately 10-20 days. FirstLight did not propose any studies specifically addressing this issue.

Literature Cited:

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Pollock, K.H., J.D. Nichols, T.R. Simons, G.L. Farnsworth, L.L. Bailey, and J.R. Sauer. 2002. Large scale wildlife monitoring studies: statistical methods for design and analysis. Environmetrics 13:105-119.

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Zimmerman, J.K.H. 2006. Response of physical processes and ecological targets to altered hydrology in the Connecticut River basin. The Nature Conservancy, Connecticut River Program, Northampton, MA.

Zipkin, E.F., J.A. Royle, D.K. Dawson, and S. Bates. 2010. Multi-species occurrence models to evaluate the effects of conservation and management actions. Biological Conservation 134:479-484.

Study Request 16: Model River Flows and Water Levels Upstream and Downstream from the Turners Falls Project Dam Generating Stations and Integration of Project Modeling with Upstream and Downstream Project Operations (Docket Number p-1889) (Docket Number p-2485)

Develop a river flow model(s) that are designed to evaluate the hydrologic changes to the river caused by the physical presence and operation of the Turners Falls Hydroelectric Project and the interrelationships between the operation of all five hydroelectric projects up for relicensing (i.e., P-1889 Turners Falls Hydroelectric Project, P-2485 Northfield Mountain Pumped Storage, P-1904 Vernon Hydroelectric Project, P-1855 Bellows Hydroelectric Project, P-1892 Wilder Hydroelectric Project) and river inflows. The flow studies should assess the following topics:

1. Conduct quantitative hydrologic modeling of the hydrologic influences and interactions that exist between the water surface elevations of the Turners Falls Project impoundment and discharges from the Turners Falls Dam and generating facilities and the upstream and downstream hydroelectric projects. Data inputs to and outputs from the model(s) should include:
    a. Withdrawals from the Turners Falls impoundment by the Northfield Mountain Pumped Storage Project, FERC No. 2485,
    b. Discharges to the Turners Falls impoundment by the Northfield Mountain Pumped Storage Project,
    c. Discharges into the Turners Falls impoundment from the Vernon Project, FERC No. 1904 and other sources.
    d. Existing and potential discharges from the Turners Falls Project generating facilities and spill flows.
    e. Existing and potential water level fluctuation restrictions (maximum and minimum pond levels) of the Turners Falls impoundment and downstream flows from the project
    f. Existing and potential required minimum flows and/or other operation requirements at each of the four upstream projects.
    g. Minimum discharge flows ranging between 2,500 and 6,300 cfs in the bypass reach from April 15th through June 22nd to support spawning, rearing, and outmigration of shortnose sturgeon at Rock Dam.

2. Document how the existing and potential outflow characteristics from the four upstream projects affect the operation of the Turners Falls Project including downstream flow releases and Turners Falls impoundment levels.

3. Assess how the operation of the existing Turners Falls Project and upstream projects affect Holyoke Project (P-2004) operations including:
    a. How Turners Falls Project flow fluctuations affect Holyoke impoundment water levels, with emphasis on the influence on the water levels on listed Puritan tiger beetle habitat at Rainbow Beach in Northampton, MA. and assess what changes would be needed in Turners Falls operations to stabilize water levels at Rainbow Beach.
    b. How Turners Falls Project operations affect Holyoke Project discharges and what changes in Turners Falls operations would be needed to reduce fluctuations in the discharges from the Holyoke Project.

4. To the extent predictable and practical, incorporate the potential effects of climate change on project operations over the course of the license.

Goals and Objectives

Determine the extent of alteration of river hydrology caused by operation of the project and the interactions between upstream project operations, Turners Falls operations and downstream operations at the Holyoke Project. The models will provide necessary information on what changes can be made to each of the five project's flow releases and/or water levels restrictions, and how those changes affect downstream resources.

Specifically, for the Turners Falls Project continuous minimum discharge flows in the Turners Falls bypass reach need to be no less than 2,500 cfs during shortnose sturgeon spawning, rearing, and outmigration (April 15th – June 22nd). Incorporating these parameters into the model will inform what changes, if any, need to be made to operations of upstream projects to accommodate such flows.

As other specific modifications of the operations of each of the projects are identified based on results of other requested studies, these desired conditions will need to be input into the models to assess how each change affects that project and other project operations and the implications of those changes on other resources and/or the ability to achieve desired operational changes at other projects.

Resource Management Goals

The Service seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.
3. Assist FERC to ensure that the continued operation of the facility is not likely to jeopardize the continued existence of shortnose sturgeon.

Specific to aquatic resources, the Service's goals are:

1. Protect, enhance, or restore, diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
3. Minimize current and potential negative project operation effects on water quality and aquatic habitat.
4. Ensure that project operations are not likely to jeopardize the continued existence of shortnose sturgeon.
5. Avoid or minimize the current negative effect of project operations on shortnose sturgeon spawning and rearing within the Montague spawning area (i.e. Rock Dam and Cabot Station spawning sites and associated early life stage rearing areas).

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), and the Federal Power Act (16 U.S.C. §791a, *et seq*.).

Public Interest

The requestor is a resource agency.

Existing Information

Available information in the PAD does not indicate how project operations have altered downstream hydrology, which may affect resident and migratory fish, macroinvertebrates, rare, threatened, and endangered species, aquatic plants and other biota and natural processes in the Connecticut River from below the Vernon Dam downstream to the Holyoke Dam.

Information in the PAD also does not reflect data analyzed in Kynard et al. 2012, which identifies minimum discharge thresholds for shortnose sturgeon spawning and rearing at the Rock Dam spawning site. Spawning success was observed at Rock Dam when discharge was between 2,500 cfs and 22,000 cfs during the spawning period (April 27–May 22nd) (Kynard et al. 2012, chapter 3). In 1995 at the Cabot spawning area, the greatest level of spawning and spawning success occurred (i.e., 21 late stage females present, 342 ELS captured, spawning period was 17 days) even though no spawning was detected at Rock Dam (Kynard et al. 2012, chapter 3). Discharges in 1995 at Rock Dam had dropped below 2,500 cfs by March 26th (Kynard et al. 2012, chapter 3), showing that even though 1995 saw the largest number of pre-spawning adults, none spawned at Rock Dam. This may indicate the need to have adequate flow well in advanced of spawning. Discharge reductions at the Rock Dam site that occurred during spawning caused females to leave the spawning cite and not return even if flow increased to acceptable levels later during the spawning period. Researchers observed that substrate did not change during fluctuating flows and thus cessation of spawning is likely due to velocities falling below the range preferred by females. Given the current flow dynamics at Rock Dam, spawning does not occur most years (Kynard et al. 2012, chapter 3). These data represent the best available scientific information and indicates that the current minimum flow thresholds at the project are not adequate for the protection of endangered shortnose sturgeon. All modeling efforts described above must incorporate the identified minimum flow and temporal parameters.

Nexus to Project Operations and Effects

The Turners Falls Project is currently operated with a seasonally-varying minimum bypass flow (400 cfs from 5/1 through 7/15, then 120 cfs through the winter until river temperature rises to ≥ 7°C) and year-round minimum flow below the projects of 1,433 cfs. The project operates as a daily peaking project, often with large, rapid, daily flow fluctuations between the minimum and project capacity (15,928 cfs) and fluctuations in headpond elevation (175’ to 186’ MSL). These changes affect biotic habitat and biota upstream and downstream of the project. Project operations and potential changes to operations to mitigate impacts are influenced by inflows and operations of upstream peaking projects and the Northfield Mountain Pumped Storage Project operations and potential changes in operations of each project could affect the ability to achieve desired operational changes at other projects. Results of river flow analyses will be used to develop flow-related license requirements and/or other mitigation measures.

Methodology Consistent with Accepted Practice

River hydrology statistics and modeling are commonly employed at hydroelectric projects to assess implications of project operations on the river environment.

Level of Effort/Cost, and Why Alternative Studies will not suffice

Level of effort and cost of model development are expected to be moderate but to be valuable in developing license conditions, the model(s) will need to be run under various scenarios throughout the relicensing process to assess the implications of changes to the operations of each project on other projects and other resources. Therefore, ongoing consultation and re-running of the model(s) are likely to be needed throughout the relicensing process. The modeling exercise will also require coordination and cooperation between First Light and the upstream licensee to assure that the model inputs and outputs can be accurately related.

We would anticipate that the expected level of effort and anticipated costs will be comparable to that experienced on similar FERC relicensing projects of this size (e.g., Conowingo, FERC No. 405).

Study Request 17: Impacts of Water Level Fluctuations on Riparian and Aquatic Vegetation Including Invasive Species and their Associated Habitats in the Turners Falls Dam Project Impoundment (Docket Number p-1889) (Docket Number p-2485)

Conduct a study to quantify impacts of reservoir fluctuation on riparian, wetland, Emergent Aquatic Vegetation (EAV), Submerged Aquatic Vegetation (SAV), littoral zone and shallow water aquatic habitats in the Turners Falls Dam impoundment.

Goals and Objectives

The goal of this study is to obtain baseline information on riparian, wetland, emergent and submerged aquatic vegetation, and associated shallow water aquatic habitats (subject to operational inundation and exposure to near exposure) known to occur in the project area. Information would be used to determine whether riparian, wetland, EAV and SAV, littoral, and shallow water (e.g., mid river bars and shoals) habitats are impacted by current water level fluctuations permitted under the Turners Falls and Northfield projects' licenses and whether these vegetation types and shallow water habitats can be protected and restored by modifications to project operations or other mitigation measures. This analysis needs to take into account existing and potential future limits on pond level fluctuations intended to limit recreation impacts, and the interactions of any changes in pond level fluctuation range or frequency and discharge changes under a new licenses of the Turners Falls and upstream projects. This information is needed to determine whether the projects operation affects plants, habitat, and wildlife in the project area, whether aquatic vegetation and its habitats can be enhanced by modifications to project operations or other mitigative measures, and whether there is any unique or important shoreline or aquatic habitats that should be protected.

The specific objectives of the field study, at a minimum, include:

- Quantitatively describe and map wetland types within 200 feet of the shoreline, and describe associated wildlife;
- Delineate, quantitatively describe, and map all wetland types including invasive species and wildlife observed (e.g., bald eagle nesting, water fowl nesting) within 200 feet of the shoreline, and the extent of this habitat if it extends beyond 200 feet; and
- Quantitatively describe (e.g., substrate composition, vegetation type and abundance) and map shallow water aquatic habitat types subject to project operation inundation and exposure, noting and describing additional areas where water depths at lowest operational range are wetted to a depth less than one foot (flats, near shore areas, gravel bars, with very slight bathymetric change);

A second year of study may be required should river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period.

The field study should produce a habitat inventory report that includes:

- The results of the field study in the form of maps and descriptions;
- An assessment of project effects on wetland, riparian, littoral zone vegetation and shallow water habitats, invasive plant species, and wildlife habitat at the project; and
- Recommendations for any necessary plant, habitat type, or wildlife, protection and/or invasive species control measures.

Resource Management Goals

Protect and restore native riparian, wetland, EAV, SAV, littoral and shallow water habitat (i.e., spawning and or nursery areas for aquatic organisms) in the project reservoir.

Public Interest

The requestor is a resource agency.

Existing Information

Existing information in the PAD does not quantify EAV and SAV in this area, or other shallow aquatic habitat types and physical features (e.g., depths, substrates, wood structure) that are the environment for aquatic biota in the project area. The PAD does provide some limited monitoring data for 2012 (2 locations) on water surface elevations that show daily fluctuations, in the upper third of this impoundment, that varied over 4 feet on a daily cycling frequency, with fluctuations generally in the 2 foot range in low flow months for the data provided in the PAD. The current license does permit a greater pool elevation operational fluctuation, up to a 9 foot change in elevation, based on the Turners Falls Dam water elevation. In the PAD it is noted these operational fluctuations under most circumstances at the Turners Falls Dam are within 3.5 feet.

In the PAD it is noted that FLP would like to expand its NMPS upper reservoir capacity (by up to 24%), how this may affect project operations and the habitats noted in this request is unknown. It is also noted that water is typically pumped to the upper reservoir in evening and generation back to the river occurs once to twice daily, in daytime hours, based upon power needs and power value. Under current license conditions, provided set thresholds for minimum flow and Turners Dam current license elevations are met, the NMPS may operate with no restriction in timing, frequency, or magnitude for pumping or generation. No data were provided on the operation of the NMPS plant over time relative to data on pumping and generation on an hourly basis, averaged values were provided over monthly periods. It is unclear what the actual timing, frequency and magnitude of these NMPS operations are over the course of a year and how that relates to; aquatic plant species establishment, growth, survival, littoral zone or other shallow water habitat fish spawning periods and their effects on these fishes (reproduction success and subsequent recruitment, e.g., bass and fall fish nests) in available and utilized habitat, and how the quantity and quality of these shallow water habitats are effected by project operational manipulation/alteration, as currently permitted or proposed.

The PAD provides lists of plant and wildlife species whose native ranges overlap with the project area, but it does not provide any baseline information on known occurrences of these species in the wetlands, riparian, littoral and shallow water habitats, within or adjacent to, the project area. Plant and wildlife occurring in these habitats may benefit from protection, mitigation, and enhancement (PMEs) measures, given the potential effects of continuing the current semiautomatic peaking operating regime. In addition, a large scale sediment discharge from NMPS resulted in regulatory actions by FERC, the EPA and MADEP in 2010. Continuing and as yet unresolved management plan measures relative to sediment and NMPS project operations, are further concerns for shallow water, littoral zone, and wetland habitats.

The Atlantic States Marine Fisheries Commission, Atlantic Coast Diadromous Fish Habitat: A Review of utilization, threats, recommendations for conservation, and research needs (ASMFC 2009), contains a review of habitat information for these species. Recommendations in this report include: Maintain water quality and suitable habitat for all life stages of diadromous species in all rivers with populations of diadromous species.

Nexus to Project Operations and Effects

Water level fluctuations due to project operations could affect EAV and SAV habitat as well as the quantity and quality littoral and shallow water habitat. These operational water level fluctuation effects are expected to impact fish species use of these habitats and may affect spawning fishes reproductive success and subsequent population recruitment including but not limited to American shad, blueback herring, sea lamprey, fall fish, and bluegill, which spawn in mid to late spring through early summer in areas subject to daily or more frequent water level fluctuations.

The current operating mode, as well as the unknowns with proposed upper reservoir expansion, may affect wetland riparian, littoral and other shallow water habitats and promote the introduction and expansion of invasive plant species through fluctuating water levels. A study that explains the relationship between the proposed mode of operation and the type and quantity or wetland, riparian, littoral, shallow water habitats, and invasive species affected would help inform a decision on the need for protection and/or control of these resources in the license.

Methodology Consistent with Accepted Practice

The PAD currently contains maps portraying general wetland types from the Cabot Station tailrace upstream to the Vernon Dam. In addition, the Service understands that the detailed bathymetry exists for the Turners Falls impoundment. The proposed study should utilize this existing information in conjunction with field surveys designed to describe the characteristics of each mapped wetland, riparian, littoral and shallow water habitat including plant species composition, relative abundance/density, habitat quality, and land use. These surveys should be conducted to describe these habitats at the lowest water level operational range permitted on a daily operation schedule, under low flow conditions. Information collected should include:

- Plant species composition, and their relative abundance/density and condition/structure (e.g., seedlings);
- Structured data, including estimates of average heights and aerial cover of each vegetation layer (specifically denoting invasive species);
- Aquatic habitat substrate composition, quantity (i.e., percent types and area), wood structure (relative abundance measure applied by area), water depths (inundated, exposed, and water less than one foot);
- Predominate land use(s) associated with each cover type;
- Wildlife sightings should be noted;
- Field verified wetland, riparian, and littoral and shallow water habitats and invasive species occurrences, should be geo-referenced as polygons and overlain on orthophoto at a suitable scale.

Level of Effort/Cost, and Why Alternative Studies will not suffice

In the PAD, First Light identified impacts of the project operations on wetlands, riparian and littoral zone habitat as a potential issue to be addressed in relicensing, and proposed wetland vegetation mapping. However, additional analysis as described above is needed to understand the impacts of the project on these resources and habitats.

A wetlands, riparian, littoral/shallow water, invasive species inventory, of the scope envisioned, would likely require 6-8 months to complete and cost $40,000 to $50,000.

Literature Cited:

Atlantic States Marine Fisheries Commission. 2009. Atlantic coast diadromous fish habitat: A review of utilization, threats, recommendations, for conservation, and research needs. Habitat Management Series #9. Washington, D.C.

Study Request 18: Impacts of the Turners Falls and Northfield Mountain Pump Storage Projects Fish Spawning and Spawning Habitat. (Docket Number p-1889) (Docket Number p-2485)

Goals and Objectives
The goal of this study is to determine if project operations and water level fluctuations in the Turners Falls Project impoundment negatively impact anadromous and resident fish species including but not limited, to sea lamprey, white sucker, fall fish, smallmouth bass, yellow perch, spottail shiners, bluegill, black crappie, chain pickerel, northern pike, common sunfish, and walleye, and if impacts are found to occur, to develop appropriate mitigation measures. This study complements a separate study requests specific to American shad spawning and also on habitats affected by water level manipulations. An additional instream flow study request will address fish habitat effects for species of concern downstream of the Turners Falls Dam.

Specific objectives include:
1) Conduct field studies in the main stem, tributaries and backwaters of project affected areas to assess timing and location of fish spawning.

2) Conduct field studies in the main stem, tributaries and backwaters of project affected areas to evaluate potential impacts of impoundment fluctuation on nest abandonment, spawning fish displacement and egg dewatering. The study should also evaluate if changes in impoundment fluctuation range would mitigate for identified impacts and if other mitigative measures would lessen these impacts.

A second year of study may be required should river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period (end of March through mid July). Similarly, water temperatures should be closely considered, to ensure representative conditions occurred to reduce bias in observations.

Resource Management Goals
The Service has identified its mission as: working with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people. The Service has identified the following Northeast Regional goals to support the Service's mission and vision, the national Fisheries Program mission, and Service priorities: 1) Conservation, and management of aquatic species: Maintain, restore, and recover populations of species of conservation and management concern to self-sustaining levels; 2) Conservation and management of aquatic ecosystems: Maintain and restore the ecological

composition, structure, and function of natural and modified ecosystems to ensure the long-term sustainability of populations of species of conservation and management concern.

A mission of both the New Hampshire Fish and Game Department and the Massachusetts Division of Fisheries and Wildlife is to protect and conserve fish and their habitats. Resident fish species are an important component of the river's ecology and in some cases are the basis for a sport fishery. This requested study will help protect and conserve resident fish species by ensuring Project operations do not negatively impact their spawning success and spawning habitats.

Public Interest
The requestor is a resource agency.

Existing Information
To our knowledge, no information exists related to this requested study. The Massachusetts Integrated List of Waters shows the Project Area from the VT/NH state line to the Turners Falls Dam impaired due to "other flow regime alterations."

Nexus to Project Operations and Effects
Project operations have the potential to impact fish species by influencing spawning success and spawning habitat quality and quantity. For example, water level changes due to Project operations could create conditions where fish eggs are exposed to air, where spawning habitat is dewatered, and/or where fish abandon nests containing eggs.

Methodology Consistent with Accepted Practice
Common tools to evaluate fish spawning would be used including visual observations of habitats and sampled fish (i.e., in spawning condition, coloration, gonads mature, and other external features that become developed with spawning) collected by gears such as electrofishing, seining and other net gears during defined environmental and or time windows for spawning activity. Project operation impacted areas, should be quantified to identify and define areas subject to dewatering and mapped relative to observations of fish nests, spawning fish, egg deposits. During identified spawning periods for these species, suitable spawning habitats subjected to daily project operational fluctuations will be surveyed to document the type and extent of project effects on nests or spawning habitat (fall fish nests, lamprey nests, bass and sunfish nests, white sucker eggs/larvae) and observable eggs or larvae, relative to water level and other environmental condition, including water temperature and water velocity in noted areas.

Level of Effort/Cost, and Why Alternative Studies will not suffice
FirstLight Power does not propose any studies to meet this need. Estimated cost for the study is moderate.

Study Request 19: In-stream Flow Habitat Assessment Downstream of Cabot Station (Docket Number p-1889)

Conduct an instream flow habitat study to assess the impacts of the range of the proposed project discharges on the wetted area and optimal habitat for key species. The study should include non-steady flow approaches to assess effects of within-day flow fluctuations due to peaking power operations on target fish species and benthic invertebrate communities. Target fish species include: federally endangered shortnose sturgeon, American shad, fallfish, and white sucker

Goals and Objectives

The goal of this study is to determine an appropriate flow regime that will protect and enhance the aquatic resources from the Cabot tailrace of the Turners Falls Project downstream to the Rt. 116 bridge in Sunderland, MA. Specifically, the objective of the study is to conduct an instream flow habitat study to assess the impacts of a range if flows on the wetted area and optimal habitat for key species, including the impacts of hydropeaking flow fluctuations on the quantity and location of aquatic habitat.

The study should include non-steady flow approaches to assess effects of within-day flow fluctuations due to peaking power operations on target fish species and benthic invertebrate communities. Target fish species include: federally endangered shortnose sturgeon, American shad, fallfish, white sucker and walleye.

For shortnose sturgeon, the flow study will need to evaluate bottom velocities in shortnose sturgeon spawning and rearing areas during discharge conditions normally observed from April 15th to June 22nd. Protection of shortnose sturgeon spawning will necessitate establishment of discharges that create bottom velocities suitable for shortnose sturgeon spawning and rearing over a sustained period of time and avoid dramatically fluctuating flows. To protect shortnose sturgeon rearing, adequate discharge without dramatic flow fluctuations are needed to ensure the rearing shoals are wetted and velocities are sufficiently protective for early life stage (ELS) rearing.

Field verification will be necessary to confirm the flow modeling results that identify the flows needed to provide sustained bottom velocities for spawning also maintain flows, depths, and water release regime adequate for spawning and rearing. Velocity and depth data should be collected under each potential operation scenarios such that actual velocity, depth, and flow conditions occurring across the entire spawning and rearing areas including wetted shoals.

Resource Management Goals

The Service seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

- Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.

- Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to aquatic resources, the Service's goals are:

- Protect, enhance, or restore, diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.

- Provide an instream flow regime that meets the life history requirements of resident and migratory fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.

- Minimize current and potential negative project operation effects on water quality and aquatic habitat.

- Avoid or minimize the current negative effect of project operations on shortnose sturgeon spawning and rearing at the Cabot Station spawning and rearing site.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), and the Federal Power Act (16 U.S.C. §791a, *et seq*.).

Public Interest
The requestor is a fish and wildlife resource agency.

Existing Information
Presently FirstLight is required to release 1,433 cfs below the Project. Information included in the PAD does not provide a detailed description of how this minimum flow was established and the Service is not aware of any previously conducted studies that evaluated the adequacy of this minimum flow in protecting aquatic resources in the 10+ miles of riverine habitat below the Cabot Station. Therefore, in order to fill this important information gap, an empirical study is needed to provide information on the relationship between flow and habitat in the Connecticut River downstream of the Cabot tailrace. Results will be used by the Service to determine an appropriate flow recommendation.

Kynard et al. (2012, chapter 3) examined the effects of water manipulation at the Turners Falls project on shortnose sturgeon spawning over the course of 17 years. This body of data represents the best available scientific information which does not support 1,433 cfs as an adequate minimum flow to support successful shortnose sturgeon spawning at Cabot Station. Peaking operations at Cabot Station cause discharge fluctuations to rapidly change bottom velocities from 0.4 m/s to 1/3 m/s over 30 minutes (Kynard et al. 2012, chapter 3). Shortnose sturgeon have not evolved to adapt to such artificial rapid changes in velocities and therefore continue to spawn during fluctuations even though conditions may be unsuitable and likely result in high egg mortality. During the 10 years when spawning succeeded at Cabot Station, discharge flow decreased to less than 35, 460 cfs by April 29th. The lowest discharge level observed while females remained on the spawning site was 4,700 cfs. Spawning behavior was not monitored during Cabot Station discharges at or below 3,500 cfs, so it is unclear what the minimum flow threshold is for spawning at Cabot Station. When peaking generation discharges cease during naturally low flow years, the tailrace shoals, likely used by shortnose ELS for rearing, were exposed (observed during years ’95, ’98-99, ’04) and may have resulted in larvae mortality due to stranding and exposure (Kynard et al 2012, chapter 3). Researchers observed that shoal exposure began when river flow below Cabot Station dropped below 7,062 cfs (Kynard and Kieffer 2007). Thus, total flow at Cabot, which may include flow from the Turners Falls Dam or Station 1, must be at least 7,062 cfs to both support adequate bottom velocities and prevent shoal exposure.

Furthermore, the emergency water control gates at Cabot Station that are used to sluice trash from the canal and balance canal flows spill large amounts of water. These large spill events create a plume of turbid turbulent flow, which caused some females to leave the area. These spill events scour bottom sediments which are then carried downstream over the spawning and rearing shoals where an entire year class of early life stages may be destroyed (Kynard et al. 2012, chapter 3). Information included in the PAD does not address adequate flows for shortnose sturgeon spawning and rearing. Results of the requested modeling will be used by the Services to determine an appropriate flow recommendation.

Researchers have also looked at suitable depth and velocity habitat for spawning (Kieffer and Kynard 1996, Kynard et al. 2012, chapter 3). Spawning sites are characterized by moderate river flows with average bottom velocities between 0.4 and 0.8 m/s (Hall et al. 1991, Kieffer and Kynard 1996, NMFS 1998). Water depth at the spawning site appears to be a less important habitat feature than substrate type and flow. A recent study by Kynard et al. (2012, chapter 6) demonstrated that females in an artificial stream will readily accept a shallow water depth of 0.6 m, with a rubble bottom, and 0.3–1.2 m/s bottom velocity. In addition, although eggs and embryos can likely tolerate very low depths, researchers measuring water depths between Turners Falls Dam and Cabot Station in order to recommend minimum flows suitable for an escape route for shortnose sturgeon trapped in the Turners Falls Dam Plunge Pool used a minimum depth of 1.5 x adult body depth. Because adults spawning in an artificial spawning channel frequently positioned themselves on top of one another (Kynard et al. 2012 Chapter 6), a minimum depth to facilitate spawning within the known Cabot Station spawning area is 3.0 body depths, or 19.2 inches.

Nexus to Project Operations and Effects

The Project is currently operated with a minimum flow release that was not based on biological criteria or field study. Further, the project generates power in a peaking mode resulting in significant with-in day flow fluctuations between the minimum and project capacity on hourly or daily basis. The large and rapid changes in flow releases from hydropower dams are known to cause adverse effects on habitat and biota downstream of the project (Cushman 1985, Blinn 1995, Freeman et al. 2001). There are more than ten miles of lotic habitat below the project's discharge that are impacted by peaking operations at Cabot Station. This section of the Connecticut River contains habitat that supports native riverine species, including important spawning and rearing habitat for migratory fish such as American shad and federally endangered shortnose sturgeon. Shortnose sturgeon larval migrants initially become bottom dwellers and transition from living off of yolk sacs to orally feeding, which is a critical stage in their life history. While the existing license does require a continuous flow of 1,433 cfs below the project (0.20 cubic feet per second flow per square mile of drainage area - cfsm), that is equal to only 40% of the Aquatic Base Flow[1]. this flow does not sufficiently protect the aquatic resources, including endangered species, in this substantial reach of river, especially in the context of the magnitude, frequency, and duration of changes in habitat that likely occur between minimum and generation flows.

Results of the flow study will be used by the Service to determine an appropriate flow recommendation that will protect and/or enhance the aquatic resources below the Project.

Methodology Consistent with Accepted Practice

In-stream flow habitat assessments are commonly employed in developing plant operational regimes that will reduce impacts or enhance habitat conditions downstream of hydroelectric projects.

The Service requests a flow study be conducted at the Project. Given the length of the river reach (10+ miles) impacted by project operations, we believe a study methodology that utilizes an IFIM approach is appropriate for this site. This same protocol was used during the

[1] The Aquatic Base Flow equates to the August Median Flow as determined using unregulated hydrography or on drainage area at the project site (0.5 cfs per square mile of drainage area) if unregulated hydrography is unavailable.

relicensing of the Housatonic River Project (FERC No. 2576),[2]and has been accepted by the Commission in other licensing proceedings[3].

At a minimum, the study design should involve collecting wetted perimeter, depth, velocity, and substrate data along transects located in the reach of river below Cabot Station. The measurements should be taken over a range of test flows. This information then should be synthesized to quantify habitat suitability (using mutually agreed upon HSI curves) of each test flow for target species identified by the fisheries agencies. Habitat modeling using standard PHABSIM 1 dimensional modeling is acceptable for the river channel downstream from the railroad bridge below the mouth of the Deerfield River. The area from the Cabot Station discharge to the railroad bridge should be modeled using 2 dimensional 2D modeling to better characterize flows and velocities in this complex channel area.

The types of data collected with this study should be sufficient to perform a dual-flow analysis and habitat time series or similar approaches that will permit assessment of how quality and location of habitat for target species changes over a range of flows between existing minimum flow and maximum project generation flows.

Level of Effort/Cost, and Why Alternative Studies will not suffice

Field work for instream flow studies can be reasonably extensive but will depend on consultation with the applicant on study methodology and on-site decisions on locations for data collection and the number of collection locations. Post-fieldwork data analysis would be a moderate cost and effort. We anticipate that the level of effort and costs will be comparable to that experienced on similar FERC relicensing projects of this size (e.g., the Conowingo Project, FERC No. 405).

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[2] Housatonic River Project License Application, Volume 4, Appendix F. Connecticut Light and Power Company, August 1999.

[3] Glendale Project (FERC No. 2801) Final Bypass Reach Aquatic Habitat and Instream Flow Study in Glendale Hydroelectric Project Application for Subsequent License (FERC No. 2801), Volume 2, Appendix B, pages 7-8, October 2007.

Kynard, B., P. Bronzi, and H. Rosenthal, eds. 2012. Life history and behaviour of Connecticut River shortnose and other sturgeons. Special Publication no. 4. World Sturgeon Conservation Society, Norderstedt, Germany.

National Marine Fisheries Service (NMFS). 1998. Recovery plan for the shortnose sturgeon (*Acipenser brevirostrum*). Prepared by the Shortnose Sturgeon Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland.

Study Request 20: In-stream Flow Habitat Assessment of the Turners Falls Bypassed Reach (Docket Number p-1889)

(1) Goals and Objectives

The goal of this study is to determine an appropriate flow regime that will protect and enhance the aquatic resources in the bypassed reach between Turners Falls Dam and the Cabot Station discharge. Specifically, the objective of the study is to conduct an instream flow habitat study to assess the impacts of the range of the proposed project discharges on the wetted area and optimal habitat for key species.

Target fish species include: federally endangered shortnose sturgeon, American shad, fallfish, white sucker, freshwater mussels and benthic macroinvertebrates.

(2) Relevant Resource Management Goals

The Service seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to aquatic resources within the Turners Falls bypassed reach, the Service's goals are:

1. Protect, enhance, or restore, diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
2. Provide a flow regime in the bypassed reach that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels), federally listed species, and diadromous fishes.
3. Minimize the current negative effects of project operations on shortnose sturgeon spawning and rearing within known spawning areas of the bypassed natural river reach (i.e., the Rock Dam).
4. Minimize current and potential negative project operation effects on water quality and aquatic habitat.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 et seq.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 et seq.), and the Federal Power Act (16 U.S.C. §791a, et seq.).

(4) Background and Existing Information

The Turners Falls Project bypasses a 2.7 mile-long section of the Connecticut River. Presently the only required spill releases from the Turners Falls dam to the bypassed reach are 400 cfs from May 1 through July 15 and 120 cfs from July 16 until the river temperature reaches 7°C.

In addition to these flows provided at the Turners Falls Dam, the bypassed reach receives flow from one small tributary (the Fall River, drainage area of 34.2 square miles), which enters the mainstem approximately 0.16 miles below the dam. The bypassed reach also receives the discharge from Station 1, when it is generating (typically when there is flow in excess of Cabot Station's needs). This discharge enters the bypassed reach approximately 0.9 miles below the dam.

Available information in the PAD does not indicate how project operations have altered downstream hydrology, habitat quantity and quality, and water quality, which may affect resident and migratory fish, macroinvertebrates, listed species, aquatic plants and other biota and natural processes in the Connecticut River from below the Turners Falls Dam downstream to the Cabot Station discharge. The PAD also provides no detailed description of the physical or biological characteristics of the bypassed reach.

Limited information exists on the adequacy of the existing bypass flow regime to protect water quality and aquatic life. However, there is existing information (not included in the PAD) relative to minimum flows necessary for shortnose sturgeon spawning and rearing at the Rock Dam spawning site (Kynard et al. 2012). Spawning success was observed at Rock Dam when discharge was between 2,500 cfs and 22,000 cfs during the spawning period of April 27th through May 22 (Kynard et al. 2012, chapter 3). In 1995 at the Cabot spawning area, the greatest level of spawning and spawning success occurred (i.e., 21 late stage females present, 342 ELS captured, and the longest spawning period of 17 days) even though no spawning was detected at Rock Dam (Kynard et al. 2012, chapter 3). Discharges in 1995 at Rock dam had dropped below 2,500 cfs by March 26th (Kynard et al. 2012, chapter 3), which may indicate the need to have mitigated flow well in advance of spawning. Flow reductions at the Rock Dam site that occurred during spawning caused females to leave the spawning site and not return even if flow later increased to acceptable levels. Researchers observed that the rubble substrates remained dominant during fluctuating flows and cessation of spawning is likely due to velocities falling outside the range preferred by females. Given the current flow dynamics at Rock Dam, spawning does not occur most years (Kynard et al. 2012, chapter 3). These data represent the best available scientific information and does not support current minimum flow thresholds at the project.

An empirical study is needed to provide information on the relationship between flow and habitat in the bypassed reach for the Service to use in determining a flow recommendation.

(5) Project Nexus

The Project includes a 2.7 mile-long bypassed reach. The Turners Falls Project is currently operated with a seasonally-varying minimum bypass flow (200 cfs starting on May 1, increasing to 400 cfs when fish passage starts through to July 15, then reduced down to 120 cfs until river temperature drops below 7°C). The 400 cfs release is primarily to facilitate upstream movement of anadromous migrants to the spillway fish ladder at Turners Falls Dam and the 120 cfs was intended to provide protection to shortnose sturgeon by maintaining a wetted habitat 1.5 times the maximum adult body depth through connections between pools within the bypassed reach. Neither of the currently required flows were based on quantitative, rigorous scientific studies.

This section of the Connecticut River contains habitat that supports native riverine species, including important spawning and rearing habitat for the federally endangered shortnose sturgeon. While the existing license does require seasonally-varying flow releases from the Turners Falls dam, we do not believe these flows sufficiently protect the aquatic resources, including endangered species, inhabiting the bypassed reach.

Results of the flow study will be used by the Service to determine an appropriate flow recommendation that will protect and/or enhance the aquatic resources in the bypassed reach for the duration of any new license issued by the Commission.

(6) Proposed methodology

The Service requests a bypass flow study be conducted at the Project. Bypass flow habitat assessments are commonly employed in developing flow release protocols that will reduce impacts or enhance habitat conditions in reaches of river bypassed by hydroelectric projects. Given the size of the bypassed reach (2.7 miles long) and the important resources known to inhabit the reach (i.e., federally endangered shortnose sturgeon and diadromous fishes), we believe a study methodology that utilizes an IFIM approach is appropriate for this site. This same protocol was used during the relicensing of the Housatonic River Project (FERC No. 2576), and has been accepted by the Commission in other licensing proceedings .

At a minimum, the study design should involve collecting wetted perimeter, depth, velocity, and substrate data within a range of discharge levels along transects located in the reach of river between the dam and the Cabot Station discharge. The measurements should be taken over a range of test flows up to 6,300 cfs or over a sufficient range of flows to model flows up to 6,300 cfs. This information then should be synthesized to quantify habitat suitability (using mutually agreed upon HSI curves) of each test flow for target species/life stages identified by the fisheries agencies. Habitat modeling using standard PHABSIM 1 dimensional modeling is acceptable for the bypassed reach from the area downstream of the spillway where the river channel constricts to Rawson's Island upstream from the Rock Dam. The area from Rawson Island to the Cabot station discharge should be modeled using 2 dimensional 2D modeling to better characterize flows and velocities in this complex channel area. Likewise, we recommend 2D modeling in the spillway area and mouth of the Falls River to the point where the channel constricts given this complex area with numerous potential flow discharge locations.

The flow study should incorporate the identified minimum flow and temporal parameters for shortnose sturgeon discussed in the Background and Existing Information section of this request.

(7) Level of effort and cost

Field work for flow studies can be reasonably extensive but will depend on consultation with the applicant on study methodology and on-site decisions on locations for data collection and the number of collection locations. Post-fieldwork data analysis would be a moderate cost and effort. Field work associated with this study could be done in conjunction with the below-project instream flow study request. We anticipate that the level of effort and costs will be comparable to that experienced on similar FERC relicensing projects (e.g., the Glendale Project, FERC No. 2801).

Study Request 21: Impact of Project Operations on Downstream Migration of Juvenile American Shad (Docket Number p-1889) (Docket Number p-2485)

Conduct a field study of juvenile American shad outmigration in the Turners Falls impoundment and the power canal and at Turners Falls Dam, Station #1, and Cabot Station to determine if project operations negatively impact juvenile American shad survival and production.

Goals and Objectives

Determine if project operations affect juvenile American shad outmigration survival, recruitment, and production. The following objectives will address this request:

- Assess project operations effects of NMPS and Turners Falls Dam on the timing, orientation, routes, migration rates, and survival of juvenile shad;
- Determine the proportion of juvenile shad that select the Gatehouse into the power canal versus the dam spill gates as a downstream passage route, under varied operational conditions, including a range of spill conditions up to full spill;
- Determine if there are any delays with downstream movement related to either spill via dam gates or through the Gatehouse and within the impoundment due to operations (i.e., NMPS pumping and generation);
- Determine survival rates for juvenile spilled over/through dam gates, under varied operation conditions, including up to full spill during the annual fall power canal outage period;
- Determine the juvenile downstream passage timing and route selection in the power canal to: Station 1; Cabot Station; and the Cabot Station log sluice bypass, and assess delays associated with each of these locations and with project operations (e.g., stockpiling in the canal);
- Based upon year 1 study results on route selection, determine the survival rate for juvenile shad entrained into Station 1; and
- Determine the survival rates for juvenile shad entrained into Cabot Station units;

If it is determined that the Project operations are adversely affecting juvenile shad survival, migration timing, or other deleterious population effects , identify operational solutions or other passage measures that will reduce and minimize these impacts within the project area. This study will require two years of field data to capture inter-annual variability of river discharge, water temperatures, and variability in the timing and abundance of juvenile production and their outmigration timing, which may relate to spring, summer, and fall conditions. This study will compliment the NMPS Fish Entrainment Study Request which includes assessment of impacts to juvenile shad.

Resource Management Goals

The Connecticut River Atlantic Salmon Commission developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following:

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.

2. Maximize outmigrant survival for juvenile and spent adult shad.

The Atlantic States Marine Fisheries Commission *Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management)*, approved in 2010 includes the following objective:

1. Maximize the number of juvenile recruits emigrating from freshwater stock complexes.

And recommendation:

1. To enhance survival at dams during emigration, evaluate survival of post spawning and juvenile fish passed via each route (e.g., turbines, spillage, bypass facilities, or a combination of the three) at any given facility, and implement measures to pass fish via the route with the best survival rate.

The Service seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to American shad, the Service's goals are:

1. Minimize current and potential negative project operation effects on juvenile American shad survival, production, and recruitment.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), Silvio O. Conte National Fish and Wildlife Refuge Act (P.L. 102-212; H.R. 794), the Federal Power Act (16 U.S.C. §791a, *et seq*.), the Atlantic States Marine Fisheries Compact (P.L. 539, 77th Congress, as amended by P.L. 721, 81st Congress), and the Atlantic Coastal Fisheries Cooperative Management Act (16 U.S.C. 5107).

Public Interest
The requestor is a resource agency.

Existing Information
Since the construction of the Turners Falls Dam upstream fishways in 1980, American shad have had access to spawning and rearing habitat upstream of Turners Dam. A number of modifications to the Turners Falls fishways have occurred since that time, with the numbers of adult shad passed at Gatehouse Ladder (into Turners Falls Dam impoundment) reaching as much 60,089 in 1992 when a record 721,764 shad passed upstream of Holyoke Dam. However, since 1980 an average of only 3.6 % of the adult shad passed upstream of Holyoke Dam subsequently have passed upstream of Turners Falls Dam, and this value has never exceeded 11%. This value is well below the CRASC 1992 Shad Plan objective of 40-60% passage from the previous dam. In addition, population number and passage numbers past Holyoke have declined substantially, with the average Holyoke passage number over the last 10 years being 211,850. Because historic data suggests that approximately half the returning adult shad to the Connecticut River pass the Holyoke Dam, recent adult returns are far below management goals. Effective upstream and downstream passage and successful in-river spawning and juvenile production are necessary to help achieve shad management restoration goals for the Connecticut River, which extends to the Bellows Falls Dam. In 1990, FirstLight's predecessor, Northeast Utilities, CRASC and its member agencies, signed an MOA on downstream fish passage to address both juvenile and adults at the Turners Falls Project and Northfield Mountain Pumped Storage Project.

American shad broadcast spawn with the highest spawning activity occurring in runs and lowest activity in pools and riffle/pools (Ross et al. 1993). Field research by Ross et al. (1993) in the Delaware River further noted that a combination of physical characteristics that seems to be avoided by spawning adults is slow current and greater depth. American shad year-class strength has been shown to depend on parent stock size and environmental conditions during the larval life stages (Creeco and Savoy 1984). Delays in juvenile American shad outmigration may affect survival rates in the transition to the marine environment (Zydlewski et al. 2003). One published study on the Connecticut River, identified that juvenile shad outmigration began when declining autumn temperatures reached 19C and peaked at 16C (O'Leary and Kynard 1986).

Juvenile American shad production has been monitored upstream of the Vernon Dam and immediately downstream of that dam by Vermont Yankee Nuclear as part of an annual monitoring program using both boat electrofishing (since 1991) and beach seining (since 2000). Sampling of juvenile shad was also conducted by a contractor hired by Northeast Utilities in the Turners Falls impoundment in 1992. O'Donnell and Letcher (2008) examined juvenile shad early life history and migration upstream and downstream of Turners Falls Dam. Their study results led to the decision by the agencies to require earlier operation of downstream fishways to protect early season juvenile shad out-migrants (1 September prior to 2010, 15 August in 2010, and since 2011, 1 August).

Downstream juvenile clupeid passage studies at Turners Falls were conducted in the fall of 1991 which included the objectives of determining the percentage of juvenile shad and herring that pass via the bypass log sluice or that were entrained in the Cabot Station turbines and related data (e.g., catch rates) were compared. The 1991 Downstream Clupeid Study did not assess survival rates for juveniles for either of these passage routes. The 1991 study report documented a higher rate entrainment into the project turbines (23.0 fish per minute) versus through the bypass sluice (11.6 fish per minute). It was concluded that only an estimated 54% (average bypass rate, weighted by estimated number bypassed) of the juvenile American shad approaching Cabot Station were bypassed via the log sluice. The range of the percent bypassed varied widely by date, between nearly 0 and 83%, with 'no clear explanation as to why." The report did not identify the percentage entrained into the turbines but it can be reasoned to be substantial based on the data presented in the report or assumed as the remaining balance (46%). as there were no spill events reported during this study, and therefore nowhere else for them to pass. It was further noted that entrainment rates for juveniles were consistently greatest for units 1 and 6 (ends), not uniform across all units. Although no concurrent bypass sampling occurred during the first entrainment sampling events, it was noted that "entrainment rates were relatively high during the end of September." Additional modifications have occurred over time without quantitative evaluation to improve downstream passage attraction and use to the bypass sluice, including lighting systems.

The 1994 Downstream Juvenile Shad Study report assessed juvenile shad survival from passage via the log sluice, reported to be 98%, based on tagged and recaptured fish (held for up to 48 hours). Scale loss (<20%) (22 of treatment fish) compared with scale loss of >20% (5 of treatment fish) was examined and determined to occur in an overall total of 10% of study fish (adjusted by control fish data).

Nexus to Project Operations and Effects

Adult American shad passed upstream of Turners Falls Dam utilize upstream spawning habitat. Juvenile American shad production occurs in these habitats upstream of Turners Falls Dam on an annual basis. Juvenile American shad require safe and timely downstream passage measures to have the opportunity to contribute to the fishery agencies' target restoration population size.

The Service is not aware of any studies being conducted specifically designed to determine:

- When spill gates are open at the Turners Falls Dam?;
- What proportion of juvenile outmigrant shad take that route of passage?;
- What is the rate of survival under a range of spill and gate configurations?
- What is the timing, duration, and magnitude of juvenile shad outmigrants in summer and fall to the Turners Falls Dam and Gatehouse?
- Are there delays in migration/movement at the dam, Gatehouse, Cabot Station, or Station 1?
- For juveniles that enter the power canal, what proportion subsequently enter the Station 1 power canal?
- As there is no downstream passage facilities at Station #1, and trash rack spacing is 2.6 inches, what is the survival rate of juvenile shad entrained at Station #1?
- What is the rate of movement through the Turners Power Canal, relative to r delay to outmigrant juvenile shad and the potential accumulation of juveniles (e.g., prior to the canal drawdown in September)?
- What proportion of juvenile shad use the downstream sluice bypass versus the Cabot Station turbines under varied operational conditions given that project operations may change (PAD notes possible increase in turbine capacity at Cabot)?
- Based upon earlier facility studies (1991 Downstream Clupeid) a large proportion and number of juvenile shad are entrained into Cabot Station turbines. What are the associated impacts in terms of short-term and longer term survival and injury (i.e., scale loss)?

The Service is concerned that project operations may impact juvenile shad outmigration survival and be contributing to the failure of the Connecticut River shad population to meet management targets. In the PAD, proposed modification include; Station 1 may be upgraded with new turbines, Station 1 may be closed, and/or the turbine capacity at Cabot may be increased. It is unclear how these scenarios will affect the questions identified in this request.

Methodology Consistent with Accepted Practice

The impact to juvenile shad outmigrants by project operations would be best studied by a combination of approaches including hydroacoustic, radio telemetry, and turbine balloon tags. Project discharge over a full range of existing and, to the extent possible, potential future operational conditions at Station 1 and Cabot, at the dam (likely increased bypass reach flows in new license) and in relation to the Gatehouse, should be examined relative to timing, duration, and magnitude of juvenile shad migration to and through these areas, with hydroacoustic equipment for natural/wild fish evaluation. In addition, study fish should be collected and tagged (PIT, radio, other mark, balloon) to also empirically determine rates of survival for fish passed over or through the dam's gates, under varied operations, including up to full spill condition that occurs annually in fall with canal outage period. The understanding of the timing, magnitude, duration of the wild fish outmigration will help inform the design, data/results, and assessment of tagged study fish. The release of tagged or marked fish (radio, PIT) upstream of the Gatehouse induction into the power canal, will provide data on concerns of delay and route selection to Station 1, Cabot Station downstream bypass, Cabot Station spill gates, and Cabot Station turbines. Additional hydroacoustic assessment at Cabot Station forebay will provide information on wild/natural juvenile fish timing, magnitude, and duration to and through this area. Based upon Year 1 study findings relative to the frequency, magnitude, timing of juvenile American shad that end up in the forebay of Station 1, the determination of whether an entrainment survival study at that site is necessary will be made.

Release sites for tagged fish will be determined based upon further consultation among the parties.

Radio tagged juvenile shad will be released in areas upstream of the NMPS facility at multiple release locations, to determine operation effects on migration rates, route, orientation, entrainment, and survival, over a full range of permitted and operational conditions.

Level of Effort/Cost, and Why Alternative Studies will not suffice

First Light does not propose any studies to meet this need. Estimated cost for the study is expected to be high, between $200,000 and $300,000, with the majority of costs associated with equipment (hydroacoustic gear, radio tags, radio receivers, and PIT readers) and related fieldwork labor.

Literature Cited:

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Study Request 22: Use of an Ultrasound Array in to Create Avoidance of the Cabot Station Tailrace By Pre-spawned Adult American shad and Facilitate Upstream Movement to the Turners Falls Dam (Docket Number p-1889)

Goals and Objectives

The goal of this study is to determine if use of ultrasound is an effective behavioral mechanism to create avoidance of the Cabot tailrace area by upstream migrating adult shad. If not attracted to the Cabot Station discharge, shad may proceed upstream and pass the Turners Falls Dam via the fishway at the dam.

The objective of the study would be to establish a high frequency sound (ultrasound) array across the entire Cabot Station tailrace and determine the effect of the ensonified field on upstream and downstream migrating radio-tagged shad moving past Cabot Station. This would be accomplished by monitoring the movements and passage of shad and the time shad spend in the tailrace area. If effective, this technology also may be applicable to the Turners Falls #1 Station discharge.

Resource Management Goals

In 1992, the Connecticut River Atlantic Salmon Commission (CRASC) developed a draft document titled: A Management Plan for American Shad in the Connecticut River. Management Objectives in the plan include the following:

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually. (Table 1)
2. Achieve annual passage of 40 to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem.
3. Maximize outmigrant survival for juvenile and spent adult shad.

The Atlantic States Marine Fisheries Commission, Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010 includes the following objective:

Maximize the number of juvenile recruits emigrating from freshwater stock complexes.

And recommendations:

Upstream Passage –

1. American shad must be able to locate and enter the passage facility with little effort and without stress.
2. Where appropriate, improve upstream fish passage effectiveness through operational or structural modifications at impediments to migration.
3. Fish that have ascended the passage facility should be guided/routed to an appropriate area so that they can continue upstream migration, and avoid being swept back downstream below the obstruction.

Downstream Passage –

1. To enhance survival at dams during emigration, evaluate survival of post spawning and juvenile fish passed via each route (e.g., turbines,, spillage, bypass facilities, or a combination of the three) at any given facility, and implement measures to pass fish via the route with the best survival rate.

Based on the CRASC plan, the Service seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:
1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to American shad movement and migration, the Service's goals are:
1. Minimize current and potential negative project operation effects such as migration delays, false attraction, turbine entrainment, survival of project passage routes, and trashrack impingement, that could hinder management goals and objectives.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 et seq.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 et seq.), and the Federal Power Act (16 U.S.C. §791a, et seq.), the Atlantic States Marine Fisheries Compact (P.L. 539, 77th Congress, as amended by P.L. 721, 81st Congress), and the Atlantic Coastal Fisheries Cooperative Management Act (16 U.S.C. 5107)..

Public Interest
The requestor is a federal natural resource agency.

Existing Information
The Turners Falls Project has two fish ladders that anadromous migrants must use to pass the project; one at the Cabot Station tailrace and one at the spillway. Both ladders have documented passage problems. Further, fish that are able to successfully swim up the Cabot Station ladder exit into the Cabot Station power canal and must successfully enter and ascend another fish ladder (Gatehouse Fishway) before entering the Turners Falls impoundment and continuing up the Connecticut River. Spillway Ladder fish must also pass the Gatehouse ladder to reach the impoundment. The Gatehouse Fishway also has well documented passage issues.

Many years of study and design changes at the Gatehouse Fishway have improved passage effectiveness of that facility, but overall passage through the Cabot and Gatehouse fishways remains less effective than necessary to achieve management goals. A potential alternative to the current configuration of fishways at the project would be to cease using the Cabot ladder (thereby eliminating problems with that ladder and the need to pass the Gatehouse ladder), and instead operate a single fish lift facility at the spillway. However, for this to be a viable option, one major issue would need to be resolved: false attraction to the Cabot Station tailrace discharge. Therefore, this study would attempt to determine if use of ultrasound technology would be an effective method to minimize false attraction to the tailrace discharge while facilitating movement past the Cabot discharge and up to the spillway area without delay.

Much information exists about adult shad avoidance of ultrasound and the adaptive significance seems related to avoidance of echolocation signals of predator bottlenose dolphins (Mann et al., 1997; 1998). These authors suggest shad can detect the echolocation clicks of dolphins up to 187 meters away. Further, in field trials in the early 1980s to develop a guidance system for downstream-migrants in the First Level Canal of the Holyoke Canal System, adult shad avoided but were not well guided by an ultrasonic array. However, upstream migrants were guided well and even stopped entirely by the ensonified field

(Kynard and Taylor 1984). Creating an ensonified field caused adult shad to leave their preferred location in the river upstream of trashracks at Holyoke Dam as long as the sound system was on.

Blueback herring also avoided the ultrasound field and behaved similar to shad in the Holyoke Canal studies (Kynard and Taylor 1984). Acoustic barriers have been used for blueback herring on the Savannah River (Richard B. Russell Dam) and Santee River (St. Stephen fish lift) in South Carolina and on the Mohawk River in New York (Crescent Project, FERC No. 4678; Vischer Ferry, FERC No. 4679). Evidence from many studies that attempted to produce behavioral avoidance by adult shad strongly suggests that ultrasound is the most effective stimuli (Carlson and Popper, 1997). Thus, the available evidence suggests that shad (and blueback herring) may be dissuaded from delaying at the tailrace of Cabot Station by installing and operating an ultrasound field.

In addition, one year of study on juvenile shad and blueback herring movements in the Holyoke Canal (Buckley and Kynard 1985) and two years of study in an experimental flume (Kynard et al. 2003) found that juveniles did not exhibit an avoidance response to the same high frequency (162 kHz) that was avoided by adult shad and bluebacks at Holyoke.

Nexus to Project Operations and Effects
Given the poor performance of the upstream passage facilities at Turners Falls, studies to assess potential passage solutions are appropriate areas during relicensing proceedings. This study, coupled with the adult shad radio-telemetry study, can provide the information needed to select the best approach to resolve upstream shad passage at the project.

Methodology Consistent with Accepted Practices
Acoustic barriers have been used for blueback herring on the Savannah River (Richard B. Russell Dam) and Santee River (St. Stephen fish lift) in South Carolina and on the Mohawk River in New York (Crescent Project, FERC No. 4678; Vischer Ferry, FERC No. 4679). This study would establish a high frequency sound (ultrasound) array across the entire Cabot Station tailrace and determine the effect of the ensonified field on upstream and downstream migrating shad moving through Cabot Station by monitoring shad behavior and the time that detected shad spend in the tailrace.

Shad tagged as part of the large-scale shad movement/migration telemetry study would be used to track shad movements through the Cabot Station area with the ultrasound system on versus off. Data would be analyzed to determine if ensonification is a successful deterrent mechanism (e.g., if shad spend less time in the tailrace when the area is ensonified relative to when it is not ensonified and whether shad move past Cabot Station to the spillway with limited delay)

Several businesses sell and operate ultrasound systems for fish avoidance. The use of these systems is world-wide at power production and water control facilities.

Level of Effort/Cost, and Why Alternatives will not suffice
The level of effort/cost for the test will be low to moderate. Costs will be related to rental, installation, and operation of the ultrasound system, analysis of data, and production of a final report. The study could utilize the same test fish and monitoring equipment as the adult shad radiotelemetry study (although a few additional tracking stations may have to be installed in the Cabot Station tailrace).

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MassWildlife

Commonwealth of Massachusetts

Division of Fisheries & Wildlife

Wayne F. MacCallum, *Director*

February 28, 2013

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E., Room 1A
Washington, DC 20426

Turners Falls Project, FERC No. 1889
Northfield Mountain Project, FERC No. 2485
Comments of the Massachusetts Division of Fisheries and Wildlife
Scoping Document 1
Preliminary Application Document
Study Requests

Dear Secretary Bose:

The Massachusetts Division of Fisheries and Wildlife (Division) is the agency responsible for the protection and management of the fish and wildlife resources of the Commonwealth. The Division is also responsible for the regulatory protection of imperiled species and their habitats as codified under the Massachusetts Endangered Species Act (M.G.L. c.131A). The Massachusetts Endangered Species Act (MESA) was enacted in December 1990. Implementing regulations (321 CMR 10.00) were promulgated in 1992 and recently revised and implemented as of November 2010. The MESA provides a framework for review of projects or activities that occur within mapped areas of the state, called *Priority Habitat*, and published in the Natural Heritage Atlas. As such, we monitor operations at hydroelectric projects within the Commonwealth, as well as comment on proposed hydroelectric facilities. The Division has received your letter dated October 30, 2012, requesting review of the Preliminary Application Document (PAD) for, the Turners Falls Project(FERC No. 1889) and the Northfield Mountain Project (FERC No. 2485), and offers the following comments on the PAD and the Scoping Document 1 (SD1).

PROJECT DESCRIPTION

The Turners Falls Project and Northfield Mountain Pumped Storage Project are located on the Connecticut River within Franklin County, Massachusetts, Windham County, Vermont, and Cheshire County, New Hampshire. The greater portion of the Turners Falls Project and Northfield Mountain Project, including developed facilities and most of the lands within the project boundary, are located in Franklin County, Massachusetts; specifically, in the towns of Erving, Gill, Greenfield, Montague, and Northfield. The northern reaches of the Turners Falls Project and Northfield Mountain Project boundary extend to the base of the Vernon dam in the towns of Hinsdale, New Hampshire, and Vernon, Vermont. The Turners Falls Project has an installed capacity of 67.709 MW and an annual generation of 320,140 MWh. The Northfield Mountain Pumped Storage Project has an installed capacity of 1,119.2 MW and an annual generation of 1,143,038 MWh.

The Turners Falls Project's dam is located at approximately RM 122 on the Connecticut River in the towns of Gill and Montague, Massachusetts. The tailrace of the Northfield Mountain Project is located approximately 5.2 miles upstream of Turners Falls Project's dam, in the town of Northfield, Massachusetts. The upper reservoir of the Northfield Mountain Project is located atop Northfield Mountain in Erving, Massachusetts. The Turners Falls impoundment serves as the lower reservoir for the Northfield Mountain Project.

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An Agency of the Department of Fish and Game

The Turners Falls dam is located on the Connecticut River at approximately RM 122 in the towns of Gill and Montague, Massachusetts. The dam consists of two individual concrete gravity dams, referred to as the Gill dam and Montague dam, which are connected by a natural rock island known as Great Island. The Montague dam is approximately 35 feet high and 630 feet long, is founded on bedrock and connects Great Island to the west bank of the Connecticut River. The Gill dam is approximately 55 feet high and 493 feet long extending from the Gill shoreline (east bank) to Great Island. The Turners Falls impoundment (which also serves as the lower reservoir for the Northfield Mountain Project), is approximately 20 miles long, extending upstream through the Connecticut River valley to the base of Vernon dam. The impoundment has a surface area of approximately 2,110 acres and a gross storage capacity of 21,500 acre-feet at elevation 185.0 feet msl (as measured at Turners Falls dam) and also serves as the lower reservoir for the Northfield Mountain Pumped Storage Project. Most of the Turners Falls impoundment lies in Massachusetts; however, approximately 5.7 miles of the northern portion of the impoundment are located in New Hampshire and Vermont. At Turners Falls dam, the total drainage area is approximately 7,163 mi^2, or about 64% of the Connecticut River Basin drainage area (11,250 mi^2). The project includes two powerhouses, Station No. 1 and Cabot Station, which together have an authorized installed capacity of 67.709 MW which generated an average of 320,140 MWh annually from 2000-2009. Station No. 1 contains seven turbine/generators of which five are currently operational. Station No. 1 generating units consist of single runner vertical Francis turbines. The approximate turbine and hydraulic capacities of each unit are as follows: 2,100hp/560 cfs for Unit 1; 590hp/140 cfs for Unit 2; 1,900hp/500 cfs for Unit 3; Unit 4 is non-operational; 1,635hp/490 cfs for Unit 5; Unit 6 is non-operational; and 1,955hp/520 cfs for Unit 7. Cabot Station generating units consist of six vertical single runner Francis turbines. The approximate turbine and hydraulic capacities of each of the Cabot unit are 13,867hp/2,288 cfs.

The tailrace of the Northfield Mountain Project is located approximately 5.2 miles upstream of Turners Falls dam, in the town of Northfield, Massachusetts, and in the Turners Falls impoundment. The upper reservoir of the Northfield Mountain Project is located atop Northfield Mountain in Erving, Massachusetts and consists of a main dam, rockfill dikes and a concrete gravity dam. The upper reservoir typically operates between elevations 1,000.5 feet msl and 938 msl which provides a 62.5 foot drawdown. Within this range of fluctuation, the upper reservoir has a surface area of 134 and 286 acres at elevations 938 and 1,000 feet msl, respectively, and approximately 12,318 acre-feet of usable storage. The underground powerhouse contains four reversible pump/turbines that operate at gross heads ranging from 753 to 824.5 msl. The project has an authorized installed capacity of 1,119.2 MW (Unit 1: 267.9 MW, Unit 2: 291.7 MW, Unit 3: 291.7 MW and Unit 4: 267.9 MW). The approximate station hydraulic capacity is 15,200 cfs (3,800 cfs per/pump) in pumping mode and 20,000 cfs (5,000 cfs per/turbine) in a generation mode.

PROPOSAL

The current FERC licenses for the Turners Falls Project and Northfield Mountain Project expire on April 30, 2018. The owner of these projects, FirstLight Hydro Generating Company (FirstLight), a subsidiary of IPR-GDF SUEZ North America, Inc., is applying to relicense the projects. FirstLight is proposing to evaluate potential modifications to the Turners Falls Project and Northfield Mountain Project at this time. The potential modifications that FirstLight is evaluating include the following:

- Upgrading Station No. 1 with new or rehabilitated turbines.
- Closing Station No. 1 and adding a turbine generator at Cabot of similar hydraulic capacity to Station No. 1's.
- Utilizing the full hydraulic capacity of the Cabot turbines including currently unused capacity.
- Utilizing more storage in the Northfield Mountain Project's upper reservoir.
- Increasing the unit and station capacity at the Northfield Mountain Project.

COMMENTS

<u>Scoping Document 1</u>

2.1 2.1
Purposes of Scoping
"Scoping is the process used to identify issues, concerns, and opportunities for enhancement or mitigation associated with a proposed action." This is a difficult mandate given that we have no idea which (if any) of the potential project modifications listed in the SD1 and PAD the project owner will propose.

3.4.2.4
Water Resources
Reservoir Drawdown. How will the proposed changes to project operations affect the current practice of limiting reservoir drawdown to 3.7 feet rather than the 9 feet allowed by the current license?

Aquatic Resources
Fishways: The Division believes that the project's fishways do not provide adequate fish passage particularly for American Shad. Studies conducted over the last few years as well as studies that the Division is now proposing should allow the FERC to determine what will be required to remedy this situation. Upstream and downstream passage for American eel must also be addressed.

Minimum Flow: The Division believes that the current minimum flow provided to the project's bypass reach is insufficient to protect aquatic life in that reach. The project owner is proposing a study to help determine a more appropriate flow. The Division has been consulting on the design of this study and believes that the FERC should allow this study to commence this summer (2013).

3.4.2.5
Aquatic Resources
The Division is concerned about the magnitude and potential effects of entrainment of fish, particularly juvenile American shad by the Northfield Mt project and has proposed studies to address this concern.

Terrestrial Resources
Bennett Meadow Wildlife Management Area
Approximately 200 acres, mostly alluvial floodplain, of Northfield Mountain project land which is presently leased to local farmers for agricultural use. The area is open to the public and managed by the Division as a wildlife management area. Hunting and fishing is permitted. Crop production plus existing wetlands, forest cover and river frontage provide excellent wildlife habitat. Bennett Brook feeds an extensive beaver flowage and a slough which create excellent habitat for waterfowl. The Division presently stocks pheasants on the Bennett Meadow property and has considered stocking fish in Bennett Brook.

Bennett Meadows was to be transferred to Massachusetts Division of Fisheries and Wildlife ownership as part of the original FERC licensing of the Northfield Mountain Project. The very similar 161 acre Pauchaug Brook Wildlife Management Area was transferred from the project owner to the Division at that time. The Division has been actively involved with the management of the Bennett Meadow Wildlife Management Area throughout the term of the current license and is still very interested in obtaining ownership of this land. The Division asks that the Project owner and the FERC consider this.

4.0
Cumulative effects
Because the five Connecticut River Projects are located contiguously on the main stem Connecticut River between RM 262 and RM 122 the Division believes that many of the project effects should be considered cumulative. In addition to those already identified by FERC staff the Division believes the following issues need to be addressed.

4.3.3
Aquatic Resources
Because delays to migration at one project may lead to a diminished chance to pass subsequent projects the Division believes that effects of project facilities and operations, (including reservoir fluctuations, and generation releases) on fish migration through and within project fishways, reservoirs, and the downstream riverine corridor should be studies cumulatively.

5.0 and 6.0 Proposed Studies and Requests for Studies

In addition to the list of studies proposed by the project owner, the Division has proposed specific studies which are attached to this letter.

Requested studies

1. In-stream Flow Habitat Assessment of the Turners Falls Bypassed Reach
2. In-stream Flow Habitat Assessment Downstream of Cabot Station
3. Telemetry Study of Upstream and Downstream Migrating Adult American Shad to Assess Passage Routes, Effectiveness, Delays, and Survival
4. Impact of Project Operations on Shad Spawning, Spawning Habitat, and Egg Deposition in the Project Area.
5. Shad Population Model for the Connecticut River
6. Impact of Project Operations on Downstream Migration of Juvenile American Shad
7. Upstream American Eel Passage Assessment at Turners Falls
8. Downstream American Eel Passage Assessment at Turners Falls and Northfield Mountain
9. Evaluation of Timing of Downstream Migratory Movements of American Eels on the Mainstem Connecticut River
10. Three-dimensional Computational Fluid Dynamics (CFD) Modeling in the Vicinity of Fishway Entrances and Powerhouse Forebays
11. Model flows in the Northfield Mountain Pumped Storage Project discharge tailrace using two-dimensional Computational Fluid Dynamics (CFD) model techniques
12. Entrainment of Migratory and Riverine Fish from the Connecticut River into the Northfield Mountain Pump Storage Project
13. Model River Flows and Water Levels Upstream and Downstream from the Turners Falls Project Dam Generating Stations and Integration of Project Modeling with Upstream and Downstream Project Operations
14. Impacts of the Turners Falls and Northfield Mountain Pumped Storage Project Operations on Tributary and Backwater Area Access and Habitats
15. Impacts of the Turners Falls and Northfield Mountain Pumped Storage Projects on Littoral Zone Fish Habitat and Spawning
16. Impacts of Turners Falls Canal Drawdown on Fish Migration and Aquatic Organism Populations
17. Climate Change as it Relates to Continued Operation of the Northfield Mountain Pumped Storage, and Turners Falls Projects
18. Climate Change as it Relates to Continued Operation of the Northfield Mountain Pumped Storage, and Turners Falls Projects
19. Integrate Modeled River Flows and Water Levels with Habitat Assessment for State-listed Riparian Invertebrate Species
20. Habitat Assessment, Surveys, and Modeling of Suitable Habitat for State-listed Mussel Species in the Connecticut River
21. Fish Assemblage Assessment and Glochidia Surveys in the Connecticut River
22. Assessing Operational Impacts on Emergence of State-listed Odonates in the Connecticut River and Northfield Mountain Upper Reservoir
23. Assessing Operational Impacts on State-listed Rare Plants in the Connecticut River

9.0 Comprehensive Plans

In 2006, the Massachusetts Division of Fisheries and Wildlife received approval for its State Wildlife Conservation Strategy, most often referred to as the State Wildlife Action Plan (SWAP). The SWAP is a comprehensive document that will help guide wildlife conservation decision making for Massachusetts' wildlife for many years. The Massachusetts Action Plan represents an important effort by the Division to engage the public in a dialogue about the future of our wildlife resources. During development of the Massachusetts Plan, we sought public input and comment through presentations of a draft to the Fisheries and Wildlife Board, the Natural Heritage and Endangered Species Advisory Committee, and the Massachusetts Teaming With Wildlife Coalition. In addition, the Fisheries and Wildlife Board held a public informational hearing. A draft copy of the Plan was posted prominently on the agency website for public comment. At least 4300 entities were directly notified of this website posting through the Division's newsletter, including media outlets, conservation organizations, sportsmen and other private citizens. As a result, we received over 600 website visits to the Plan. The final Plan incorporated public comments and was reposted on the website for further public review prior to formal submission to the US Fish and Wildlife Division.

The Plan includes:

- A brief history of the Division and past successful efforts to conserve the biodiversity of the Commonwealth.
- A review of the landscape changes which have affected wildlife populations and sets the stage for problems we see facing these species today.
- An explanation of the process used to identify the habitats and species in the greatest need of conservation. Identifies the primary strategies needed to conserve these species and their habitats
- An recognition of the need to monitor these efforts as strategies are implemented both to ensure that time and money are providing the expected results and to determine if changing conditions require a change in strategy.

Massachusetts' Plan is organized around 22 habitat types and 257 wildlife species in greatest need of conservation. The habitat types range from large-scale habitats such as Upland Forests; to medium-scale habitats like Grasslands, to small-scale habitats such as Vernal Pools. Information for each habitat type includes

- habitat description;
- the suite of species in associated with that habitat;
- the problems and threats faced by them;
- a map showing the distribution of the habitat type across the state, when available;
- a listing of the conservation strategies needed to conserve the habitat; and
- monitoring requirements that will ensure the success of the conservation strategies.

There is also information about the 257 wildlife species in greatest need of conservation occurring in one or more of the above 22 habitat types including:

- Conservation status ranking and habitat association
- Species Life History
- State distribution and abundance
- Habitat requirement
- Conservation threats

The Division has requested that FERC add the MA SWAP to the list of Comprehensive Plans in a separate filing on February 13, 2013.

Preliminary Application Document

General
The PAD is very thorough and provides a higher level of detail than we see in most applications.

Specific
Section 4.14: Tributary Streams. The Fall River which enters the project bypass reach just below the Turners falls Dam is not listed.

Figure 4.1-2: Connecticut River Subbasins, Tributaries, and Dams. Several Hydroelectric dams are not depicted in this figure. The Crescent Street Dam on the Millers River is located between the two projects that are depicted. There are three hydroelectric projects on the Westfield River in Russell- the figure depicts only one project in this location. The figure does not depict the two large USACE flood control dams on the Westfield River, Knightville on the East Branch and Littleville on the Middle Branch. There are a number of hydroelectric dams on the Chicopee that are not depicted. Starting at the Connecticut River they are: Dwight, Chicopee Falls, Indian Orchard, Putts Bridge, Collins, and Red Bridge.

4.4.5.2: American Shad. Timing of outmigration of YOY is cited as September. New studies have shown that YOY shad in the CT River move all summer long[1].

4.4.5.2: Blueback Herring. Blueback Herring were known to spawn in the Fall River- a tributary to the Turners Falls project bypass reach.

Figure 4.4.5-2: Annual Number of Blueback Herring Passed into the Holyoke Impoundment below the Turners Falls Project, 1980-2012. Perhaps the use of a log scale would be better suited to the wide range of data depicted.

Section 5.4 Relevant Qualifying Resource Management Plans

In 2006, the Massachusetts Division of Fisheries and Wildlife received approval for its State Wildlife Conservation Strategy, most often referred to as the State Wildlife Action Plan (SWAP). The SWAP is a comprehensive document that will help guide wildlife conservation decision making for Massachusetts' wildlife for many years. The Massachusetts Action Plan represents an important effort by the Division to engage the public in a dialogue about the future of our wildlife resources. During development of the Massachusetts Plan, we sought public input and comment through presentations of a draft to the Fisheries and Wildlife Board, the Natural Heritage and Endangered Species Advisory Committee, and the Massachusetts Teaming With Wildlife Coalition. In addition, the Fisheries and Wildlife Board held a public informational hearing. A draft copy of the Plan was posted prominently on the agency website for public comment. At least 4300 entities were directly notified of this website posting through the Division's newsletter, including media outlets, conservation organizations, sportsmen and other private citizens. As a result, we received over 600 website visits to the Plan. The final Plan incorporated public comments and was reposted on the website for further public review prior to formal submission to the US Fish and Wildlife Division.

The Plan includes:

- A brief history of the Division and past successful efforts to conserve the biodiversity of the Commonwealth.
- A review of the landscape changes which have affected wildlife populations and sets the stage for problems we see facing these species today.
- An explanation of the process used to identify the habitats and species in the greatest need of conservation. Identifies the primary strategies needed to conserve these species and their habitats
- An recognition of the need to monitor these efforts as strategies are implemented both to ensure that time and money are providing the expected results and to determine if changing conditions require a change in strategy.

Massachusetts' Plan is organized around 22 habitat types and 257 wildlife species in greatest need of conservation. The habitat types range from large-scale habitats such as Upland Forests; to medium-scale habitats like Grasslands, to small-scale habitats such as Vernal Pools. Information for each habitat type includes

- habitat description;
- the suite of species in associated with that habitat;
- the problems and threats faced by them;
- a map showing the distribution of the habitat type across the state, when available;
- a listing of the conservation strategies needed to conserve the habitat; and
- monitoring requirements that will ensure the success of the conservation strategies.

There is also information about the 257 wildlife species in greatest need of conservation occurring in one or more of the above 22 habitat types including:

- Conservation status ranking and habitat association
- Species Life History
- State distribution and abundance
- Habitat requirement

[1] O'Donnell, M.J. and B.H. Letcher. 2008. Size and age distributions of juvenile Connecticut River American shad above Hadley Falls: influence on outmigration representation and timing. River Research and Applications 24:929-940

- Conservation threats

The Division has requested that FERC add the MA SWAP to the list of Relevant Qualifying Resource Management Plans for these projects in a separate filing on February 11, 2013. The plan is available online at (http://www.mass.gov/dfwele/dfw/habitat/cwcs/pdf/mass_cwcs_final.pdf).

Thank you for this opportunity to comment.

Sincerely, Caleb Slater, Ph.D. Anadromous Fish Project Leader	Sincerely, Thomas W. French, Ph.D. Assistant Director for the Natural Heritage & Endangered Species Program

cc: Melissa Grader, USFWS
Robert Kubit, MA DEP

Requested Study No. 1.
In-stream Flow Habitat Assessment of the Turners Falls Bypassed Reach

Goals and Objectives

The goal of this study is to determine an appropriate flow regime that will protect and enhance the aquatic resources in the bypassed reach between Turners Falls Dam and the Cabot Station discharge. Specifically, the objective of the study is to conduct an instream flow habitat study to assess the impacts of the range of the proposed project discharges on the wetted area and optimal habitat for key species.

Target fish species include: State listed (endangered) Shortnose sturgeon, American shad, fallfish, white sucker, freshwater mussels and benthic macroinvertebrates.

Relevant Resource Management Goals

The Division seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

- Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
- Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to aquatic resources within the Turners Falls bypassed reach, the Division's goals are:

- Protect, enhance, or restore, diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
- Provide a flow regime in the bypassed reach that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels), state listed species, and diadromous fishes.
- Minimize the current negative effects of project operations on shortnose sturgeon spawning and rearing within known spawning areas of the bypassed natural river reach (i.e., the Rock Dam).
- Minimize current and potential negative project operation effects on water quality and aquatic habitat.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq*.).

Public Interest

The requestor is a resource agency.

Background and Existing Information

The Turners Falls Project bypasses a 2.7 mile-long section of the Connecticut River. Presently the only required spill releases from the Turners Falls dam to the bypassed reach are 400 cfs from May 1 through July 15 and 120 cfs from July 16 until the river temperature reaches 7°C.

In addition to these flows provided at the Turners Falls Dam, the bypassed reach receives flow from one small tributary (the Fall River, drainage area of 34.2 square miles), which enters the mainstem approximately 0.16 miles below the dam. The bypassed reach also receives the discharge from Station 1, when it is generating (typically when there is flow in excess of Cabot Station's needs). This discharge enters the bypassed reach approximately 0.9 miles below the dam.

Available information in the PAD does not indicate how project operations have altered downstream hydrology, habitat quantity and quality, and water quality, which may affect resident and migratory fish, macroinvertebrates, listed species, aquatic plants and other biota and natural processes in the Connecticut River from below the Turners

Falls Dam downstream to the Cabot Station discharge. The PAD also provides no detailed description of the physical or biological characteristics of the bypassed reach.

Limited information exists on the adequacy of the existing bypass flow regime to protect water quality and aquatic life. However, there is existing information (not included in the PAD) relative to minimum flows necessary for shortnose sturgeon spawning and rearing at the Rock Dam spawning site (Kynard et al. 2012). Spawning success was observed at Rock Dam when discharge was between 2,500 cfs and 22,000 cfs during the spawning period of April 27 through May 22 (Kynard et al. 2012, chapter 3). In 1995 at the Cabot spawning area, the greatest level of spawning and spawning success occurred (i.e., 21 late stage females present, 342 early life stage captured, and the longest spawning period of 17 days) even though no spawning was detected at Rock Dam (Kynard et al. 2012, chapter 3). Discharges in 1995 at Rock dam had dropped below 2,500 cfs by March 26th (Kynard et al. 2012, chapter 3), which may indicate the need to have mitigated flow well in advance of spawning. Flow reductions at the Rock Dam site that occurred during spawning caused females to leave the spawning site and not return even if flow later increased to acceptable levels. Researchers observed that the rubble substrates remained dominant during fluctuating flows and cessation of spawning is likely due to velocities falling outside the range preferred by females. Given the current flow dynamics at Rock Dam, spawning does not occur most years (Kynard et al. 2012, chapter 3). These data represent the best available scientific information and does not support current minimum flow thresholds at the project.

An empirical study is needed to provide information on the relationship between flow and habitat in the bypassed reach for the Division to use in determining a flow recommendation.

Nexus to Project

The Project includes a 2.7 mile-long bypassed reach. The Turners Falls Project is currently operated with a seasonally-varying minimum bypass flow (200 cfs starting on May 1, increasing to 400 cfs when fish passage starts through to July 15, then reduced down to 120 cfs until river temperature drops below 7°C). The 400 cfs release is primarily to facilitate upstream movement of anadromous migrants to the spillway fish ladder at Turners Falls Dam and the 120 cfs was intended to provide protection to shortnose sturgeon by maintaining a wetted habitat 1.5 times the maximum adult body depth through connections between pools within the bypassed reach. Neither of the currently required flows were based on quantitative, rigorous scientific studies.

This section of the Connecticut River contains habitat that supports native riverine species, including important spawning and rearing habitat for the state endangered shortnose sturgeon. While the existing license does require seasonally-varying flow releases from the Turners Falls dam, we do not believe these flows sufficiently protect the aquatic resources, including endangered species, inhabiting the bypassed reach.

Results of the flow study will be used by the Division to determine an appropriate flow recommendation that will protect and/or enhance the aquatic resources in the bypassed reach for the duration of any new license issued by the Commission.

Proposed methodology

The Division requests a bypass flow study be conducted at the Project. Bypass flow habitat assessments are commonly employed in developing flow release protocols that will reduce impacts or enhance habitat conditions in reaches of river bypassed by hydroelectric projects.

Given the size of the bypassed reach (2.7 miles long) and the important resources known to inhabit the reach (i.e., state endangered shortnose sturgeon and diadromous fishes), we believe a study methodology that utilizes an IFIM approach is appropriate for this site. This same protocol was used during the relicensing of the Housatonic River Project (FERC No. 2576),[2]and has been accepted by the Commission in other licensing proceedings[3].

At a minimum, the study design should involve collecting wetted perimeter, depth, velocity, and substrate data within a range of discharge levels along transects located in the reach of river between the dam and the Cabot Station discharge. The measurements should be taken over a range of test flows up to 6,300 cfs or over a sufficient

[2] Housatonic River Project License Application, Volume 4, Appendix F. Connecticut Light and Power Company, August 1999.

[3] Glendale Project (FERC No. 2801) Final Bypass Reach Aquatic Habitat and Instream Flow Study in Glendale Hydroelectric Project Application for Subsequent License (FERC No. 2801), Volume 2, Appendix B, pages 7-8, October 2007.

range of flows to model flows up to 6,300 cfs. This information then should be synthesized to quantify habitat suitability (using mutually agreed upon HSI curves) of each test flow for target species/life stages identified by the fisheries agencies. Habitat modeling using standard PHABSIM 1 dimensional modeling is acceptable for the bypassed reach from the area downstream of the spillway where the river channel constricts to Rawsons Island upstream from the Rock Dam. The area from Rawson Island to the Cabot station discharge should be modeled using 2 dimensional (2D) modeling to better characterize flows and velocities in this complex channel area. Likewise, we recommend 2D modeling in the spillway area and mouth of the Falls River to the point where the channel constricts given this complex area with numerous potential flow discharge locations.

The flow study should incorporate the identified minimum flow and temporal parameters for shortnose sturgeon discussed in the Background and Existing Information section of this request.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

Field work for flow studies can be reasonably extensive but will depend on consultation with the applicant on study methodology and on-site decisions on locations for data collection and the number of collection locations. Post-fieldwork data analysis would be a moderate cost and effort. Field work associated with this study could be done in conjunction with the below-project instream flow study request. We anticipate that the level of effort and costs will be comparable to that experienced on similar FERC relicensing projects (e.g., the Glendale Project, FERC No. 2801).

Literature Cited

Kieffer, M. and B. Kynard. 2012. Spawning and non-spawning migrations, spawning, and effects of river regulation on spawning success of Connecticut River shortnose sturgeon. In Life history and behavior of Connecticut Rver shortnose sturgeon and other sturgeons. B. Kynard, P. Bronzi, and H. Rosenthal Editors. World Sturgeon Conservation Society: Special Publication #4. Norderstedt, Germany.

Requested Study No. 2.
In-stream Flow Habitat Assessment Downstream of Cabot Station

Conduct an instream flow habitat study to assess the impacts of the range of the proposed project discharges on the wetted area and optimal habitat for key species. The study should include non-steady flow approaches to assess effects of within-day flow fluctuations due to peaking power operations on target fish species and benthic invertebrate communities. Target fish species include: state listed (endangered) shortnose sturgeon, American shad, fallfish, and white sucker.

Goals and Objectives

The goal of this study is to determine an appropriate flow regime that will protect and enhance the aquatic resources from the Cabot tailrace of the Turners Falls Project downstream to the Rt. 116 bridge in Sunderland, MA. Specifically, the objective of the study is to conduct an instream flow habitat study to assess the impacts of a range if flows on the wetted area and optimal habitat for key species, including the impacts of hydropeaking flow fluctuations on the quantity and location of aquatic habitat.

The study should include non-steady flow approaches to assess effects of within-day flow fluctuations due to peaking power operations on target fish species and benthic invertebrate communities. Target fish species include: state endangered shortnose sturgeon, American shad, fallfish, white sucker and walleye.

For shortnose sturgeon, the flow study will need to evaluate bottom velocities in shortnose sturgeon spawning and rearing areas during discharge conditions normally observed from April 15th to June 22nd. Protection of shortnose sturgeon spawning will necessitate establishment of discharges that create bottom velocities suitable for shortnose sturgeon spawning and rearing over a sustained period of time and avoid dramatically fluctuating flows. To protect shortnose sturgeon rearing, adequate discharge without dramatic flow fluctuations are needed to ensure the rearing shoals are wetted and velocities are sufficiently protective for early life stage (ELS) rearing.

Field verification will be necessary to confirm the flow modeling results that identify the flows needed to provide sustained bottom velocities for spawning also maintain flows, depths, and water release regime adequate for spawning and rearing. Velocity and depth data should be collected under each potential operation scenarios such that actual velocity, depth, and flow conditions occurring across the entire spawning and rearing areas including wetted shoals.

Resource Management Goals

The Division seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

- Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
- Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to aquatic resources, the Division's goals are:

- Protect, enhance, or restore diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
- Provide an instream flow regime that meets the life history requirements of resident and migratory fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
- Minimize current and potential negative project operation effects on water quality and aquatic habitat.
- Avoid or minimize the current negative effect of project operations on shortnose sturgeon spawning and rearing at the Cabot Station spawning and rearing site.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq*.).

Public Interest
The requestor is a resource agency.

Existing Information
Presently FirstLight is required to release 1,433 cfs below the Project. Information included in the PAD does not provide a detailed description of how this minimum flow was established and the Division is not aware of any previously conducted studies that evaluated the adequacy of this minimum flow in protecting aquatic resources in the 10+ miles of riverine habitat below the Cabot Station. Therefore, in order to fill this important information gap, an empirical study is needed to provide information on the relationship between flow and habitat in the Connecticut River downstream of the Cabot tailrace. Results will be used by the Division to determine an appropriate flow recommendation.

Kynard et al. (2012, chapter 3) examined the effects of water manipulation at the Turners Falls project on shortnose sturgeon spawning over the course of 17 years. This body of data represents the best available scientific information which does not support 1,433 cfs as an adequate minimum flow to support successful shortnose sturgeon spawning at Cabot Station. Peaking operations at Cabot Station cause discharge fluctuations to rapidly change bottom velocities from 0.4 m/s to 1/3 m/s over 30 minutes (Kynard et al. 2012, chapter 3). Shortnose sturgeon have not evolved to adapt to such artificial rapid changes in velocities and therefore continue to spawn during fluctuations even though conditions may be unsuitable and likely result in high egg mortality. During the 10 years when spawning succeeded at Cabot Station, discharge flow decreased to less than 35, 460 cfs by April 29th. The lowest discharge level observed while females remained on the spawning site was 4,700 cfs. Spawning behavior was not monitored during Cabot Station discharges at or below 3,500 cfs, so it is unclear what the minimum flow threshold is for spawning at Cabot Station. When peaking generation discharges cease during naturally low flow years, the tailrace shoals, likely used by shortnose ELS for rearing, were exposed (observed during years ’95, ’98-99, ’04) and may have resulted in larvae mortality due to stranding and exposure (Kynard et al 2012, chapter 3). Researchers observed that shoal exposure began when river flow below Cabot Station dropped below 7,062 cfs (Kieffer and Kynard 2007). Thus, total flow at Cabot, which may include flow from the Turners Falls Dam or Station 1, must be at least 7,062 cfs to both support adequate bottom velocities and prevent shoal exposure.

Furthermore, the emergency water control gates at Cabot Station that are used to sluice trash from the canal and balance canal flows spill large amounts of water. These large spill events create a plume of turbid turbulent flow, which caused some females to leave the area. These spill events scour bottom sediments which are then carried downstream over the spawning and rearing shoals where an entire year class of early life stages may be destroyed (Kynard et al. 2012, chapter 3). Information included in the PAD does not address adequate flows for shortnose sturgeon spawning and rearing. Results of the requested modeling will be used by the Divisions to determine an appropriate flow recommendation.

Researchers have also looked at suitable depth and velocity habitat for spawning (Kieffer and Kynard 1996, Kynard et al. 2012, chapter 3). Spawning sites are characterized by moderate river flows with average bottom velocities between 0.4 and 0.8 m/s (Hall et al. 1991, Kieffer and Kynard 1996, NMFS 1998). Water depth at the spawning site appears to be a less important habitat feature than substrate type and flow. A recent study by Kynard et al. (2012, chapter 6) demonstrated that females in an artificial stream will readily accept a shallow water depth of 0.6 m, with a rubble bottom, and 0.3–1.2 m/s bottom velocity. In addition, although eggs and embryos can likely tolerate very low depths, researchers measuring water depths between Turners Falls Dam and Cabot Station in order to recommend minimum flows suitable for an escape route for shortnose sturgeon trapped in the Turners Falls Dam Plunge Pool used a minimum depth of 1.5 x adult body depth. Because adults spawning in an artificial spawning channel frequently positioned themselves on top of one another (Kynard et al. 2012 Chapter 6), a minimum depth to facilitate spawning within the known Cabot Station spawning area is 3.0 body depths, or 19.2 inches.

Nexus to Project

The Project is currently operated with a minimum flow release that was not based on biological criteria or field study. Further, the project generates power in a peaking mode resulting in significant with-in day flow fluctuations between the minimum and project capacity on hourly or daily basis. The large and rapid changes in flow releases from hydropower dams are known to cause adverse effects on habitat and biota downstream of the project (Cushman 1985, Blinn 1995, Freeman *et al*. 2001). There are more than ten miles of lotic habitat below the project's discharge that are impacted by peaking operations at Cabot Station. This section of the Connecticut River contains habitat that supports native riverine species, including important spawning and rearing habitat for migratory fish such as American shad and state endangered shortnose sturgeon. Shortnose sturgeon larval migrants initially become bottom dwellers and transition from living off of yolk sacs to orally feeding, which is a critical stage in their life history. While the existing license does require a continuous flow of 1,433 cfs below the project (0.20 cubic feet per second flow per square mile of drainage area - cfsm), that is equal to only 40% of the Aquatic Base Flow[4] this flow does not sufficiently protect the aquatic resources, including endangered species, in this substantial reach of river, especially in the context of the magnitude, frequency, and duration of changes in habitat that likely occur between minimum and generation flows.

Results of the flow study will be used by the Division to determine an appropriate flow recommendation that will protect and/or enhance the aquatic resources below the Project.

Methodology Consistent with Accepted Practice

In-stream flow habitat assessments are commonly employed in developing plant operational regimes that will reduce impacts or enhance habitat conditions downstream of hydroelectric projects.

The Division requests a flow study be conducted at the Project. Given the length of the river reach (10+ miles) impacted by project operations, we believe a study methodology that utilizes an IFIM approach is appropriate for this site. This same protocol was used during the relicensing of the Housatonic River Project (FERC No. 2576),[5]and has been accepted by the Commission in other licensing proceedings[6].

At a minimum, the study design should involve collecting wetted perimeter, depth, velocity, and substrate data along transects located in the reach of river below Cabot Station. The measurements should be taken over a range of test flows. This information then should be synthesized to quantify habitat suitability (using mutually agreed upon HSI curves) of each test flow for target species identified by the fisheries agencies. Habitat modeling using standard PHABSIM 1 dimensional modeling is acceptable for the river channel downstream from the railroad bridge below the mouth of the Deerfield River. The area from the Cabot Station discharge to the railroad bridge should be modeled using 2 dimensional (2D) modeling to better characterize flows and velocities in this complex channel area.

The types of data collected with this study should be sufficient to perform a dual-flow analysis and habitat time series or similar approaches that will permit assessment of how quality and location of habitat for target species changes over a range of flows between existing minimum flow and maximum project generation flows.

Level of Effort/Cost, and Why Alternative Studies will not suffice

Field work for instream flow studies can be reasonably extensive but will depend on consultation with the applicant on study methodology and on-site decisions on locations for data collection and the number of collection locations. Post-fieldwork data analysis would be a moderate cost and effort. We anticipate that the level of effort and costs will be comparable to that experienced on similar FERC relicensing projects of this size (e.g., the Conowingo Project, FERC No. 405).

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[4] The Aquatic Base Flow equates to the August Median Flow as determined using unregulated hydrography or on drainage area at the project site (0.5 cfs per square mile of drainage area) if unregulated hydrography is unavailable.
[5] Housatonic River Project License Application, Volume 4, Appendix F. Connecticut Light and Power Company, August 1999.
[6] Glendale Project (FERC No. 2801) Final Bypass Reach Aquatic Habitat and Instream Flow Study <u>in</u> Glendale Hydroelectric Project Application for Subsequent License (FERC No. 2801), Volume 2, Appendix B, pages 7-8, October 2007.

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Requested Study No. 3.
Telemetry Study of Upstream and Downstream Migrating Adult American Shad to Assess Passage Routes, Effectiveness, Delays, and Survival

Goals and Objectives

Assess behavior, approach routes, passage success, survival, and delay by adult American shad as they encounter the projects during both upstream and downstream migrations, under permitted project operations conditions, proposed operational conditions, and study treatment operational conditions. There are multiple fishways and issues related to both upstream and downstream passage success at the projects.

Telemetry Study - This requested study requires use of telemetry using both radio and Passive Integrated Transponder (PIT) tag types to provide information to address multiple upstream and downstream fish passage issues. The following objectives shall be addressed in these studies:

- Assessment of any migration delays resulting from the presence of the dam and peaking flow operations of the Turners Falls Project;
- Determine route selection and behavior of upstream migrating shad at the Turners Falls Project under various spill flow levels (e.g., movement to the dam, attraction to Cabot Station, attraction to Station 1 discharge, movement between locations, delay, timing, etc.). A plan and schedule for dam spill flow releases will need to be developed that provides sufficient periods of spill flow conditions, and various generating levels from Turners #1 Station coupled with Cabot Station generation flows (e.g., treatments will require multiple days of consistent discharge). Evaluated spill flows should include flows between 2,500 – 6,300 cfs, which relate to bypass flows identified as providing spawning opportunities for shortnose sturgeon in the lower bypass reach at the Rock Dam. (Kieffer and Kynard 2012). Sturgeon spawning and upstream shad passage occur concurrently;
- Assess near field attraction to, and entrance efficiency of the Spillway Ladder by shad reaching the dam spillway, under a range of spill conditions;
- Evaluate the internal efficiency of the Turners Falls Spillway Ladder;
- Continue data collection of Cabot Station Ladder and Gatehouse Ladder efficiency, to include rates of approach to fishway entrances, entry into fishways, and passage through them, under different operational conditions that occur in these areas;
- Evaluate modifications to the Cabot and/or Spillway fishways recommended by the Division if they are implemented;
- Assess upstream migration from Turners Falls to the Vernon Dam in relation to Northfield Mountain's pumping and generating operations and Vernon Project peaking generation operations. Typical existing and proposed project operation alterations should be evaluated;
- Assess impacts of Northfield Mountain operations on up- and downstream adult shad migration, including delays, entrainment, and behavioral changes and migration direction shifts under existing and proposed project operations;
- Determine downstream passage route selection, timing/delay, and survival under varied project operational flows into the power canal and spill flows at Turners Falls Dam;
- Determine downstream passage route selection, timing/delay in the canal, Cabot Station fish bypass facility effectiveness, and survival of Cabot-bypassed adult shad that enter the Turners Falls Canal system;
- Compare rates and or measures of delay, movement and survival etc., among project areas or routes utilized (e.g., spill at dam vs. power canal) under the range of permitted and proposed conditions; and
- Utilize available data sets and further analyze raw data (e.g., 2003- 2012 Conte Lab Studies) where possible to address these questions and inform power analyses and experimental design.

Information to address all of these questions would rely on the tagging of upstream migrating adult shad at Holyoke Dam and releasing them to migrate naturally from Holyoke through the Turners Falls and Vernon projects and back downstream after spawning. Additional tagged individuals would likely need to be released farther upstream (Turners Falls Canal, upstream of Turners Falls Dam), to ensure that enough tagged individuals encounter project dams on both upstream and downstream migrations, that these individuals are exposed to a sufficient range of turbine and operational conditions to test for project effects, and to provide adequate samples sizes for statistically valid data analyses to address the many objectives listed. This study will require two years of field data collection to attempt to account for inter-annual variability in river discharge and water temperatures.

<u>Evaluation of Past Study Data</u>- In addition to collection and analysis of new telemetry data, substantial data has already been collected at Turners Falls from multiple years of passage assessments conducted for First Light by U.S. Geological Survey's Conte Anadromous Fish Research Center (Conte Lab) researchers and there are also data from the 2011 and 2012 full river study conducted by the Conte Lab that address Turners Falls, Northfield Mountain and Vernon project migration and passage questions that have not yet been analyzed. These data include several million records each year from more than 30 radio telemetry receivers deployed between Middletown, CT and Vernon Dam. This data will provide substantial information free from the field data collection costs and therefore should be analyzed as part of this study. This data analysis should be completed in 2013 to help inform the design of subsequent field studies.

<u>Evaluation of Methods to Get Shad Past Cabot Station for Spillway Passage at the Turners Falls Dam</u> – The poor passage efficiency of the Cabot Ladder, the first and most used fishway encountered by shad arriving at the Turners Falls Project, and at the entrance to the Gatehouse Ladder, which all Cabot fishway-passed fish must use, has resulted in very poor overall shad passage efficiency at the project. An alternative to passing fish at the Cabot Station is to install a fish lift at the dam that would put fish directly into the Turners Falls pool, thereby eliminating problems with the Cabot Fishway, and the Gatehouse Fishway entrance and the variable passage efficiency of the Gatehouse Fishway. For this to be effective, attraction of shad to the Cabot Station discharge and associated delays would need to be overcome. It is possible that spillway flow releases coupled with behavioral measures at Cabot Station that dissuade shad from that tailrace could achieve this end. In order to assess the possibilities, we recommend the following study:

- A literature search and desk-top assessment of the possible behavioral measures that could be effective in getting shad to pass Cabot Station tailrace and continue upstream to the dam.
- Based on results of the desk-top assessment, possible evaluation of behavioral measures that are likely to be effective.
- Field evaluation of the effect of different levels of spill at the dam that would induce fish to move past the Cabot Station into the bypass reach and up to the dam (as noted in objectives).

Besides passage success and delays at passage facilities, these studies would assess the impacts of project operations on migration passage delay, route, timing, injury, mortality, and passage structure attraction, retention, and success. Of particular interest will be fish behavior during periods when flow releases from the project increase from the required minimum flows to peak generation flows and when flows subside from peak generation flows to minimum flows and the operation of NMPS in pumping and generation modes.

Resource Management Goals

The Connecticut River Atlantic Salmon Commission (CRASC) developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following

- Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.
- Achieve annual passage of 40% to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem.
- Maximize outmigrant survival for juvenile and spent adult shad.

The Atlantic States Marine Fisheries Commission, Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010 includes the following objective:

- Maximize the number of juvenile recruits emigrating from freshwater stock complexes and recommendations:
- Upstream Passage –

  - American shad must be able to locate, enter, and pass the passage facility with little effort and without stress.
  - Where appropriate, improve upstream fish passage effectiveness through operational or structural modifications at impediments to migration.
  - Fish that have ascended the passage facility should be guided/routed to an appropriate area so that they can continue upstream migration, and avoid being swept back downstream below the obstruction.
- Downstream Passage –
  - To enhance survival at dams during emigration, evaluate survival of post spawning and juvenile fish passed via each route (e.g., turbines,, spillage, bypass facilities, or a combination of the three) at any given facility, and implement measures to pass fish via the route with the least delay and best survival rate.

Based on the CRASC plan, the Division seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

- Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
- Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to American shad movement and migration, the Division's goals are:

- Minimize current and potential negative project operation effects such as migration delays, false attraction, turbine entrainment, survival of project passage routes, and trashrack impingement that could hinder management goals and objectives.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq*.).

Public Interest

The requestor is a fish and wildlife resource agency.

Background and Existing Information

Passage of adult shad at the Turners Falls fishway complex has been the subject of intense study by the Conte Lab since before 1999. These studies have clearly demonstrated that passage through the existing fishways at Cabot and Spillway is poor (<10% in many years). Passage through the Gatehouse fishway is better, but still rarely exceeds 80%, despite the short length of this ladder. In addition to poor passage for fish entering the ladders, shad that ascend the Cabot Fishway experience extensive delays before entry into the Gatehouse Fishway. Shad that ascend Spillway frequently fall back into the canal and are also subject to these upstream delays. A new entrance to the Gatehouse Fishway installed in 2007 led to dramatic improvements in passage out of the canal (from 5% to over 50% in 2011), but passage still falls well short of management goals. In addition, shad spend considerable time (up to several weeks) attempting to pass. These delays likely influence spawning success and survival. Adult shad, unable to pass Gatehouse, experience similar delays in downstream passage, even after they have stopped trying to pass Gatehouse. Without spill, all outmigrating shad that have passed Gatehouse must enter the canal at the Gatehouse and may be subject to delays exiting the canal.

During the course of these studies a very large dataset has been compiled that could yield useful information for further improving passage of shad out of the canal in both the upstream and downstream directions. A unique feature of these data is a 2-dimensional array covering the canal just downstream of Gatehouse, documenting fine scale movements and occupancy of this zone. These data should be combined with computational fluid dynamics (CFD) and real-time hydraulic data to determine how canal hydraulics influence the ability of shad to locate and enter the fishway, and to identify modifications that are likely to lead to improvements in approach and entry rates. A separate

CFD modeling study is requested that includes modeling of the Gatehouse Fishway entrance are at the head of the power canal.

In addition, whole-river shad telemetry studies performed in 2011 and 2012 will likely provide useful information and should be analyzed. These data should allow quantification of delay below Turners Falls, and could help guide studies requested above. Preliminary analyses of data through 2011 have been made available to FirstLight and the resource agencies (Castro-Santos and Haro 2005; Castro-Santos and Haro 2010).

The whole-river studies have also shown that, at least in 2011, most shad that pass Turners Falls rapidly progress upstream to Vernon Dam where extensive delays also occur. Data from the 2012 study were not available at this time, but Dr. Castro-Santos stated similar patterns were noted in the data between the years on the topic of upstream delay (personal communication, Dr. Theodore Castro-Santos). Similarly, concerns relative to the downstream passage of spent shad also remain relative to delays, with existing unpublished USGS telemetry data sets suggesting this is an issue within the Turners Falls canal.

Since the first year of operation of the Turners Falls upstream fishways (1980), the percent passage of American shad annually passed upstream of Turners Falls Dam compared to the number passed at the Holyoke Fish Lift has averaged 3.6% (1980-2012 data). The highest values for this metric has not exceed 11% and are well below the noted CRASC Management Plan target range for this objective noted earlier as 40-60% on a five year running average.

Since the first year of operation of the Vernon Dam upstream fish ladder (1981), the percent passage of American shad annually passed at Vernon compared to the number passed upstream of Turners Falls Dam (Gatehouse counts) has averaged 39.4%, ranging from 0.42% to 116.4% (> 100% due to counting error at one or both facilities, unknown).

Nexus to Project

Existing project operations (peaking power generation) and limited bypass flows have a direct impact on instream flow and zones of passage (migration corridors). Project flow releases affect passage route selection, entry into fishways, and create delays to upstream migration. Inefficient downstream bypasses can result in migration delays and increased turbine passage. Mortality of adult shad passing through these turbines is expected to be high (Bell and Kynard 1985), additional stresses associated with passage and delay may cause mortality as shad are unable to return to salt water in a timely manner. The project's upstream and downstream passage facilities need to be designed and operated to provide timely and effective upstream and downstream fish passage to meet restoration goals of passage to upstream habitat and maximize post-spawn survival. These factors are all critically important to the success of restoration efforts.

Methodology Consistent with Accepted Practice

Use of radio including passive-integrated transponder (PIT) telemetry is widely accepted as the best method to assess fish migratory behavior and passage success and has been used extensively to assess migration and passage issues at Turners Falls as well as other Connecticut River projects. These studies include one conducted in 2011 and 2012 by the U.S. Fish and Wildlife Service and U.S. Geological Survey's Conte Anadromous Fish Research Center, which has provided substantial information related to some of the issues identified here. The requested study will build and expand on the information collected over the past two years.

The study design must specify sample sizes, tag configurations and receiver configurations, to ensure that rates of entry and exit to the tailraces, fishways, downstream bypasses, and the bypassed reach can be calculated with sufficient precision to determine effectiveness of flow. For project assessments at Turners Falls (e.g., Cabot, Spillway and Gatehouse ladder attraction and entry, route selection, operational effects), double tagged (radio and PIT) shad will be required for release from Holyoke Dam. Additional shad must be released directly into the Turners Falls Canal to support assessment of the various operational and structural conditions in effect, to be modified in this period, and proposed conditions within the Turners Falls power canal relative to entrances to the Gatehouse fishway. A related request on CFD modeling in the Cabot Station tailrace, the upper power canal near Gatehouse, and in the area around the entrance of the Spillway Ladder will address related project operational effects that will also address identified objectives in this telemetry request. Shad captured at Holyoke and tagged and release upstream of Turners Falls Dam, or tagged out of Gatehouse Ladder, would help to ensure an adequate sample size for evaluations in the vicinity of NMPS and to the Vernon Dam and the ability to address identified study objectives in those project areas. Additional tagged shad are expected to be required for release upstream of the Vernon Dam, which should ensure adequate sample for a separate study request, where shad spawn upstream of Vernon Dam as well as ensuring there is an adequate number of outmigrating spent adults to address related study objectives for adult outmigrants. The required number of tagged fish to address study objectives may be adjusted accordingly from area to area depending on target numbers (i.e., best information on resultant viable tagged fish and power analyses to detect effects) to account for typical passage rates, survival rates, and handling effects as examples.

Existing information on captured, handled, tagged fish performance (e.g., percent that drop back, unsuitable for tracking) and factors such as timing of tagging and potentially transport, must all be carefully considered to ensure an adequate sample size of healthy (e.g., viable to characterize behavior, survival, etc.) tagged fish is available to address the many questions identified in this request (as supported by a statistical power analysis). Additionally, ensuring adequate downstream adult fish sample sizes (to address project effect questions above) requires close consideration as expected losses of healthy tagged fish during upstream passage, natural mortality rates, and tagging related effects, are expected to reduce sample sizes on downstream passage objectives/questions as the season progresses. The use of single PIT tagged fish can help improve sample sizes, but will be of limited use to answer some of the passage questions we have identified.

Due to environmental variability, two years of study work will be necessary. A large array of stationary monitoring stations (radio and PIT) will be needed to address the issues identified among the project areas. A sufficient level of radio receiver and PIT reader coverage will be required, to provide an appropriate level of resolution, for data analyses, to answer these questions on project operational effects. The study will provide information on a variety of structural and operational aspects of fish migration, relative to route selection, timing, survival, and up and downstream passage attraction, retention, delay, efficiency, survival as some examples at three projects (Turners Falls, NMPS, and Vernon). The use of video monitoring may also be utilized for specific study areas such as the Spillway Ladder, to provide additional information on shad entrance activity, with the understanding of some data limitations associated with this approach (fish identification, water visibility).

In addition to the tagging studies, use of video monitoring of the Spillway Fishway would provide additional overall data on Spillway Fishway efficiency as all shad attempting to pass could be monitored versus just those shad that have been tagged.

Level of Effort/Cost, and Why Alternative Studies will not suffice

The requested study is extensive and will require a substantial effort and cost to capture, PIT tag, and radio tag a sufficient number of shad at Holyoke to release at upstream locations. We are not aware of any other study technique that would provide project specific fish behavior and migration information to adequately assess existing project operations and provide insight in possible alternative operations and measures needed to address observed negative impacts to fish migration success. Cost for the entire multi-project tagging, tracking and data analysis are expected to range from $400,000 to $500,000 based on past Turners Falls' studies and the 2011 and 2012 shad telemetry studies. Video monitoring of the Spillway fishway would add a modest cost to this study.

Due to the fact tagged shad will move throughout the larger five project area, to varying degrees, there will be expected cost savings (e.g., radio tags) to both owner/operators, provided cooperation in study planning and implementation occurs.

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Requested Study No. 4.
Impact of Project Operations on Shad Spawning, Spawning Habitat, and Egg Deposition in the Project Area.

Conduct a field study of spawning by American shad in the Connecticut River mainstem downstream of Turners Falls Dam and in the Turners Falls Dam impoundment to determine if project operations (including operations of the Northfield Mountain Pump Storage) negatively impact shad spawning behavior, spawning habitat use, areal extent and quality of those spawning areas, and spawning activity in terms of egg deposition in those areas.

Goals and Objectives

Determine if project operations (under the permitted and proposed operational ranges) affect American shad spawning site use and availability, spawning habitat quantity and quality, and spawning activity in the river reaches downstream from Cabot Station and in the project bypass reach of Turners Falls Dam and in the Turners Falls Dam impoundment and in relation to Northfield Mountain Pump Storage operations. The following objectives will address this request:

- Determine areas utilized by American shad for spawning by conducting night-time visual observation of spawning activity, identify and define areas geospatially, and obtain data on physical habitat conditions effected by project operations (e.g., water depth, velocity, discharge, substrate, exposure and inundation of habitats);
- Determine project operation effects on observed spawning activity, under a range of permitted or proposed project operation conditions;
- Quantify effects (e.g., water velocity, depths, inundation, exposure of habitats) of project operation on identified spawning areas for a range of conditions, over the complete period of spawning activity;
- Quantify spawning activity as measured by night-time spawning/splash surveys and egg collection in areas of spawning activity, and downstream of these areas, to further determine project operation effects (location extent of exposure from changing water levels and flows and on associated habitats from project operations).

If it is determined that the Project operations are adversely affecting the spawning activity of American shad and impacting spawning area habitat, identify operational regimes that will reduce and minimize impacts spawning habitat and spawning success, within the project area. This study will require two years of field data to capture inter-annual variability to river discharge and water temperatures and to allow for evaluation of alternative flow regimes if year one studies determine that the present peaking regime negatively affects spawning.

Resource Management Goals

The Connecticut River Atlantic Salmon Commission developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following:

- Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.
- Achieve annual passage of 40% to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem.

The Atlantic States Marine Fisheries Commission, Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010 includes the following objective:

- Maximize the number of juvenile recruits emigrating from freshwater stock complexes

and recommendations:

- To mitigate hydrological changes from dams, consider operational changes such as turbine venting, aerating reservoirs upstream of hydroelectric plants, aerating flows downstream, and adjusting in-stream flows.
- Natural river discharge should be taken into account when instream flow alterations are being made to a river (flow regulation) because river flow plays an important role in the migration of diadromous fish.

- Ensure that decisions on river flow allocation (e.g., irrigation, evaporative loss, out of basin water transport, hydroelectric operations) take into account instream flow needs for American shad migration, spawning, and nursery use, and minimize deviation from natural flow regimes.
- When considering options for restoring alosine habitat, include study of impacts and possible alteration of dam-related operations to enhance river habitat.

The Division seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

- Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
- Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to American shad, the Division's goals are:

- Minimize current and potential negative project operation effects on American shad spawning and recruitment.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq*.).

Public Interest
The requestor is a resource agency.

Existing Information
Since the construction of the first fish lift facility at Holyoke Dam in 1967, American shad have had access to spawning and rearing habitat upstream from Holyoke Dam. A number of improvements to the Holyoke fishway have occurred since that time, but while the numbers of shad lifted at Holyoke have reached as much as 721,764 and the overall shad population to the river exceeded 1.6 million shad in 1992 (CRASC 1992), total shad population, and numbers of shad passing Turners Falls and Vernon Dam have not met CRASC management plan objectives. Population number and passage numbers past Holyoke have declined substantially from those totals in recent years, with average Holyoke passage numbers over the last 10 years of 211,850. Since historically approximately half of the returning population of shad to the river passed upstream of Holyoke, recent returns are far below management goals. Effective upstream and downstream passage and successful in-river spawning and juvenile production are necessary to help achieve shad management goals for the Connecticut River.

American shad broadcast spawn in congregations over shallow flats and rocky or sandy substrates (Davis et al, 1970, Mansuetti and Kolb 1953), at depths less than 10 feet and often far shallower with spawning fish swimming vigorously near the surface in a closely packed circle (Marcy 1972, Mackenzie et al 1985). Fertilized eggs drift downstream until hatching (Mackenzie et al 1985).

American shad are known to spawn downstream from the Turners Falls Project. Layzer (1974) identified 6 spawning sites from an area below the mouth of the Deerfield River (river mile 191.9) to river mile 161.7 below the Mill River in Hatfield, MA. Kuzmeskus (1977) verified 16 different spawning sites ranging from downstream of the Cabot tailrace to just upstream of the Holyoke dam (river mile 87.1). The only parameter that all spawning sites had in common was current (Kuzmeskus 1977). The Division is not aware of any more recent studies that document whether these 16 sites are still viable spawning locations for shad.

First Light Power conducted studies in the late spring and summer of 2012, examined habitat conditions downstream of the Turners Falls Dam. The study documented that in low flow conditions, Cabot Station project operations produced fluctuations in water level elevations that can range over 4 feet in magnitude (daily operation) at the USGS Montague Gage Station, to lower values of 2 to 3 feet at the Route 116 Bridge, Sunderland, MA (PAD). Similar short-term, limited monitoring in the upper Turners Falls Dam impoundment identified water level changes due to project operations that d cyclically varied several feet on a sub-daily frequency.

Nexus to Project

American shad are known to spawn at five locations downstream from the Turners Falls Project from an area below the mouth of the Deerfield River (river mile 191.9) and ten other locations downstream to river mile 161.7 below the Mill River in Hatfield (Layzer 1974, Kuzmeskus 1977).

Shad spawning is likely influenced by river flow, which fluctuates greatly due to the project's peaking mode of operation. These fluctuations may impact shad spawning activity by altering current velocities and water depth at the spawning sites. Effects on spawning behavior could include suspension of spawning activity, poor fertilization, flushing of eggs into unsuitable habitat due to higher peaking discharges, eggs dropping out into unsuitable substrate and being covered by sediment deposition and/or eggs becoming stranded on dewatered shoal areas as peak flows subside.

While a number of shad spawning and egg deposition studies were conducted in the 1970s, that research was aimed at assessing the potential impact of developing a nuclear power station in the Montague Plains section of the Connecticut River. The Division is not aware of any studies being conducted specifically designed to determine if a relationship between spawning behavior, habitat use, and egg deposition and project operations effects of the Turners Falls, Northfield Mountain Pump Storage.

The Division is concerned that peaking operations may be altering spawning behavior and contributing to the failure of the Connecticut River shad population to meet management targets.

Methodology Consistent with Accepted Practice

The first year of study should examine known spawning areas downstream of the Turners Falls Dam project, to determine operation effects on shad spawning behavior, activity, and success. In areas upstream of Turners Falls Dam to the Bellow Falls Dam tailrace, the study should identify areas utilized for spawning by American shad. In the second year, should results from year one determine project operations affected spawning activity, access to habitat, or success, downstream of Turners Falls Dam, then an identical more detailed assessment (identified objectives) should be conducted in spawning areas upstream of Turners Falls Dam to the Bellows Falls Dam tailwater. Measures to reduce or eliminate any documented project operation impacts should be explored and evaluated in year two, downstream of Turners Falls Dam.

The impacts to spawning behavior would best be studied by night-time observations of actual in-river spawning behavior (Ross et al. 1993). Project discharge increases or decreases during actual observed spawning activity will provide empirical evidence of change in behaviors. The observational methodology should follow the protocol specified in Layzer (1974) and/or as described in Ross et al. (1993). The analysis should utilize the observational field data in conjunction with operational data from the projects (station generation and spill on a sub-hourly basis). To assess the impacts of changes in generation flows, the study should include scheduled changes in project operation to ensure that routine generation changes that occur during the nighttime spawning period affect downstream spawning habitats selected for study while shad are spawning. Stier and Crance (1985) provide optimal water velocities during spawning to range between 1 to 3 ft/sec.

In areas used for spawning, the characteristics of those areas (e.g., location, depth, flow, substrate) should be recorded. The effect of project operations (discharge, water velocity, inundation and exposure) should be assessed. Drift nets will be used to collect eggs to quantify egg production before and after flow changes at the spawning site.

In the reaches above the Turners Falls dam, night time observations of splashing associated with shad spawning should be done in each reach as sufficient numbers of shad are passed above each dam. Observations should be done regularly until the end of the spawning season. The use of radio-tagged adult shad from a separate Study Request will aid in this effort. An estimate of the total area used for spawning and an index of spawning activity should be recorded for each site.

Level of Effort/Cost, and Why Alternative Studies will not suffice
First Light has not proposed any studies to meet this need. Estimated cost for the study is expected to be moderate (up to $40,000), with the majority of costs associated with fieldwork labor.

Literature Cited

Atlantic States Marine Fisheries Commission. 2010. Amendment #3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management). Washington, D.C.

CRASC (Connecticut River Atlantic Salmon Commission). 1992. A management plan for American shad in the Connecticut River basin. Sunderland, MA.

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Kuzmeskus, D. M. 1977. Egg production and spawning site distribution of Americans had, *Alosa sapidissima*, in the Holoke Pool, Connecticut River, Massachusetts. Master's thesis. University of Massachusetts, Amherst, MA.

Layzer, J.B. 1974. Spawning Sites and Behavior of American Shad, *Alosa sapidissima* (Wilson), in the Connecticut River Between Holyoke and Turners Falls, Massachusetts, 1972. Master of Science Thesis. University of Massachusetts, Amherst, Massachusetts.

MacKenzie, C., L. Weiss-Glanz, and J. Moring. 1985. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (mid-Atlantic) American shad. U. S. Fish and Wildlife Service Biological Report No. 82 (11.37), Washington, D.C.

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Marcy, B. C. Jr. 1972. Spawning of the American shad, Alosa sapidissima, in the lower Connecticut River. Chesapeake Science 13:116-119.

Ross, R. R., T. W. H. Backman, R. M. Bennett. 1993. Evaluation of habitat suitability index models for riverine life stages of American shad, with proposed models for premigratory juveniles. Biological Report #14. U. S. Department of the Interior, Fish and Wildlife Service, Washington, D.C.

Stier, D. J. and J. H. Crance. 1985. Habitat suitability index models and instream flow suitability curves: American shad. U. S. Fish and Wildlife Service Biological Report No. 82(10.88), Washington, D.C.

Requested Study No. 5.
Shad Population Model for the Connecticut River

Develop an American shad annual step, mathematical simulation population model for the Connecticut River to quantify how project operations and potential restoration/mitigation measures impact the population of shad in the Connecticut River.

Goals and Objectives
The goal of the model is to assess impacts of both upstream and downstream passage at each of the Connecticut River projects and potential management options for increasing returns to the river.

Specific objectives include:
- Annual projections of returns to the Connecticut River;
- A deterministic and stochastic option for model runs
- Life history inputs of Connecticut River shad
- Understanding the effect of upstream and downstream passage delay at projects
- Calibration of the model with existing data
- Analysis of the sensitivity of model inputs
- Analysis of sensitivity to different levels of up- and downstream passage efficiencies at all projects
- Multiple output formats including a spreadsheet with yearly outputs for each input and output parameter

Resource Management Goals
The Connecticut River Atlantic Salmon Commission (CRASC) developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following:
- Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.
- Achieve annual passage of 40 to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem.
- Maximize outmigrant survival for juvenile and spent adult shad.

The Division seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:
- Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
- Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to American shad, the Division's goals are:
- Minimize current and potential negative project operation effects on American shad spawning and recruitment.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq*.).

Public Interest
The requestor is a resource agency.

Existing Information
Since the construction of the first fish lift facility at Holyoke Dam in 1967, American shad have had access to spawning and rearing habitat upstream from Holyoke Dam. A number of improvements to the Holyoke fishway have occurred since that time, but while the numbers of shad lifted at Holyoke have reached as much as 721,764 and

the overall shad population to the river exceeded 1.6 million shad in 1992 (CRASC 1992), total shad populations, and numbers of shad passing Holyoke, Turners Falls and Vernon Dam have not met CRASC management goals.

Population and passage numbers past Holyoke have declined substantially from those totals in recent years, with average Holyoke passage numbers since 2000 of 229,876. Whole river population estimates have shown that approximately half of the returning population of shad pass upstream of Holyoke. Recent returns to Holyoke are far below management goals. Average passage efficiency of shad at Turners Falls (Gatehouse counts) and Vernon since 2000 has been 3.1 and 20.4 % respectively. These too are well below the CRASC management goals.

Safe, timely and effective up- and downstream passage along with successful spawning and juvenile production are necessary to help achieve shad management goals for the Connecticut River.

Nexus to Project
Existing project operations and fish ladder efficiencies have a direct effect on shad populations in the Connecticut River. Poor upstream passage efficiencies and delays restrict river access to returning shad. Fish unable to reach upriver spawning grounds may not spawn or have reduced fitness or survival of young. Poor downstream passage survival and downstream passage delays affect outmigration and consequently repeat spawning, an important ecological aspect of the iteroparous Connecticut River shad population (Limberg et al. 2003).

The Division is concerned that poor passage efficiencies and delays at projects may be limiting access to upstream reaches of the river, altering spawning behavior, decreasing outmigration survival and contributing to the failure of the Connecticut River shad population to meet management targets (Castro-Santos and Letcher 2010).

Development of a population model will allow an assessment of individual project impacts on the population as well as the cumulative impacts of multiple projects. The model will allow managers to direct their efforts in the most efficient manner toward remedying the conditions that most impact the shad population.

Methodology Consistent with Accepted Practice
Population models are commonly used to assess anthropomorphic and natural impacts and are consistent with accepted practice. A model similar to this request was constructed for the Susquehanna River by Exelon (FERC #405, RSP 3.4). The model is constructed in Microsoft Access

Specific parameters that would be included in the model:

- Upstream passage efficiency at Holyoke, Turners Falls (Cabot, Gatehouse and Spillway Ladders), Vernon fishways, and any impacts associated with Northfield Mountain.
- Distribution of shad approaching the Turners Falls project between the Cabot Ladder and the spillway at the dam
- Downstream passage efficiencies at Vernon, Northfield Mountain, Turners Falls, and Holyoke projects for juveniles and adults
- Entrainment at Mount Tom and Vermont Yankee
- Sex ratio of returning adults
- The proportion of virgin female adults returning at 4, 5, 6, and 7 years
- The proportion of repeat spawning females at 5, 6 and 7 years
- Spawning success of females in each reach
- Fecundity
- Percent egg deposition
- Fertilization success
- Larval and juvenile in-river survival
- Calibration factor to account for unknown parameters such as at sea survival
- Options for fry stocking and trucking as enhancement measures
- Start year and model run years
- Start population
- Rates of movement to and between barriers

- Temperature, river discharge, and other variable of influence to migration and other life history events

The model should be adaptable to allow the input of new data and other inputs.

Level of Effort/Cost, and Why Alternative Studies will not suffice
Neither First Light nor TransCanada have proposed any study to meet this need. Estimated cost for the study is expected to be low to moderate. As the model describes the impacts of multiple projects and two owners, both project owners would share the cost of model development.

Literature cited:

CRASC (Connecticut River Atlantic Salmon Commission). 1992. A management plan for American shad in the Connecticut River basin. Sunderland, MA

Castro-Santos, T and B. H. Letcher. 2010. Modeling migratory bioenergetics of Connecticut River American shad (*Alosa sapidissima*): implications for the conservation of an iteroparous anadromous fish. Can.J.Fish.Aquat.Sci. 67: 806-830

Limberg, K. E., K. A. Hattala, and A. Kahne. 2003. American shad in its native range. Pages 125-140 in K. E. Limberg and J. R. Waldman, editors. Biodiveristy, status and conservation of the world's shads. American Fisheries Society, Symposium 35, Bethesda, Maryland

Requested Study No. 6.
Impact of Project Operations on Downstream Migration of Juvenile American Shad

Conduct a field study of juvenile American shad outmigration in the Turners Falls impoundment and the power canal and at Turners Falls Dam, Station #1, and Cabot Station to determine if project operations negatively impact juvenile American shad survival and production.

Goals and Objectives
Determine if project operations affect juvenile American shad outmigration survival, recruitment, and production. The following objectives will address this request:

- Assess project operations effects of NMPS and Turners Falls Dam on the timing, orientation, routes, migration rates, and survival of juvenile shad;
- Determine the proportion of juvenile shad that select the Gatehouse into the power canal versus the dam spill gates as a downstream passage route, under varied operational conditions, including a range of spill conditions up to full spill;
- Determine if there are any delays with downstream movement related to either spill via dam gates or through the Gatehouse and within the impoundment due to operations (i.e., NMPS pumping and generation);
- Determine survival rates for juvenile spilled over/through dam gates, under varied operation conditions, including up to full spill during the annual fall power canal outage period;
- Determine the juvenile downstream passage timing and route selection in the power canal to: Station 1; Cabot Station; and the Cabot Station log sluice bypass, and assess delays associated with each of these locations and with project operations (e.g., stockpiling in the canal);
- Based upon year 1 study results on route selection, determine the survival rate for juvenile shad entrained into Station 1; and
- Determine the survival rates for juvenile shad entrained into Cabot Station units;

If it is determined that the Project operations are adversely affecting juvenile shad survival, migration timing, or other deleterious population effects , identify operational solutions or other passage measures that will reduce and minimize these impacts within the project area. This study will require two years of field data to capture inter-annual variability of river discharge, water temperatures, and variability in the timing and abundance of juvenile production and their outmigration timing, which may relate to spring, summer, and fall conditions. This study will compliment the NMPS Fish Entrainment Study Request which includes assessment of impacts to juvenile shad.

Resource Management Goals
The Connecticut River Atlantic Salmon Commission developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following:

- Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.
- Maximize outmigrant survival for juvenile and spent adult shad.
-

The Atlantic States Marine Fisheries Commission *Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management*), approved in 2010 includes the following objective:

- Maximize the number of juvenile recruits emigrating from freshwater stock complexes.

and Recommendation:

- To enhance survival at dams during emigration, evaluate survival of post spawning and juvenile fish passed via each route (e.g., turbines, spillage, bypass facilities, or a combination of the three) at any given facility, and implement measures to pass fish via the route with the best survival rate.

The Division seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

- Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.

- Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to American shad, the Division's goals are:

- Minimize current and potential negative project operation effects on juvenile American shad survival, production, and recruitment.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq*.).

Public Interest
The requestor is a resource agency.

Existing Information
Since the construction of the Turners Falls Dam upstream fishways in 1980, American shad have had access to spawning and rearing habitat upstream of Turners Dam. A number of modifications to the Turners Falls fishways have occurred since that time, with the numbers of adult shad passed at Gatehouse Ladder (into Turners Falls Dam impoundment) reaching as much 60,089 in 1992 when a record 721,764 shad passed upstream of Holyoke Dam. However, since 1980 an average of only 3.6 % of the adult shad passed upstream of Holyoke Dam subsequently have passed upstream of Turners Falls Dam, and this value has never exceeded 11%. This value is well below the CRASC 1992 Shad Plan objective of 40-60% passage from the previous dam. In addition, population number and passage numbers past Holyoke have declined substantially, with the average Holyoke passage number over the last 10 years being 211,850. Because historic data suggests that approximately half the returning adult shad to the Connecticut River pass the Holyoke Dam, recent adult returns are far below management goals. Effective upstream and downstream passage and successful in-river spawning and juvenile production are necessary to help achieve shad management restoration goals for the Connecticut River, which extends to the Bellows Falls Dam. In 1990, FirstLight's predecessor, Northeast Utilities, CRASC and its member agencies, signed an MOA on downstream fish passage to address both juvenile and adults at the Turners Falls Project and Northfield Mountain Pumped Storage Project.

American shad broadcast spawn with the highest spawning activity occurring in runs and lowest activity in pools and riffle/pools (Ross et al. 1993). Field research by Ross et al. (1993) in the Delaware River further noted that a combination of physical characteristics that seems to be avoided by spawning adults is slow current and greater depth. American shad year-class strength has been shown to depend on parent stock size and environmental conditions during the larval life stages (Creeco and Savoy 1984). Delays in juvenile American shad outmigration may affect survival rates in the transition to the marine environment (Zydlewski et al. 2003). One published study on the Connecticut River, identified that juvenile shad outmigration began when declining autumn temperatures reached 19C and peaked at 16C (O'Leary and Kynard 1986).

Juvenile American shad production has been monitored upstream of the Vernon Dam and immediately downstream of that dam by Vermont Yankee Nuclear as part of an annual monitoring program using both boat electrofishing (since 1991) and beach seining (since 2000). Sampling of juvenile shad was also conducted by a contractor hired by Northeast Utilities in the Turners Falls impoundment in 1992. O'Donnell and Letcher (2008) examined juvenile shad early life history and migration upstream and downstream of Turners Falls Dam. Their study results led to the decision by the agencies to require earlier operation of downstream fishways to protect early season juvenile shad out-migrants (1 September prior to 2010, 15 August in 2010, and since 2011, 1 August).

Downstream juvenile clupeid passage studies at Turners Falls were conducted in the fall of 1991 which included the objectives of determining the percentage of juvenile shad and herring that pass via the bypass log sluice or that were entrained in the Cabot Station turbines and related data (e.g., catch rates) were compared. The 1991 Downstream Clupeid Study did not assess survival rates for juveniles for either of these passage routes. The 1991 study report documented a higher rate of entrainment into the project turbines (23.0 fish per minute) versus through the bypass sluice (11.6 fish per minute). It was concluded that only an estimated 54% (average bypass rate, weighted by estimated number bypassed) of the juvenile American shad approaching Cabot Station were bypassed via the log sluice. The range of the percent bypassed varied widely by date, between nearly 0 and 83%, with "no clear explanation as to why." The report did not identify the percentage entrained into the turbines but it can be reasoned to be substantial based on the data presented in the report or assumed as the remaining balance (46%) as there were no spill events reported during this study, and therefore nowhere else for them to pass. It was further noted that entrainment rates for juveniles were consistently greatest for units 1 and 6 (ends), not uniform across all units. Although no concurrent bypass sampling occurred during the first entrainment sampling events, it was noted that "entrainment rates were relatively high during the end of September." Additional modifications have occurred over time without quantitative evaluation to improve downstream passage attraction and use to the bypass sluice, including lighting systems.

The 1994 Downstream Juvenile Shad Study report assessed juvenile shad survival from passage via the log sluice, reported to be 98%, based on tagged and recaptured fish (held for up to 48 hours). Scale loss (<20%) (22 of treatment fish) compared with scale loss of >20% (5 of treatment fish) was examined and determined to occur in an overall total of 10% of study fish (adjusted by control fish data).

Nexus to Project
Adult American shad passed upstream of Turners Falls Dam utilize upstream spawning habitat. Juvenile American shad production occurs in these habitats upstream of Turners Falls Dam on an annual basis. Juvenile American shad require safe and timely downstream passage measures to have the opportunity to contribute to the fishery agencies' target restoration population size.

The Division is not aware of any studies being conducted specifically designed to determine:

- When spill gates are open at the Turners Falls Dam?;
- What proportion of juvenile outmigrant shad take that route of passage?;
- What is the rate of survival under a range of spill and gate configurations?
- What is the timing, duration, and magnitude of juvenile shad outmigrants in summer and fall to the Turners Falls Dam and Gatehouse?
- Are there delays in migration/movement at the dam, Gatehouse, Cabot Station, or Station 1?
- For juveniles that enter the power canal, what proportion subsequently enter the Station 1 power canal?
- As there is no downstream passage facilities at Station #1, and trash rack spacing is 2.6 inches, what is the survival rate of juvenile shad entrained at Station #1?
- What is the rate of movement through the Turners Power Canal, relative to r delay to outmigrant juvenile shad and the potential accumulation of juveniles (e.g., prior to the canal drawdown in September)?
- What proportion of juvenile shad use the downstream sluice bypass versus the Cabot Station turbines under varied operational conditions given that project operations may change (PAD notes possible increase in turbine capacity at Cabot)?
- Based upon earlier facility studies (1991 Downstream Clupeid) a large proportion and number of juvenile shad are entrained into Cabot Station turbines. What are the associated impacts in terms of short-term and longer term survival and injury (i.e., scale loss)?

The Division is concerned that project operations may impact juvenile shad outmigration survival and be contributing to the failure of the Connecticut River shad population to meet management targets. In the PAD, proposed modification include; Station 1 may be upgraded with new turbines, Station 1 may be closed, and/or the turbine capacity at Cabot may be increased. It is unclear how these scenarios will affect the questions identified in this request.

Methodology Consistent with Accepted Practice
The impact to juvenile shad outmigrants by project operations would be best studied by a combination of approaches including hydroacoustic, radio telemetry, and turbine balloon tags. Project discharge over a full range of existing and, to the extent possible, potential future operational conditions at Station 1 and Cabot, at the dam (likely increased bypass reach flows in new license) and in relation to the Gatehouse, should be examined relative to timing, duration, and magnitude of juvenile shad migration to and through these areas, with hydroacoustic

equipment for natural/wild fish evaluation. In addition, study fish should be collected and tagged (PIT, radio, other mark, and balloon) to also empirically determine rates of survival for fish passed over or through the dam's gates, under varied operations, including up to full spill condition that occurs annually in fall with canal outage period. The understanding of the timing, magnitude, duration of the wild fish outmigration will help inform the design, data/results, and assessment of tagged study fish. The release of tagged or marked fish (radio, PIT) upstream of the Gatehouse induction into the power canal, will provide data on concerns of delay and route selection to Station 1, Cabot Station downstream bypass, Cabot Station spill gates, and Cabot Station turbines. Additional hydroacoustic assessment at Cabot Station forebay will provide information on wild/natural juvenile fish timing, magnitude, and duration to and through this area. Based upon Year 1 study findings relative to the frequency, magnitude, timing of juvenile American shad that end up in the forebay of Station 1, the determination of whether an entrainment survival study at that site is necessary will be made. Release sites for tagged fish will be determined based upon further consultation among the parties.

Radio tagged juvenile shad will be released in areas upstream of the NMPS facility at multiple release locations, to determine operation effects on migration rates, route, orientation, entrainment, and survival, over a full range of permitted and operational conditions.

Level of Effort/Cost, and Why Alternative Studies will not suffice
First Light does not propose any studies to meet this need. Estimated cost for the study is expected to be high, between $200,000 and $300,000, with the majority of costs associated with equipment (hydroacoustic gear, radio tags, radio receivers, and PIT readers) and related fieldwork labor.

Literature Cited:

Atlantic States Marine Fisheries Commission. 2010. Amendment #3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management). Washington, D.C.

CRASC (Connecticut River Atlantic Salmon Commission). 1992. A management plan for American shad in the Connecticut River basin. Sunderland, MA

Crecco, V. A. and T. F. Savoy. 1984. Effects of fluctuations in hydrographic conditions on year-class strength of American shad (Alosa sapidissima) in the Connecticut River. Canadian Jounral of Fisheries and Aquatic Sciences 41: 1216-1223.

Layzer, J.B. 1974. Spawning Sites and Behavior of American Shad, *Alosa sapidissima* (Wilson), in the Connecticut River Between Holyoke and Turners Falls, Massachusetts, 1972. Master of Science Thesis. University of Massachusetts, Amherst, Massachusetts. Pp. 22- 32.

O'Donnell, M and B. H. Letcher. 2008. Size and age distributions of juvenile Connecticut River American shad above Hadley Falls: influence on outmigration representation and timing. River Research Applications #24: 929-940.

O'Leary, J. A. and B. Kynard. 1986. Behavior, length, and sex ration of seaward-migrating juvenile American shad and blueback herring in the Connecticut River. Transactions of the American Fisheries Society 115: 529-536

Ross, R. M., T. W. Backman, and R. M. Bennett. 1993. Evaluation of habitat suitability index models for riverine life stages of American shad, with proposed models for premigratory juveniles. Biological Report 14. U. S. DOI, U. S. Fish and Wildlife Service. Washington, D.C.

Zydlewski, J., S. D. McCormick, and J. G. Kunkel. 2003. Late migration and seawater entry is physiological disadvantageous for American shad juveniles. Journal of Fish Biology #63, 1521-1537.

Requested Study No. 7.
Upstream American Eel Passage Assessment at Turners Falls

Goals and Objectives

This study has two objectives:

- Conduct systematic surveys of eel presence/abundance at Cabot Station discharge, Station #1 discharge, canal discharges, and Turners Falls Dam to identify areas of concentration of eels staging in pools or attempting to ascend wetted structures that would potentially establish the most effective locations to place upstream eel passage facilities.
- Collect eels with temporary trap/pass devices from areas identified from surveys as potential locations of eel concentration to assess whether eels can be collected/passed in substantial numbers, and whether locations are viable sites for permanent eel trap/pass structures.

Resource Management Goals

The Atlantic States Marine Fisheries Commission has developed two documents related to the management of American eel:

- Interstate Fishery Management Plan for American Eel. April 2000. Atlantic States Marine Fisheries Commission.
- Addendum II to the Fishery Management Plan for American Eel. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

In addition, the Connecticut River Atlantic Salmon Commission (CRASC) developed *A Management Plan for American Eel (Anguilla rostrata) in the Connecticut River Basin* in 2005. The goal of the plan is "to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem…" Management objectives in the plan include the following:

- Protect and enhance eel populations where they currently exist;
- Where practical, restore populations to waters where they had historical abundance;
- Provide effective upstream and downstream fish passage around dams and other barriers within the species' range in the basin; and
- Comply with all requirements of the Fishery Management Plan of the ASMFC.

Based on these plans, the Division seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

- Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
- Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to upstream passage of American eel, the Division's goals are:

- Minimize current and potential negative project operation effects that could hinder management goals and objectives.
- Minimize project-related sources of upstream passage delay, injury, and stress in order to facilitate access to historical rearing habitat.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq*.).

Public Interest

The requester is a resource agency.

Existing Information

The PAD contains no information relative to areas where eels seeking to move upstream concentrate downstream of the dam, or annual numbers of eels attempting to ascend past Turners Falls Dam. While eels have been known to ascend the Cabot Station ladder (A. Haro, U.S. Geological Survey, pers. comm.), its efficiency is unknown, and it is only operated during the American shad passage season (from April 1 through July 15). Eels are currently able to pass the Turners Falls Dam complex (as evidenced by documented presence of eels upstream), but the total number of eels attempting to pass Turners Falls and the proportion successfully passing the project is unknown (but suspected to be low). The downstream Holyoke Project has operated upstream eel passage facilities since 2004. Last year these facilities passed over 40,000 juvenile eels. While there is rearing habitat in between the Holyoke and Turners Falls dams, some eels will attempt to continue upstream, and passage needs to be provided so these fish can access historical habitat.

These information gaps need to be filled so resource agencies can determine the best locations to site upstream eel passage facilities and assess whether operating the existing anadromous ladders would be an effective mechanism to move juvenile eels upstream past the project.

We also note that within the past seven years, the U.S. Fish and Wildlife Service (Service) has received two petitions to list the American eel under the Endangered Species Act. The first petition was received on November 18, 2004. On July 6, 2005 the Service issued a substantial 90-day finding on the petition and initiated a 12-month status review that concluded on February 2, 2007 with a finding that listing was not warranted. The second petition was filed on April 30, 2010 by the Council for Endangered Species Act Reliability (CESAR). On September 29, 2011 the Service issued a substantial 90-day finding and initiated a 12-month status review. The Service is still accepting new American eel information for the ongoing status review. The Service also is currently in settlement negotiations with CESAR on their legal complaint that the Service failed to complete the 12-month finding within the statutory timeframe. Although the date for completion of the Service's 12-month finding on the latest petition is uncertain, it is likely that it will be made before any new licenses are issued for the projects.

Nexus to Project

The project generates hydropower on the head created by the Turners Falls dam. This dam creates a barrier to upstream migrating eels. While some eels are able to pass dams, some are not, and the passability of a given dam depends on factors such as its height, hydraulics, presence of climbable surfaces, presence of predators, risk of exposure to heat or drying while climbing a dam, etc. The Turners Falls dam is high (35 feet above bedrock), and the majority of the dam face is dry during most of the upstream eel passage season. Design of the dam is not currently amenable to passage of eels by climbing. While flow is released to the bypass reach via a bascule gate (typically the one closest to the gatehouse), this would not facilitate eel passage, as bascule gates open outward and downward (i.e., requiring the eels to essentially swim nearly upside down to get over the gate). As mentioned earlier, the existing anadromous passage facilities are not designed to pass eels, and even if some eels are able to ascend the ladders, they may incur delays (in attraction or passage rates), be size-selective (e.g. velocity barrier for small eels presented by ~8 ft/sec flow through weirs and orifices), present a potential predation risk (predators in or near the fishways), and are not operated throughout the upstream eel passage season.

Methodology Consistent with Accepted Practice

- <u>Objective 1: Systematic Surveys</u>
  Surveys of eel presence and relative abundance should be conducted at regular intervals throughout the eel upstream migratory season (~1 May to ~15 October, or when river temperatures exceed 10 C). Surveys should consist of visual inspection and trapping in likely areas where eels may concentrate as they attempt to climb structures wetted by significant spill or leakage flow in the Turners Falls dam complex area. These locations include: Cabot Station downstream bypass outfall, Cabot Station spillway (including attraction water stilling basin), Cabot Fishway (dewatered state), USGS Conte Lab flume outfall, Number One Station outfall, various small turbine and process water outfalls from the Cabot Canal, Spillway Fishway attraction water stilling basin, and leakage points along the downstream face of Turners Falls Dam (bascule and taintor gates). Methods should include visual surveys (on foot, from a boat, or snorkeling) and trapping using small mesh (< 1/8” clear opening) baited eel pots. Visual surveys should be performed

once per week, at night, preferentially during precipitation events. Trap sets should be performed once per week, with an overnight soak time. Recorded data should include location, observation of eels (presence, absence, relative numbers, relative sizes, behaviors, time/date of observation), and survey method.

- Objective 2: Trap/Pass Collections
  Areas identified from Systematic Surveys as having significant number of eels present should be targeted as potential areas for permanent eel trap/passes, and should be initially assessed using temporary/portable trap passes. At a minimum (regardless of survey results), temporary trap passes should be installed at the following locations: Cabot Fishway attraction flow stilling basin (during dewatered fishway period), Number One Station outfall, and Spillway Fishway attraction flow stilling basin (during watered and dewatered fishway period), as these locations may be supplemented with additional attraction flow and have high potential for being concentration points for upstream migrant eels. Temporary trap/passes should be purpose-designed and built for each location, and operated throughout the eel upstream migratory season (~1May to 15 October, or when river temperatures exceed 10 C). Ramp-type traps with supplementary attraction flow are preferred temporary trap/pass designs. Traps should operate daily, with catches quantified every 2-3 days. Recorded data should include location, trapping interval, absolute numbers of eels trapped, relative eel sizes, and hydraulic and environmental conditions during the trapping period.

All collected eels from surveys should be released at their point of capture; those eels collected from trap/pass collections should be transported to and released above the dam in the Turners Falls Pool.

These methodologies are consistent with accepted practice.

Level of Effort/Cost, and Why Alternative Studies will not suffice

The level of cost and effort for the survey component of the study would be low; a minimal number of personnel may be able to conduct the weekly surveys. The trap/pass component would require low to moderate cost (estimated at $40,000) and effort.

In the PAD, the applicant has identified the need to assess issues related to upstream passage for American eels at the project, but indicates that it intends to rely on information from previously conducted studies and ongoing studies. The Division is not aware of any previously conducted or ongoing studies related to upstream eel passage.

Literature Cited:

Atlantic States Marine Fisheries Commission. 2008. Addendum II to the Fishery Management Plan for American Eel. Approved October 23, 2008.

Atlantic States Marine Fisheries Commission. 2000. Interstate Fishery Management Plan for American Eel. Fishery Management Report No. 36 of the ASMFC. April 2000.

CRASC (Connecticut River Atlantic Salmon Commission). 2005. A management plan for American eel in the Connecticut River basin. Sunderland, MA.

Requested Study No. 8.
Downstream American Eel Passage Assessment at Turners Falls and Northfield Mountain

Goals and Objectives

The goal of this study is to determine the impact of two hydroelectric projects on the outmigration of silver eels in the Connecticut River. Entrainment of eels at the Northfield Mountain Pumped Storage Station (NFMPS) removes eels from the river, effectively removing them from the population. Entrainment into the turbines at Station 1 and Cabot Station of the Turners Falls Project may result in mortality or injury. It is important to understand the passage routes at each project and the potential for mortality to assess alternative management options to increase survival.

The objectives of this study are:

- Quantify the movement rates (including delays) and relative proportion of eels passing via various routes at the projects; i.e. for NFMPS, the proportion entrained into the intake; for Turners Falls Dam, the proportion entrained into the power canal and spilled via bascule and taintor gates; for the Cabot Canal, proportion of fish passing via spillways, turbines, and the downstream bypass.
- Evaluate instantaneous and latent mortality and injury of eels passed via the Turners Falls Dam routes, including bascule and taintor gates, spillways, turbines, and the downstream bypass.

Resource Management Goals

The Atlantic States Marine Fisheries Commission has developed two documents related to the management of American eel:

- <u>Interstate Fishery Management Plan for American Eel</u>. April 2000. Atlantic States Marine Fisheries Commission.
- <u>Addendum II to the Fishery Management Plan for American Eel</u>. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

Objectives of the management plan include: (1) protect and enhance American eel abundance in all watershed where eel now occur; and (2) where practical, restore American eel to those waters where they had historical abundance but may now be absent by providing access to inland waters for glass eel, elvers, and yellow eel and adequate escapement to the ocean for pre-spawning adult eel.

Addendum II contains specific recommendations for improving upstream and downstream passage of American eel, including requesting that member states and jurisdictions seek special consideration for American eel in the FERC relicensing process.

In addition, the Connecticut River Atlantic Salmon Commission (CRASC) developed *A Management Plan for American Eel (Anguilla rostrata) in the Connecticut River Basin* in 2005. The goal of the plan is "to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem…" Management objectives in the plan include the following:

- Protect and enhance eel populations where they currently exist;
- Where practical, restore populations to waters where they had historical abundance;
- Provide effective upstream and downstream fish passage around dams and other barriers within the species' range in the basin; and
- Comply with all requirements of the Fishery Management Plan of the ASMFC.

Based on these plans, the Division seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

- Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
- Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to downstream passage of American eel, the Division's goals are:

- Minimize current and potential negative project operation effects that could hinder management goals and objectives.
- Minimize project-related sources of downstream passage delay, injury, stress, and mortality in order to maximize the number of silver eels migrating to the spawning grounds.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq*.).

Public Interest

The requester is a resource agency.

Existing Information

The PAD contains information on the biology, life history, and regulatory status of American eel. It also discusses 2-D and 3-D telemetry studies that were conducted at Cabot Station in 1996, 1997, 2002 and 2003. Results of those studies indicate that a significant proportion of eels entering the Cabot forebay become entrained (90% in 2002, 100% in 2003; Brown 2005, Brown *et al*. 2009). The PAD notes that the study done in 2003 determined that 15 of the 29 test eels were detected at the Hadley Falls Station. However, that study was not designed to assess turbine mortality.

To date, no directed studies of eel mortality at Cabot Station or eel entrainment or mortality at either Station 1 or the NFMPS facility have been conducted. These information gaps need to be filled so resource agencies can assess the relative and cumulative impact of project operations on outmigrating eels and develop adequate passage and protection measures to meet management goals and objectives.

We also note that within the past seven years, the U.S. Fish and Wildlife Service (Service) has received two petitions to list the American eel under the Endangered Species Act. The first petition was received on November 18, 2004. On July 6, 2005 the Service issued a substantial 90-day finding on the petition and initiated a 12-month status review that concluded on February 2, 2007 with a finding that listing was not warranted. The second petition was filed on April 30, 2010 by the Council for Endangered Species Act Reliability (CESAR). On September 29, 2011 the Service issued a substantial 90-day finding and initiated a 12-month status review. The Service is still accepting new American eel information for the ongoing status review. The Service also is currently in settlement negotiations with CESAR on their legal complaint that the Service failed to complete the 12-month finding within the statutory timeframe. Although the date for completion of the Service's 12-month finding on the latest petition is uncertain, it is likely that it will be made prior to any new licenses are issued for the projects.

Nexus to Project

The Turners Falls Project operates as a peaking facility, except during periods when inflow exceeds the hydraulic capacity of Cabot Station and Station 1. Silver eels outmigrate during the mid- summer through late fall, a time of year when flows are generally near the maximum operating capacity of the stations. Therefore, the project would be expected to spill infrequently during the silver eel outmigration beyond the nominal amount required in the bypass reach.

Racks at Cabot Station, Station 1, and NFMPS facility are not designed to protect eels from entrainment. At Cabot, the racks have one-inch clear spacing on the top 11-feet, with five-inch clear spacing on the bottom 20 feet of racks. The approach velocity at the racks is approximately 2.0 feet per second at maximum hydraulic capacity. At Station 1, the racks have 2.6-inch clear spacing and an approach velocity of 1.2 feet per second. Eels can readily pass through a 2.6-inch clear space. NFMPS has 48-foot-deep trashracks with six-inch clear spacing over the intake and an approach velocity of 3.5 feet per second at full pumping capacity (15,000 cfs).

As mentioned above, previous studies conducted at Cabot Station documented eel entrainment. Cabot Station has existing downstream passage facilities designed for anadromous species, but studies have documented few eels utilizing the surface bypass (likely because Cabot has a relatively deep, wide intake area). Station 1 has no passage and protection facilities. NFMPS has a seasonally-deployed barrier net to minimize entrainment of Atlantic salmon smolts, but it is only operated from April through June 15 annually. While no studies have been conducted at Station 1 or NFMPS facility, the rack spacing is wide enough to allow for entrainment.

Methodology Consistent with Accepted Practice

In order to understand the movements of outmigrating silver eels as they relate to operations at the Northfield Mountain Pump Storage Facility, Station 1, and Cabot Station, radio telemetry technology should be utilized. Radio telemetry is an accepted technology that has been used for a number of studies associated with hydropower projects, including at the Muddy Run Project (FERC No. 2355).

Studies should be designed to investigate route selection (i.e., entrainment vs. spill) independently from estimation of mortality/injury, because these metrics require different telemetric methodologies. Studies also will likely benefit from data from several seasons (especially route selection studies, which may be more significantly affected by environmental conditions during a given season that mortality/injury studies). It is also envisioned that results from route selection studies can guide design of turbine mortality studies. Therefore, it is proposed, at a minimum, that route selection studies be conducted in multiple years, but mortality/injury studies may be conducted after the first year of route selection studies have been completed.

- Objective 1: Route Selection

  This study will involve systematic releases of radio-tagged silver phase eels at strategic points above areas of interest, to assess general routes of passage (i.e., via spill, bypass, or turbines). Active downstream migrants should be collected within-basin if possible (i.e., Cabot or Holyoke bypass samplers), but fish sourced from out of basin may be acceptable to meet sample size demands. Experimental fish must meet morphometric (e.g. eye diameter relative to body size) criteria to ensure they are migrant silver phase. Collections should be made within the migratory season (late Aug to mid Oct), and eels should be tagged and released within 7 days of collection.

  - NFMPS Route Selection Study:
    A minimum number of 50 telemetered eels (e.g., 5 separate groups of approximately 10 eels each) will be required to maximize the data return. Eels will be released at least 5 km upstream of the NFMPS project; releases should be timed so that there is a significant probability that migrating eels will encounter NFMPS during the pumping stage. Radio telemetry antennas will be strategically placed to determine times eels are present within the river reach in the vicinity of the NFMPS intakes, within the intakes themselves, and whether they are entrained into the upper reservoir.

  - Turners Falls Dam Route Selection Study:
    A minimum number of 50 telemetered eels (e.g., 5 separate groups of approximately 10 eels each) will be required to maximize the data return. Groups of eels should be released during spill and non-spill periods if possible. Tagged eels will be released at least 3 km upstream of the Turners Falls dam but several km below the intake to NFMPS. Telemetry receivers and antennas will be located above and below the dam to assess passage via the following potential routes: entrainment into power canal; passage via spill over the bascule gates; passage via spill through the taintor gates.

    Eels from the NFMPS route study not entrained into the NFMPS intake and migrating to the Turners Falls Dam may be used to supplement (but not serve in lieu of) these release groups.

  - Turners Falls Project – Canal Route Selection Study:
    A minimum number of 50 telemetered eels (e.g., 5 separate groups of approximately 10 eels each) will be required to maximize the data return. Groups of eels should be released during periods of low, moderate, and high generation conditions if possible. Eels will be released in the upper canal (ideally just downstream of the Gatehouse), and allowed to volitionally descend through the canal. Telemetry receivers and antennas will be located within the canal, bypass, channel, and mainstem below Cabot Station to assess passage via the following potential routes: Spillway Fishway attraction water intake

(if operational); Station 1 turbines; Cabot Station spillway; Cabot Station bypass; Cabot Station turbines

Eels from the NFMPS and Turners Falls Dam Route Studies not entrained into the NFMPS intake and migrating into the Turners Falls Canal may be used to supplement (but not serve in lieu of) these release groups.

Mobile tracking (i.e., via boat) in river reaches between release sites and several km downstream of Cabot Station will be performed at regular intervals during and after releases to confirm routes and fates of passed fish, or fish lost to follow-up.

Movement rates (time between release and passage) of eels passing the projects by various routes will also be quantified.

The route selection portion of this study should occur in both study years.

- Objective 2: Spill, Bypass, and Turbine Mortality/Injury Studies

  Spill, bypass, and turbine mortality will be assessed using a radio-telemetric balloon tag method. A minimum number of 50 tagged eels (e.g., 5 separate groups of approximately 10 eels each) will be required at each location (dam bascule gate, dam taintor gate, Cabot Station spillway, Cabot Station bypass, Station 1 and Cabot Station) to maximize the data return. Turbine mortality studies are not required at NFMPS because it is assumed that all entrained fish (including eels) are lost to the Connecticut River system.

  For spill mortality sites (dam bascule gate, dam taintor gate, Cabot spillway, Cabot Station bypass), tagged eels will be injected or released into spill flow at points where water velocity exceeds 10 ft/sec, to minimize the possibility of eels swimming upstream into the headpond or canal. Passed balloon-tagged eels will be recovered below areas of spill and held for 48 hours in isolated tanks for observation of injury and latent mortality; unrecovered balloon-tagged eels will be censored from the data.

  For turbine mortality sites (Station 1 and Cabot Station), tagged eels will be injected into intakes of units operating at or near full generation at points where intake water velocity exceeds 10 ft/sec, to minimize the possibility of eels swimming back upstream through the intakes. Passed balloon-tagged eels will be recovered in the tailrace and held for 48 hours in isolated tanks for observation of injury and latent mortality; unrecovered balloon-tagged eels will be censored from the data.

  Mobile tracking (i.e., via boat) in river reaches between release sites and several km downstream of Cabot Station will be performed at regular intervals after releases to confirm routes and fates of passed fish, or fish lost to follow-up.

  The turbine mortality component of the study should occur in Study Year 2.

Data analyses of route selection and turbine mortality (instantaneous and latent) will follow standard methodology.

Project operation (flows, levels, gate openings, number of units operating and operation level) and environmental conditions (river flow, temperature, turbidity, air temperature, precipitation) will be monitored regularly (hourly measurements if possible) throughout the duration of the studies.

These methodologies are consistent with accepted practice.

Level of Effort/Cost, and Why Alternative Studies will not suffice

The level of cost and effort for the downstream eel passage study would be moderate to high; silver eels would need to be collected, tagged, and released in several locations over the course of the migration season. Antennas and receivers would need to be installed at the intakes to all stations as well as at the Turners Falls dam spillway and Cabot Station bypass, and monitored regularly. Data would need to be retrieved periodically, then analyzed. A multi-site route selection study conducted by the USGS Conte Lab on the Shetucket River in Connecticut cost approximately $75,000 for the first year of study. Cost are estimated at $100,000 per year for the Route Selection studies and $75,000 per year for the Spill, Bypass, and Turbine Mortality/Injury Studies.

In the PAD, the applicant has identified the need to assess issues related to downstream passage for American eels at the project, but indicates that it intends to rely on information from previously conducted studies and ongoing studies. The Division is not aware of any previously conducted or ongoing studies related to downstream eel passage.

Literature Cited

Atlantic States Marine Fisheries Commission. 2008. Addendum II to the Fishery Management Plan for American Eel. Approved October 23, 2008.

Atlantic States Marine Fisheries Commission. 2000. Interstate Fishery Management Plan for American Eel. Fishery Management Report No. 36 of the ASMFC. April 2000.

Brown, L.S. 2005. Characterizing the downstream passage behavior of silver phase American eels at a small hydroelectric facility. M.Sc. Thesis, Department of Natural Resource Conservation, University of Massachusetts, Amherst, Massachusetts. 110 pp.

Brown, L., A. Haro, and T. Castro-Santos. 2009. Three-dimensional movement of silver-phase American eels in the forebay of a small hydroelectric facility. Pages 277-291in: J. Casselman et al. editors. Eels at the Edge: Science, Status, and Conservation Concerns. American Fisheries Society, Bethesda, MD.

CRASC (Connecticut River Atlantic Salmon Commission). 2005. A management plan for American eel in the Connecticut River basin. Sunderland, MA.

EPRI (Electric Power Research Institute). 2001. Review and documentation of research and technologies on passage and protection of downstream migrating catadromous eels at hydroelectric facilities. EPRI Technical Report No. 1000730, Palo Alto, California 270 pp.

Requested Study No. 9.
Evaluation of Timing of Downstream Migratory Movements of American Eels on the Mainstem Connecticut River

Goals and Objectives

The goal of this study is to better understand migration timing of adult, silver-phase American eels as it relates to environmental factors and operations of mainstem hydropower projects on the Connecticut River.

The objectives of this study are:

- Quantify and characterize the general migratory timing and presence of adult, silver-phase American eels in the Connecticut River relative to environmental factors and operations of mainstem river hydroelectric projects

Resource Management Goals

The Atlantic States Marine Fisheries Commission has developed two documents related to the management of American eel:

- Interstate Fishery Management Plan for American Eel. April 2000. Atlantic States Marine Fisheries Commission.
- Addendum II to the Fishery Management Plan for American Eel. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

Objectives of the management plan include: (1) protect and enhance American eel abundance in all watershed where eel now occur; and (2) where practical, restore American eel to those waters where they had historical abundance but may now be absent by providing access to inland waters for glass eel, elvers, and yellow eel and adequate escapement to the ocean for pre-spawning adult eel.

Addendum II contains specific recommendations for improving upstream and downstream passage of American eel, including requesting that member states and jurisdictions seek special consideration for American eel in the FERC relicensing process.

In addition, the Connecticut River Atlantic Salmon Commission (CRASC) developed *A Management Plan for American Eel (Anguilla rostrata) in the Connecticut River Basin* in 2005. The goal of the plan is “to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem…” Management objectives in the plan include the following:

- Protect and enhance eel populations where they currently exist;
- Where practical, restore populations to waters where they had historical abundance;
- Provide effective upstream and downstream fish passage around dams and other barriers within the species’ range in the basin; and
- Comply with all requirements of the Fishery Management Plan of the ASMFC.

Based on these plans, the Division seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

- Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
- Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to downstream passage of American eel, the Division’s goals are:

- Minimize current and potential negative project operation effects that could hinder management goals and objectives.
- Minimize project-related sources of downstream passage delay, injury, stress, and mortality in order to maximize the number of silver eels migrating to the spawning grounds.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq*.).

Public Interest
The requester is a resource agency.

Existing Information
Data on timing of downstream migratory movements and rates of American eels in the mainstem Connecticut River are sparse and relatively incomplete. Preliminary data on presence of "eel-sized" acoustic targets have been collected (Haro et al. 1998) within the Turners Falls Project's Cabot Station forebay that were somewhat confirmed by video monitoring at the Cabot Station downstream fish bypass; however, these were short-term studies, with acoustic monitoring only performed from 17 September to 5 October and video monitoring only conducted between 18 September to 22 October.

Some daily monitoring of the downstream bypass at the Holyoke Dam (canal louver array) was performed in 2004 and 2005 (Kleinschmidt, Inc. 2005, 2006, Normandeau Associates 2007); these studies also were of relatively short duration (spanning from October 5 to November 10 in 2004 and September 9 to November 11 in 2005) and the sampler was only operated at night.

To date, no other directed studies of eel migratory movements have been conducted at any location on the Connecticut River mainstem. This information gap needs to be filled, as it relates directly to when downstream passage and protection measures need to be operated.

We also note that within the past seven years, the U.S. Fish and Wildlife Service (Service) has received two petitions to list the American eel under the Endangered Species Act. The first petition was received on November 18, 2004. On July 6, 2005 the Service issued a substantial 90-day finding on the petition and initiated a 12-month status review that concluded on February 2, 2007 with a finding that listing was not warranted. The second petition was filed on April 30, 2010 by the Council for Endangered Species Act Reliability. On September 29, 2011 the Service issued a substantial 90-day finding and initiated a 12-month status review. The Service is still accepting new American eel information for the ongoing status review. The Service also is currently in settlement negotiations with CESAR on their legal complaint that the Service failed to complete the 12-month finding within the statutory timeframe. Although the date for completion of the Service's 12-month finding on the latest petition is uncertain, it is likely that it will be made before any new licenses are issued for the projects.

Nexus to Project
The timing of downstream migration of adult eels is poorly defined for the Connecticut River; therefore the general effects of hydroelectric project operations on eel survival to the ocean are unknown. Although separate study requests have been submitted to address project-specific downstream passage route selection, delays, and mortality of eels, general characteristics of river flow and environmental conditions may have significant relationships with project operation and eel migratory success and survival. For example, eels may tend to move immediately before or during periods of significant precipitation (or consequently river flow); times at which projects may be generating at maximum capacity or spilling, which may (or may not) present a higher passage risk to eels. Conversely, periods of low flow may be associated with a significant proportion of total river flow passing through turbine units, which present additional (or different) passage risk to eels. If discrete conditions which promote eel downstream migration are known, it may be possible to take actions with respect to project operations which reduce or minimize passage risk; i.e., operation of a bypass, reduction of intake approach velocities, directed spillage through a "safe" route, etc. These studies should provide baseline information on river-specific downstream migration to predict when silver-phase eels are expected to be migrating in the mainstem Connecticut River, from which project operations could be modified to minimize passage risks.

The studies are proposed for a single or multiple sites; the results will be relevant to all sites on the Connecticut River mainstem.

Methodology Consistent with Accepted Practice
Quantification of downstream movements of American eels in river systems requires systematic sampling of migrants throughout the migratory season. This can be accomplished with traditional active trapping methods; i.e., fyke or stow net sampling, weirs, or eel racks, but these methods are technically challenging on larger mainstem rivers, due to the scale of flows that need to be sampled, difficulties in operation throughout all flow conditions, and high debris loading during fall flows. Passive monitoring of migrant eels using hydroacoustic methods offers an alternative to active trapping. However, passive monitoring requires verification of potential acoustic targets with some level of active (collection) or visual (traditional optical or acoustic video) sampling.

Two potential locations offer opportunities to conduct simultaneous passive and active sampling: the Cabot Station (Turners Falls project) canal/forebay and the Holyoke Dam forebay and canal louver/bypass system. Each location possesses a route of downstream passage which conducts a significant proportion of river flow (Cabot canal and Holyoke forebay or canal), and each has a proximal bypass equipped with a sampler so that fish can be concentrated/collected from the passage route and identified to species. Project operations do influence the relative proportion of flow (and thus numbers of downstream migrant eels) in each passage route, so numbers of eels sampled in each route represent only a proportion of the total number of eels migrating downstream within the entire river. Because the absolute proportion of eels using a specific route at any one time is unknown, numbers of eels quantified within a route must serve as a relative index of the degree of migratory movement.

This study shall quantify eel movements in either one, or preferably both, locations for two consecutive years (since environmental conditions strongly influence migratory timing of eels, which can vary significantly from year to year; Haro 2003). Eels will be quantified using methods similar to Haro et al. (1999), by continuously monitoring a fixed location at the projects with hydroacoustics. Because eels tend to concentrate in areas of dominant flow (Brown et al. 2009, EPRI 2001), the zone to be monitored should pass a dominant proportion of project flow throughout most periods of operation (i.e., forebay intake area). Hydroacoustic monitoring shall encompass the entire potential migratory season, beginning in mid-August and ending in mid-December, and shall operate 24 hours per day. Data will be recorded for later processing and archiving.

Systematic active quantification of eels at downstream bypass samplers shall be performed simultaneously with passive hydroacoustic monitoring, to verify presence of eels and relative abundance of eel-sized hydroacoustic targets from the hydroacoustic data. Although daily operation of the bypass sampler could be performed, a more comprehensive technique is to monitor eels entering the bypass with an acoustic camera (i.e. DIDSON, BlueView, etc.). The acoustic camera will afford positive visual identification of eels as they enter the bypass, which is a concentration point for migrating eels. Acoustic camera monitoring will also allow monitoring to be performed 24 hours a day, and will be relatively unaffected by water turbidity (which influences effectiveness of traditional optical video monitoring). The acoustic camera system will be operated during the same time period as acoustic monitoring, and images will be recorded for later processing and archiving.

Data analyses of hydroacoustic, acoustic camera, bypass sampling, and environmental/ operational data will follow standard methodology.

Project operation (flows, levels, gate openings, number of units operating and operation level) and environmental conditions (river flow, temperature, turbidity, air temperature, precipitation) will be monitored regularly (hourly measurements if possible) throughout the duration of the studies.

These methodologies are consistent with accepted practice.

Level of Effort/Cost, and Why Alternative Studies will not suffice
The level of cost and effort for the downstream migrant eel migratory timing study would be moderate, given the level of cost for instrumentation, deployment, and data review/analysis. Cost is estimated at $50,000 per year for the study.

The applicant did not propose any studies to meet this need in the PAD.

Literature Cited

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Requested Study No. 10.
Three-dimensional Computational Fluid Dynamics (CFD) Modeling in the Vicinity of Fishway Entrances and Powerhouse Forebays

Goals and Objectives
The goal of this study is to determine the flow field conditions that exist in and around the fishway entrances, and upstream of both Turners Falls powerhouses (Station 1 and Cabot). The information from this request is meant to be coupled with data from telemetry studies such that a comprehensive understanding of fish behavior is developed.

The objective of this study is to develop a series color contour maps of velocity magnitude and direction at discharges that have been agreed upon by the resource agencies and the licensee. With respect to upstream passage, the results will show approach velocities and orientation within the approach zone of the fish that may create a response in fish. This information can be coupled with telemetry data (from the requested telemetry studies) and passage counts to understand which conditions are optimal for guiding migrating fish to the fishway entrances and for stimulating fishway entry.

With respect to downstream migration, the results will show velocities and orientations in front of each powerhouse. At Cabot Station, the results will indicate to what degree, if any, flow directs downstream migrating fish towards the surface bypass weir. At Station 1, we will have an improved understanding of the magnitude of velocity in front of the turbine intakes.

Resource Management Goals
The management goals of this study request are to obtain information that will help assist in designing effective upstream fishways for upstream migrating trust species and to reduce impingement, entrainment and delay for downstream migrating fish. CFD models are a relatively cost effective way to analyze existing and future conditions. As such, changes in the amount of attraction water, changes in which turbines are operating, and which spillway gates are releasing water can all be examined. As stated, the results from this study are meant to be used along with the data generated from the telemetry study. The combined analysis from these two data sources can help assess which flow conditions are most advantageous for migrating trust species to enter the fishway under current and proposed conditions.

As for downstream migration of adult and juvenile shad, and adult eel, the results from the models will reveal flow magnitude and direction in front of each powerhouse. Given the limited information that currently exists on survival through Cabot and Station 1, our management goal is to direct as many downstream migrating fish as possible towards the uniform acceleration weir and downstream bypass. With respect to upstream passage, we want to maximize the number of fish that find and enter the fishway entrances

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq*.).

Public Interest
The requester is a resource agency.

Existing Information and the Need for Additional Information
To date, no CFD modeled data exist in front of either fish ladder, nor do they exist in front of either powerhouse. Some preliminary modeling has been done downstream of the gatehouse, but changes to the gatehouse entrances would require updated modeling. It is our understanding that the licensee has worked with the firm Alden Research Laboratory, Inc., to develop a CFD model of the upper end of the power canal and that elevation survey data from the power canal also are available. Detailed two-dimensional movement data on shad are available from observations made between 2003 to 2005 and 2010 to 2012. By coupling and analyzing these two data sets, flow and fish movement, we believe this will have substantial benefits to our management efforts.

Nexus to Project

The Turners Fall Project has direct impacts to upstream and downstream migrating shad and eel.
When designing upstream passage structures, a site assessment is critical. The development of these models will give resource agencies valuable information into the hydraulic cues which may elicit a response from upstream migrants. For downstream passage, the U.S. Fish and Wildlife Service has approach velocity guidelines; the output from these models would inform the resource agencies under what conditions appropriate approach velocities are being met and when they are being exceeded

With respect to upstream migration, the auxiliary water system (AWS) plays a critical role in determining whether or not fish are attracted to the entrance. The results from this study would allow us to assess how well the AWS is performing and under what conditions it attracts the most fish.

With respect to downstream migration, the development of a CFD model under existing conditions also informs the design of future modifications and improves the survivability of downstream migrating shad and eel.

The CFD models for the spillway fishway and gatehouse fishway should be developed as part of year one studies and it would be preferable to have them completed prior to year one field studies in spring 2014. It would be useful to have the gatehouse area CFD modeling completed as soon as possible to begin comparing hydraulic conditions to the two-dimensional shad location data from prior studies. This analysis may provide information on adjustments to canal operations or structures that can subsequently be analyzed.

Understanding the entrance conditions of the spillway fishway under a range of spill conditions would be informative as we evaluate the spillway fishway entrances. If developed prior to the year one upstream shad telemetry studies, it would provide information on spill gate settings that would likely best achieve entrance and ultimately passage. Further work with the model after year one studies could evaluate changes in ladder entrance or spill conditions that could improve passage and be tested with year two telemetry, video and/or count data.

CFD modeling of the flows leading to the canal via the gatehouse and the Cabot Station and Number 1 Station forebays would have value in interpretation of year one downstream passage telemetry results, but would not need to be completed prior to the year one telemetry, downstream juvenile shad and downstream eel passage studies, as those studies will provide the context for how and where shad and eels are passing the project and how successful passage is. The CFD modeling could then be focused on the locations indicated as important based on the field studies and could assess changes to structures or operations that could be evaluated in the model. Promising alternatives could then be tested in year two studies.

Methodology Consistent with Accepted Practice

A three-dimensional CFD model has become an increasing common standard of analysis at hydro-electric projects around the nation. Within the northeast region, we have seen these types of models developed at the Holyoke (P-2004), Brunswick (P-2284), Shawmut (P-2322), Milford (P-2534) and Orono (P-2710) projects. We would expect to engage with the licensee in terms of determining the appropriate area and flows to be modeled. We expect that the spatial extent of the model at each study site will vary. Given the large number of ways that output from these models can be presented and the near infinite number of flows that could potentially be modeled, we would expect to consult with the licensee to reach agreed upon modeling efforts and scenarios to be examined.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

The cost of developing, running and testing a CFD model can vary tremendously; one large variable in determining the cost is based on the amount of existing bathymetric data to which the Applicant currently has access. We roughly estimate that the cost of each CFD model could run as high as $50,000, assuming no bathymetric data currently exist. Proactive communication with resource agencies will reduce the cost and iterative effort. Given the level of effort that has occurred at other projects that have proposed to amend their license, we see the level of effort requested here as reasonable, given that the Applicant is seeking a renewal of its license.

Requested Study No. 11.
Computational Fluid Dynamics (CFD) modeling of the Northfield Mountain Pumped Storage Project Intake/Tailrace Channel and Connecticut River Upstream and Downstream of the Intake/Tailrace.

Goals and Objectives
The goal of this study is to determine the potential impacts of the Northfield Mountain Pump Storage Project (NMPS) operations (pumping and generating) on: (1) the zone of passage for migratory fish near the turbine discharge/pump intake; (2) natural flow regimes in the area of the Connecticut River immediately upstream and downstream of the project; and (3) the potential for fish entrainment during pumping operations.

Specific objectives of the study include:

- Develop a CFD model of the NMPS intake and tailrace channel, along with the full width of the Connecticut River upstream and downstream of the discharge.
- Model flow characteristics upstream and downstream of the project under existing project operations (pumping and generating) and at several representative river flow levels, as well as proposed operations such as those proposed in section 3.4.4 of the PAD, and any other modifications under consideration, to assess potential impacts to fish and wildlife resources
- Assess velocities and flow fields at and in proximity to the NMPS intake/discharge structure when pumping or generating and their potential to interfere with fish migration, create undesirable attraction flows and result in fish entrainment.
- Assess the potential for velocity barriers in the mainstem river resulting from pumping and generation flows at the project, alone or in combination with generation flows from the upstream Vernon Project and operations at the Turners Falls Project.
- Assess the potential of a mainstem instream local flow reversal associated with pumping operations to impact migrating fish.
- Model and then evaluate flow characteristics under alternative project operations with potential measures to avoid, minimize, or mitigate impacts to fish and wildlife resources.

Resource Management Goals
The Division seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

- Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
- Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to aquatic resources, the Division's goals are:

- Protect, enhance, or restore, diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
- Provide an instream flow regime that meets the life history requirements of resident and migratory fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
- Minimize current and potential negative project operation effects on water quality and aquatic habitat.
- Avoid or minimize the current negative effect of project operations on shortnose sturgeon spawning and rearing at the Cabot Station spawning and rearing site.

Instream flow is an important riverine habitat characteristic that can have a great impact on aquatic habitat for fish, wildlife, and plants. Flow is an important directional guidance cue for instream navigation and attraction to fishway entrances for migratory fish.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq*.).

Public Interest
The requester is a resource agency.

Existing Information
No project specific information exists that will allow for a comprehensive assessment of existing project operations (pumping and generating flows) on Connecticut River flows and on fish and aquatic organisms in the project area upstream and downstream of the project in the Connecticut River. Preliminary results from an ongoing study of radio-tagged American shad by the USFWS and USGS Silvio O. Conte Anadromous Fish Research Center indicate that shad are exposed to the intakes and some individuals spend substantial amounts of time in the vicinity of the intakes. The PAD does not contain any information or tool that will allow for predictions of impacts of alternative project operations, or potential mitigation measures to protect or enhance aquatic fish and wildlife resources.

Nexus to Project Operations and Effects
Existing project operations have a direct impact on instream flow and aquatic habitat in the pump/discharge area of the Connecticut River. The PAD in section 3.2.2 says that the discharge at the trash racks when operating at full capacity is 20,000 cfs and maximum pumping conditions are 15,200 cfs. Annual flow duration curves shown for below the Vernon Dam submitted in the PAD section 4.3.1.2 (for years 1944-1973; recent and near project flows are not available; see p. 459) indicate that river flows are ≤ 20,000 cfs more than 85% of the time. Flows released from the project must therefore influence flow patterns and velocities in the Connecticut River, particularly at flows below some unknown threshold level.

Recreational users of the Connecticut River in the Turners Falls impoundment have anecdotally described flow reversals in the mainstem river. Discharges from the project could potentially be larger than river flows or at least act like a major tributary to the Connecticut River. Project flows may influence the availability and extent of upstream and downstream migration zones, or may confuse fish and delay migration.

Methodology Consistent with Accepted Practice

CFD modeling is consistent with generally accepted practice, and has been used to assess proposed modifications to the Holyoke Project (FERC No. 2004) fish passage facilities, upstream of the intakes and downstream of the dam, as well as at hydroelectric projects on the Susquehanna River to assess existing and proposed project operations, and develop mitigation measures for fish and wildlife resources.

A study plan that describes the specific modeling tools to be used, the amount of bathymetric data to be gathered, the geographic scope of the assessment and the flow conditions to be modeled will need to be developed in consultation with the Division and other parties.

Level of Effort/Cost, and Why Alternative Studies will not suffice
This study will require a detailed elevation map of the study area upstream and downstream of the NMPS intake structure. Some information already exists in historic construction files for the project and past hydraulic analyses. Additional bathymetric data likely will need to be collected in the field using standard survey techniques. The CFD computer program will need to simulate existing project operations as well as accommodate all potential variations of pumping and generating, and static operation.

No project-specific instream flow analysis tool has been developed for the NMPS that will allow for assessment of existing operations and alternative operational impacts on instream flow and aquatic habitat for fish and wildlife resources. The computer model, once built, can be used to simulate flow conditions in the vicinity of the project during migratory fish passage and can be used together with behavior studies (i.e., telemetry studies and entrainment studies requested herein) to assess the impacts of varying project operations or potential mitigation operations and measures on fish migration and aquatic habitat. We know of no other tool that will provide for these types of assessments. Cost is expected to be moderate to high.

Requested Study No. 12.
Entrainment of Migratory and Riverine Fish from the Connecticut River into the Northfield Mountain Pump Storage Project.

Goals and Objectives
The goal of the study is to determine the impact of Northfield Mountain Pump Storage Project (NFMPS) during the pumping cycle on entrainment of juvenile American shad, adult shad, adult American eel, and riverine fish, including early life stages.
The objective of the study is to quantify the number of resident and migratory fishes entrained at the NFMPS intake on an annual basis in order to evaluate potential impacts to riverine fish populations in the Turners Falls pool and diadormous fish migrants moving through the project area. This will be accomplished through a combination of hydroacoustic monitoring and netting using various gear types to quantify and identify species of different life stages.

Resource Management Goals
The Connecticut River Atlantic Salmon Commission (CRASC) developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following

- Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually. (Table 1)
- Achieve annual passage of 40 to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem.
- Maximize outmigrant survival for juvenile and spent adult shad.

Based on the CRASC plan, the Division seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

- Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
- Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

The Atlantic States Marine Fisheries Commission has developed two documents related to the management of American eel:

- Interstate Fishery Management Plan for American Eel. April 2000. Atlantic States Marine Fisheries Commission.
- Addendum II to the Fishery Management Plan for American Eel. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

Objectives of the management plan include: (1) protect and enhance American eel abundance in all watershed where eel now occur; and (2) where practical, restore American eel to those waters where they had historical abundance but may now be absent by providing access to inland waters for glass eel, elvers, and yellow eel and adequate escapement to the ocean for pre-spawning adult eel.

Addendum II contains specific recommendations for improving upstream and downstream passage of American eel, including requesting that member states and jurisdictions seek special consideration for American eel in the FERC relicensing process.

In addition, the Connecticut River Atlantic Salmon Commission (CRASC) developed *A Management Plan for American Eel (Anguilla rostrata) in the Connecticut River Basin* in 2005. The goal of the plan is “to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem…” Management objectives in the plan include the following:

- Protect and enhance eel populations where they currently exist;
- Where practical, restore populations to waters where they had historical abundance;

- Provide effective upstream and downstream fish passage around dams and other barriers within the species' range in the basin; and
- Comply with all requirements of the Fishery Management Plan of the ASMFC.

Specific to resident riverine and migratory fish entrainment, the Division's goals are:

- Minimize current and potential negative project operation effects such as turbine entrainment that could hinder management goals and objectives.
- Minimize project-related sources of mortality to resident and migratory fishes in order to restore natural food web interactions and ecosystem functions and values.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq*.).

Public Interest
The requestor is a fish and wildlife resource agency.

Existing Information
Limited project-specific information exists regarding entrainment of fish and aquatic organisms at the NFMPS. As part of a Memorandum of Agreement between then-owner Northeast Utilities Service Company (NUSCO) and regulatory agencies (including the Division), NUSCO conducted studies to determine the impact of NFMPS on anadromous fishes, including Atlantic salmon, American shad, and blueback herring. Results of a pilot study conducted in the fall of 1990 indicated that trap netting at the intake was ineffective at collecting fish. Gill netting and boat-shocking did result in collection of some juvenile shad, but further refinement in both methods was recommended to improve effectiveness. A total of 78 fish were collected at the intake (77 of which were American shad) by gill netting and 11 shad were collected by boat electrofishing. Hydoacoustic monitoring was deemed an effective method for monitoring entrained fish during pumpback operation. Hydroacoustic sampling over a two-week period (September 12-27, 1990) produced hourly entrainment estimates that cumulatively equaled 14,816 fish. Based on the results of the pilot study, NUSCO developed a two-year plan to quantitatively determine the number of shad and salmon entrained at NFMPS station. In 1992, an entrainment study targeting juvenile American shad life stages was conducted in the lower (mainstem river) and upper reservoirs of NMPS. The study used several gear types to quantify egg through juvenile shad densities in different areas. Entrained juveniles were sampled using an upper reservoir net. Pumping operations were modified to only run three (77% of sample time) and sometimes two (23% of sample time) of the station's four units during the study and effort was limited to a total of 80 hours over a period spanning 9 August through 27 October (80 days). An estimated total of 1,175,900 shad eggs, 2,744,000 yolk-sac larvae, 10,525,600 post yolk-sac larvae, and 37,260 juveniles were reported entrained.

There are no reliable data on the timing, magnitude and duration of entrainment of larval riverine fishes in the NFMPS area. Unlike anadromous shad and river herring, riverine species occurrence and susceptibility relative to space and time exposure windows to NFMPS pumping are undocumented. The complete lack of any long-term fish population monitoring data for riverine species in the Turners Falls impoundment leaves questions unanswered on the types and extent of impacts to these populations that may be linked to the near daily cycling of river water up and down through the NFMPS operations system. As a starting point, it is necessary to obtain baseline data on project operation impacts for all species potentially impacted by NFMPS. An additional study request seeks to obtain a more accurate documentation of all fish species inhabiting or utilizing the Turners Falls impoundment.

Nexus to Project Operations and Effects
Entrainment of fish and aquatic organisms associated with water withdrawal and hydroelectric operations has been documented to result in injury or death of entrained organisms. Migratory and resident fish pass through the project area directly in front of the pump intakes. These organisms may be entrained and thus exposed to passage though the project pumps and reservoir supply tubes. How far from the intake these species and life stages may be drawn into the intake on a pumping cycle or how susceptible they are to the repeated daily cycles of pumping and discharge, and how these factors vary in relation to habitat and river conditions are unknown. Survival of fish

subjected to entrainment on the pumping cycle is unknown, but regardless of whether fish survive the pumping process, they are lost to the Connecticut River system. Depending on the species, life stages, and numbers entrained, this loss could impact the ecosystem productivity of the Turners Falls pool and may hinder restoration goals for diadromous fishes.

Previous entrainment studies have been conducted at the project. Those studies, which were done 20 years ago, documented entrainment of American shad and Atlantic salmon at the project, including over 13 million yolk sac and post-yolk sac larvae of American shad. This level of entrainment is cause for concern, not only due to the resultant loss of potential adult returns, but for the important role early life history phases and juveniles play in their ecological contributions to the river system (e.g., trophic interactions).

No entrainment studies for other species of fish have been conducted at the project. The unknown extent of other riverine species ichthyoplankton entrained by the NFMPS requires evaluation. Studies conducted in 1969 and 1970 at the Muddy Run Pumped Storage Station documented significant entrainment of eggs and larval fish. In June and July of 1970, 5.3 million eggs and 56.6 million larvae were entrained (Snyder 1975). Muddy Run and NFMPS are of a similar size and both use a river as the lower reservoir. It is anticipated that a considerable number of eggs and larvae will be entrained by the NFMPS.

Since the previous studies were conducted, operations at the NFMPS facility have changed (e.g., the project increased the efficiency of its turbines, and raised the pumping capacity from 12,000 cfs up to 15,000 cfs), as have river conditions (e.g., Vermont Yankee has increased its thermal discharge and the Vernon Project has increased its station capacity). Further, the PAD indicates that FirstLight will evaluate the feasibility of utilizing an additional 3,009 acre-feet of storage capacity to generate an additional 1,990 MWhs (this represents a 23% increase over existing storage and stored generation levels). While not specified in the PAD, increasing storage and generation would mean longer periods of both pumping and generation at NFMPS. In addition, anticipated improvements in fish passage at the Turners Falls Project will result in increased juvenile production above the NFMPS. These factors, individually or cumulatively, could increase the potential for entrainment at NFMPS station.

Methodology Consistent with Accepted Practice

Previous studies used varying methodologies for determining entrainment. The 1990 study concluded that hydroacoustic monitoring at the intake was a viable method for determining entrainment of later life stages, but does not allow for identification of the species being entrained. While trap netting was ineffective at collecting fish near the intake, gill netting and boat shocking did capture some fish. Both may prove to be viable sampling methods; however it is likely that additional testing and gear refinement will be necessary.

The 1992 study used nets at the pump discharge location into the upper reservoir to collect entrained fish. Testing showed that this method was only 10% efficient. Plankton netting in the nearfield area of intake was used to estimate entrainment of ichthyofauna. It is likely that a combination of methods would provide the most reliable results (e.g., hydroacoustic monitoring at the racks during pumpback operations, variable gear sampling in the vicinity of the intake immediately prior to initiation of pumpback operations to determine species composition, and plankton netting in the nearfield area of the intake to obtain information on entrainment of ichthyofauna). As these methodologies have previously been utilized at the site, they are consistent with accepted practice.

Although a previous entrainment study was conducted, the Division believes it should be repeated, using a modified study design. The 1992 study only collected a total of 330 juvenile shad over a three-month period (resulting in an overall estimate of 37,260 juveniles entrained, after accounting for poor net efficiency); whereas the hydroacoustic study conducted in 1990 estimated nearly 15,000 fish in 15 days (while these fish were not identified, 77 of the 78 fish collected at the intake during the study were juvenile shad). It also should be noted that in the 1992 study, juvenile shad were collected on the first day of sampling, indicating that the sampling did not begin early enough, which would mean the results are an underestimate of the number of juvenile shad that were actually entrained. In 1990, 27,908 adult shad passed the Turners Falls gatehouse, while in 1992 over 60,000 shad passed gatehouse. The fact that the numbers entrained were so variable between study years argues for repeating the study, using a combination of previously-used methodologies.

The study will require deployment of at least five hydroacoustic transducers (one per rack face and one offshore). These transducers would be operated during every pumping cycle from April 15 through May 14 to assess riverine fish entrainment, from May 15 through July 15 for spent adult shad, and from July 16 through November 30 for entrainment of adult silver eels, juvenile American shad, and riverine fishes. Concurrent field sub-sampling at the intake to determine species composition would need to occur.

Sampling for planktonic fish larvae should capture early spring spawning species (white suckers) through later season centrarchid species (bass and sunfish). Active plankton trawl surveys should utilize a sampling design that adequately captures temporal and spatial changes in water pumping cycle (i.e., early start-up is local water, later cycle pumping is drawn in from both upstream and downstream habitat areas).

Level of Effort/Cost, and Why Alternative Studies will not suffice
We know of no other tool that will provide for this type of assessments for all fish species and organisms that may pass through the project. Cost and effort are expected to be high.
The applicant did not propose any studies to meet this need in the PAD.

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Requested Study No. 13.
Model River Flows and Water Levels Upstream and Downstream from the Turners Falls Project Dam Generating Stations and Integration of Project Modeling with Upstream and Downstream Project Operations

Goals and Objectives

Develop a river flow model(s) that are designed to evaluate the hydrologic changes to the river caused by the physical presence and operation of the Turners Falls Hydroelectric Project and the interrelationships between the operation of all five hydroelectric projects up for relicensing (i.e., P-1889 Turners Falls Hydroelectric Project, P-2485 Northfield Mountain Pumped Storage, P-1904 Vernon Hydroelectric Project, P-1855 Bellows Hydroelectric Project, P-1892 Wilder Hydroelectric Project) and river inflows. The flow studies should assess the following topics:

- Conduct quantitative hydrologic modeling of the hydrologic influences and interactions that exist between the water surface elevations of the Turners Falls Project impoundment and discharges from the Turners Falls Dam and generating facilities and the upstream and downstream hydroelectric projects. Data inputs to and outputs from the model(s) should include:
  - Withdrawals from the Turners Falls impoundment by the Northfield Mountain Pumped Storage Project, FERC No. 2485,
  - Discharges to the Turners Falls impoundment by the Northfield Mountain Pumped Storage Project,
  - Discharges into the Turners Falls impoundment from the Vernon Project, FERC No. 1904 and other sources.
  - Existing and potential discharges from the Turners Falls Project generating facilities and spill flows.
  - Existing and potential water level fluctuation restrictions (maximum and minimum pond levels) of the Turners Falls impoundment and downstream flows from the project
  - Existing and potential required minimum flows and/or other operation requirements at each of the four upstream projects.
  - Minimum discharge flows ranging between 2,500 and 6,300 cfs in the bypass reach from April 15th through June 22nd to support spawning, rearing, and outmigration of shortnose sturgeon at Rock Dam.

- Document how the existing and potential outflow characteristics from the four upstream projects affect the operation of the Turners Falls Project including downstream flow releases and Turners Falls impoundment levels.

- Assess how the operation of the existing Turners Falls Project and upstream projects affect Holyoke Project (P-2004) operations including:
  - How Turners Falls Project flow fluctuations affect Holyoke impoundment water levels, with emphasis on the influence on the water levels on listed Puritan tiger beetle habitat at Rainbow Beach in Northampton, MA and assess what changes would be needed in Turners Falls operations to stabilize water levels at Rainbow Beach.
  - How Turners Falls Project operations affect Holyoke Project discharges and what changes in Turners Falls operations would be needed to reduce fluctuations in the discharges from the Holyoke Project.

A. To the extent predictable and practical, incorporate the potential effects of climate change on project operations over the course of the license.

Determine the extent of alteration of river hydrology caused by operation of the project and the interactions between upstream project operations, Turners Falls operations and downstream operations at the Holyoke Project. The models will provide necessary information on what changes can be made to each of the five project's flow releases and/or water levels restrictions, and how those changes affect downstream resources.

Specifically, for the Turners Falls Project continuous minimum discharge flows in the Turners Falls bypass reach need to be no less than 2,500 cfs during shortnose sturgeon spawning, rearing, and outmigration (April 15th – June

22nd). Incorporating these parameters into the model will inform what changes, if any, need to be made to operations of upstream projects to accommodate such flows.

As other specific modifications of the operations of each of the projects are identified based on results of other requested studies, these desired conditions will need to be input into the models to assess how each change affects that project and other project operations and the implications of those changes on other resources and/or the ability to achieve desired operational changes at other projects.

Resource Management Goals

The Division seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

- Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
- Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.
- Assist FERC to ensure that the continued operation of the facility is not likely to jeopardize the continued existence of shortnose sturgeon.

Specific to aquatic resources, the Division's goals are:

- Protect, enhance, or restore, diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
- Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
- Minimize current and potential negative project operation effects on water quality and aquatic habitat.
- Ensure that project operations are not likely to jeopardize the continued existence of shortnose sturgeon.
- Avoid or minimize the current negative effect of project operations on shortnose sturgeon spawning and rearing within the Montague spawning area (i.e. Rock Dam and Cabot Station spawning sites and associated early life stage rearing areas).

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq*.).

Public Interest

The requestor is resource agency.

Existing Information

Available information in the PAD does not indicate how project operations have altered downstream hydrology, which may affect resident and migratory fish, macroinvertebrates, rare, threatened, and endangered species, aquatic plants and other biota and natural processes in the Connecticut River from below the Vernon Dam downstream to the Holyoke Dam.

Information in the PAD also does not reflect data analyzed in Kynard et al. 2012, which identifies minimum discharge thresholds for shortnose sturgeon spawning and rearing at the Rock Dam spawning site. Spawning success was observed at Rock Dam when discharge was between 2,500 cfs and 22,000 cfs during the spawning period (April 27–May 22nd) (Kynard et al. 2012, chapter 3). In 1995 at the Cabot spawning area, the greatest level of spawning and spawning success occurred (i.e., 21 late stage females present, 342 early life stage captured, spawning period was 17 days) even though no spawning was detected at Rock Dam (Kynard et al. 2012, chapter 3). Discharges in 1995 at Rock Dam had dropped below 2,500 cfs by March 26th (Kynard et al. 2012, chapter 3), showing that even though 1995 saw the largest number of pre-spawning adults, none spawned at Rock Dam. This may indicate the need to have adequate flow well in advanced of spawning. Discharge reductions at the Rock Dam site that occurred during spawning caused females to leave the spawning cite and not return even if flow increased to acceptable levels later during the spawning period. Researchers observed that substrate did not change during fluctuating flows and thus cessation of spawning is likely due to velocities falling below the range preferred by females. Given the current flow dynamics at Rock Dam, spawning does not occur most years (Kynard et al. 2012, chapter 3). These data represent the best available scientific information and indicates that the current minimum flow thresholds at the project are not adequate for the protection of endangered shortnose sturgeon. All modeling efforts described above must incorporate the identified minimum flow and temporal parameters.

Nexus to Project

The Turners Falls Project is currently operated with a seasonally-varying minimum bypass flow (400 cfs from 5/1 through 7/15, then 120 cfs through the winter until river temperature rises to ≥ 7°C) and year-round minimum flow below the projects of 1,433 cfs. The project operates as a daily peaking project, often with large, rapid, daily flow fluctuations between the minimum and project capacity (15,928 cfs) and fluctuations in headpond elevation (175' to 186' MSL). These changes affect biotic habitat and biota upstream and downstream of the project. Project operations and potential changes to operations to mitigate impacts are influenced by inflows and operations of upstream peaking projects and the Northfield Mountain Pumped Storage Project operations and potential changes in operations of each project could affect the ability to achieve desired operational changes at other projects. Results of river flow analyses will be used to develop flow-related license requirements and/or other mitigation measures.

Methodology Consistent with Accepted Practice

River hydrology statistics and modeling are commonly employed at hydroelectric projects to assess implications of project operations on the river environment.

Level of Effort/Cost, and Why Alternative Studies will not suffice

Level of effort and cost of model development are expected to be moderate but to be valuable in developing license conditions, the model(s) will need to be run under various scenarios throughout the relicensing process to assess the implications of changes to the operations of each project on other projects and other resources. Therefore, ongoing consultation and re-running of the model(s) are likely to be needed throughout the relicensing process. The modeling exercise will also require coordination and cooperation between First Light and the upstream licensee to assure that the model inputs and outputs can be accurately related.

We would anticipate that the expected level of effort and anticipated costs will be comparable to that experienced on similar FERC relicensing projects of this size (e.g., Conowingo, FERC No. 405).

Literature Cited

Kynard, B., P. Bronzi, and H. Rosenthal, eds. 2012. Life history and behaviour of Connecticut River shortnose and other sturgeons. Special Publication no. 4. World Sturgeon Conservation Society, Norderstedt, Germany.

Requested Study No. 14.
Impacts of the Turners Falls and Northfield Mountain Pumped Storage Project Operations on Tributary and Backwater Area Access and Habitats

Goals and Objectives
One goal of this study is to determine if water level fluctuations from the Turners Falls and Northfield Mountain Pumped Storage projects result in a barrier(s) to fish movement in and out of tributaries and backwaters to the impoundments and riverine reaches below dams.

A second goal is to determine if water level fluctuations in the Turners Falls and Northfield Mountain Pumped Storage project impoundments impact water levels, available fish habitat and water quality in tributaries and backwaters to the impoundments and riverine reaches below dams, and if impacts are found, to ascertain how spatially far reaching they are and develop mitigation measures.

Results of this study may also be used to help determine the adequacy of existing downstream minimum flow requirements.

Specific objectives include:

- Conduct a field study of tributaries and backwaters, including water velocity and habitat data where appropriate, to evaluate potential impacts of impoundment fluctuation on fish access to tributaries and backwater areas. The study should also evaluate if changes in impoundment fluctuation range would mitigate for any identified impacts and if other mitigative measures would improve access.

- Conduct a field study to examine potential impacts of impoundment fluctuations on water levels, available habitat and water quality in tributaries and backwaters. The evaluation should also evaluate if changes in impoundment fluctuation range would mitigate for identified impacts and if other mitigative measures would lessen these impacts.

Resource Management Goals
This requested study will help promote tributary and backwater access and protect valuable fish habitat and maintain appropriate water quality conditions for diadromous and riverine fish species in project-affected areas. Maintaining connectivity between the mainstem of the Connecticut River and tributaries and backwaters is vital to the fish populations in these systems, as many fish species utilize these areas for spawning, rearing, refuge, and feeding.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq*.).

Public Interest
The requestor is resource agency.

Existing Information
To our knowledge, limited information exists related to this requested study.

Nexus to Project
Project operations have the potential to impact fish species life history requirements, biological interactions, and habitat quantity and quality. For example, water level changes due to project operations could create conditions that could impede free movement of fish between tributaries/backwaters and the mainstem of the Connecticut River, thus limiting access to spawning habitat and/or growth opportunities. Additionally, water level changes could also alter tributary and backwater fish habitat quality, quantity, and also water quality, thus decreasing productivity and available habitat.

Methodology Consistent with Accepted Practice

Common tools to evaluate water level impacts would be used including: bathymetric mapping, substrate, depth and velocity measurements, and water quality information (dissolved oxygen, temperature, turbidity, and pH). Studies should be conducted throughout the year.

The study area for tributary and backwater fish sampling should cover all tributaries and backwaters within the project-affected areas of the Turners Falls and Northfield Mountain Pumped Storage projects. A second year of study may be required if first year data collection is limited due to environmental or other conditions, or if river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period.

Level of Effort/Cost, and Why Alternative Studies will not suffice
First Light does not propose any studies to meet this need. Estimated cost for the study is moderate.

Requested Study No. 15.
Impacts of the Turners Falls and Northfield Mountain Pumped Storage Projects on Littoral Zone Fish Habitat and Spawning

Goals and Objectives
The goal of this study is to determine if project operations and water level fluctuations in the Turners Falls Project impoundment negatively impact anadromous and resident fish. This study complements a separate study request specific to American shad spawning and also on habitats affected by water level manipulations.

Specific objectives include:

- delineate, quantitatively describe (e.g., substrate composition, vegetation type and abundance), and map shallow water aquatic habitat types subject to inundation and exposure due to project operations, noting and describing additional areas where water depths at lowest operational range are wetted to a depth less than one foot (flats, near shore areas, gravel bars, etc. with very slight bathymetric change);
- conduct analyses of the impacts of normal operations and the maximum permitted reservoir fluctuation range on the suitability of littoral zone habitats for all life stages of target species likely to inhabit these areas;
- conduct field studies to assess timing and location of fish spawning;
- conduct field studies to evaluate potential impacts of impoundment fluctuations on nest abandonment, spawning fish displacement, and egg dewatering; and
- evaluate potential impoundment fluctuation ranges and how implementation of such changes would mitigate for identified impacts.

Resource Management Goals
The mission of the Massachusetts Division of Fisheries and Wildlife is to protect and conserve fish and their habitats. Resident fish species are an important component of the river's ecology and in some cases are the basis for a sport fishery. This requested study will help protect and conserve resident fish species by ensuring project operations do not negatively impact their spawning success and spawning habitats.

Public Interest
The requestor is a resource agency.

Existing Information
To our knowledge, no information exists related to this requested study. The Massachusetts Integrated List of Waters shows the project area from the Vermont/New Hampshire state line to the Turners Falls Dam impaired due to "other flow regime alterations."

Nexus to Project
Project operations have the potential to impact fish species by influencing spawning success and spawning habitat quality and quantity. For example, water level changes due to project operations could create conditions where fish eggs are exposed to air, where spawning habitat is dewatered, and/or where fish abandon nests containing eggs.

Methodology Consistent with Accepted Practice
Common tools to evaluate water level impacts would be used, including bathymetric mapping and measurement of physical habitat characteristics such as substrate, depth and velocity. Studies should be conducted throughout the spawning season (e.g., April through August).

Common tools to evaluate fish spawning would be used, including visual observations of habitats and sampled fish (i.e., in spawning condition, coloration, gonads mature, and other external features that become developed with spawning) collected by gears such as electrofishing, seining and other net gears during defined environmental and/or time windows for spawning activity. Project operation-impacted areas should be quantified to identify and define areas subject to dewatering and mapped relative to observations of fish nests, spawning fish, and egg deposits. During identified spawning periods for the target species, suitable spawning habitats subjected to daily project operational fluctuations will be surveyed to document the type and extent of project effects on nests or spawning habitat (e.g., nests of fallfish, lamprey, bass and sunfish) and observable eggs or larvae, relative to water level and other environmental conditions, including water temperature and water velocity in noted areas.

At least one year of data collection is necessary. A second year of study may be required should environmental (e.g., river discharge, air/water temperature) or operational conditions in the first year prove to be atypical during the study period (end of March through August).

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice
FirstLight Power does not propose any studies to meet this need. Estimated cost for the study is moderate.

Literature Cited

Massachusetts Year 2012 Integrated List of Waters, *Proposed Listing of the Condition of Massachusetts' Waters Pursuant to Sections 305(b), 314 and 303(d) of the Clean Water Act*, Massachusetts Division of Watershed Management, Watershed Planning Program, Worcester, Massachusetts, January, 2012.

Requested Study No. 16.
Evaluate the frequency and impact of:
1) Emergency water control gate discharge events and:
2) Bypass flume spill events, on shortnose sturgeon spawning and rearing habitat in the tailrace and downstream from Cabot Station

Goals and Objectives

This evaluation should directly address the impact of sediment disturbance and excessive velocities on habitat in Cabot Station tailrace and downstream resulting from emergency water control gate discharge events and bypass spill events and effects of spill from the downstream fish bypass sluice on shortnose sturgeon spawning and incubation.

The goal of this study is to determine appropriate scenarios for operation of the emergency water control gates and bypass flume that will be sufficiently protective of shortnose spawning and rearing below Cabot Station from excessive water velocities and exposure to abrasive sediments dislodged and transported across spawning and rearing areas. Furthermore, avoidance or minimization of rapid fluctuations in flow is also a goal of this study applicable to the operations of the emergency water control gates and bypass flume.

The objective of the study will be to determine how often the emergency water control gates are operated to discharge large quantities of water and evaluate the impact of these events on sediment transport and bottom velocities within known shortnose sturgeon spawning and rearing habitat below Cabot Station. Another objective is to understand the operation of the bypass flume that result in bypass flume spill events and evaluate the impacts of these spill events on sediment transport and bottom velocities within known shortnose sturgeon spawning and rearing habitat below Cabot station. Even when bottom velocities fall within the range optimum for shortnose sturgeon spawning, rapid fluctuations may result in sediment transport having a harmful impact on developing eggs and embryos.

Specific Objectives include:

- Emergency water control gate discharge events
    - Field verification during operation of the emergency water control gates during a range of spill and discharge conditions is necessary during years 2014 and 2015 if emergency water control gates will continue to be operated during shortnose sturgeon spawning and rearing (April 15th – June 22nd).
        - Collection of sedimentation and bottom velocity data during 2014 and 2015 is necessary to verify proposed alternative operation scenarios for the emergency water control gates that will avoid or minimize negative impacts to spawning and rearing habitat.

- Bypass flume spill events
    - Field verification during bypass flume spill events under a range of spill and discharge conditions is necessary during years 2014 and 2015 if bypass flume spill events continue to be a part of future project operations and will occur during shortnose sturgeon spawning and rearing (April 15th and June 22nd).
        - Collection of sedimentation and bottom velocity data during 2014 and 2015 is necessary to verify proposed alternative operation scenarios for the bypass flume that will avoid or minimize negative impacts to spawning and rearing habitat.

Resource Management Goals

The Division seeks to understand current emergency water control gate bypass flume operations and associated impacts to determine potential operation scenarios that avoid or minimize negative effects on shortnose sturgeon spawning a rearing.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq*.).

Public Interest
The requestor is resource agency.

Existing Information
The emergency water control gates are used to spill large amounts of water and Cabot Station also spills water from the bypass flume (Kynard et al. 2012, chapter 3, Kieffer and Kynard 2007). These large spill events created a plume of turbid turbulent flow, which caused some females to leave the area (Kynard et al. 2012, chapter 3, Kieffer and Kynard 2007). Additional spill events create a scour effect on the bottom and the scoured sediments are then pushed downstream over, or deposited on spawning and rearing shoals where an entire years class of Shortnone sturgeon eggs early life stages may be destroyed (Kynard et al. 2012, chapter 3, Kieffer and Kynard 2007). Information included in the PAD does not address operation of the emergency water control gates or bypass flume and impacts on shortnose sturgeon spawning and rearing.

Nexus to Project
The large and rapid changes in flow releases from hydropower dams are known to cause adverse effects on habitat and biota downstream of the project (Cushman 1985, Blinn 1995, Freeman *et al*. 2001). One of the two critical shortnose sturgeon spawning and rearing areas in the Connecticut River is located within the Cabot Station tailrace and impacted by the project's discharges, including spill from the emergency water control gates and bypass flume. This section of the Connecticut River also contains habitat that supports important spawning and rearing areas for migratory fish such as American shad and American eel. Current operations of the emergency water control gates and bypass flume create flow dynamics that are not sufficiently protective of shortnose sturgeon spawning and rearing. Results of this study will be used by the Division to determine recommendations for operation of the emergency water control gates and bypass flume that will avoid or minimize sedimentation and improve bottom velocities that are sufficiently protective of shortnose sturgeon spawning and rearing.

Methodology Consistent with Accepted Practice

River hydrology modeling is commonly employed at hydroelectric projects to assess implications of project operations on the river environment. It is assumed that the planned hydrologic modeling can incorporate emergency water control gate operations and associated impacts. Thus, an additional model would not be required for this request.

Field assessment will be needed to collect sedimentation and bottom velocity data at the emergency water control gates and fish bypass sluice discharge areas to determine what operational scenarios of those structures avoid or minimize impacts to shortnose sturgeon spawning and rearing. Velocity gauges will be employed to collect data on bottom velocities associated with project operations at Cabot Station. Coordination of gauge placement for this request with the field measurements for the instream flow study should help minimize the number of necessary gauges. Field assessment of sedimentation may be collected using a variety of techniques. One potential method of collection of sedimentation data would be to set fine-mesh nets similar to shortnose sturgeon larval collection nets; these nets may show changes in the amount of dislodged substrate material that travels along the spawning site as a result of powerful releases at both the Cabot spillway and bypass flume.

Level of Effort/Cost, and Why Alternative Studies will not suffice

Field verification for this study request will likely be coordinated with other field work for related study requests. It is not expected that the required field work for this request will result in significant additional cost and effort beyond what is expected for field work related to the instream flow study request. Post-fieldwork data analysis would be a moderate cost and effort. We anticipate that the level of effort and costs will be comparable to that experienced on similar FERC relicensing projects of this size (e.g., the Conowingo Project, FERC No. 405).

Literature Cited

Blinn, W., J.P. Shannon, L.E. Stevens, and J.P. Carder. 1995. Consequences of fluctuating discharge for lotic communities. Journal of the North American Benthological Society 14: 233–248.

Cushman, R.M. 1985. Review of ecological effects of rapidly varying flows downstream from hydroelectric facilities. North American Journal of Fisheries Management 5: 330–339.

Freeman, M.C, Z.H. Bowen, K.D. Bovee, and E.R. Irwin. 2001. Flow and habitat effects on juvenile fish abundance in natural and altered flow regimes. Ecological Applications 11: 179–190.

Kieffer, M. and B. Kynard. 2007. Effect of Water Manipulation by the Turners Falls Dam Hydroelectric Complex on Rearing Conditions for Connecticut River Shortnose Sturgeon Early Life Stages. S.O. Conte Anadromous Fish Research Center, Turners Falls, MA.

Kynard, B., P. Bronzi, and H. Rosenthal, eds. 2012. Life history and behaviour of Connecticut River shortnose and other sturgeons. Special Publication no. 4. World Sturgeon Conservation Society, Norderstedt, Germany.

Requested Study No. 16.
Impacts of Turners Falls Canal Drawdown on Fish Migration and Aquatic Organism Populations

Goals and Objectives
Quantitatively assess the effects of the Turners Falls Canal drawdown on diadromous fishes and other aquatic organisms known to be present in the canal during the annual drawdown.
Objectives of this study request include:

- Determine whether juvenile shad and American eel abundance in the canal increases leading up to the time of its closure, due to delays in downstream passage (e.g., is fish accumulation occurring?)
- Determine level of mortality for juvenile sea lamprey from exposure of burrow habitats;
- Conduct surveys to determine aquatic organisms (fishes, freshwater mussels, and mudpuppies) present in the canal during the drawdown, their densities, status (stranded, dead, alive), and locations (mapping to document habitat, substrate type, wetted , at complete drawdown);
- Evaluate measures to minimize aquatic organism population impacts of the canal drawdown.

Resource Management Goals
The Connecticut River Atlantic Salmon Commission developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following:

- Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.
- Maximize outmigrant survival for juvenile and spent adult shad.

The Atlantic States Marine Fisheries Commission Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010, has the stated goal of "*Protect, enhance, and restore Atlantic coast migratory stocks and critical habitat of American shad in order to achieve levels of spawning stock biomass that are sustainable, can produce a harvestable surplus, and are robust enough to withstand unforeseen threats,*" and includes the following objective:

- Maximize the number of juvenile recruits emigrating from freshwater stock complexes.

and recommendation:

- To enhance survival at dams during emigration, evaluate survival of post spawning and juvenile fish passed via each route (e.g., turbines, spillage, bypass facilities, or a combination of the three) at any given facility, and implement measures to pass fish via the route with the best survival rate.

The Division seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

- Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
- Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to diadromous fishes, the Division's goals are:

- Minimize current and potential negative project operation effects on diadromous fishes, including juvenile shad, adult silver eels, and sea lamprey ammocetes.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq*.).

Public Interest
The requestor is a resource agency.

Existing Information
Existing information in the PAD does not provide data on the population size or survival rates of juvenile American shad, American eels, or juvenile sea lamprey located in the power canal during the de-watering process. The power canal is dewatered in early September of each year for over a one week period to perform facility maintenance, inspections, and repairs including substantial silt removal and bank repairs. Historically, the canal drawdown occurred in July, but approximately five years ago it was moved to September, where it has occurred annually since then, with the exception of 2010. The agencies were informed in a letter by FLP that the shift to September was at the request of the Independent System Operator –New England (ISO-NE) to avoid peak load months of June through August. Studies conducted by the previous operator, Northeast Utilities Service Company (NUSCO), to assess downstream clupeid survival and use (1991 and 1994 studies at Cabot Station) support the contention that juvenile shad out-migration is occurring within the current drawdown time frame. There are no data to suggest that out-migration would occur earlier than 1 August, but likely does begin in the month of August (O'Donnell and Letcher 2008). Based on these data, CRASC altered its Fish Passage Notification Letter for Downstream Passage Operations for juvenile shad and herring to require the Cabot Station downstream bypass to begin operating on 15 August in 2010 and then moved the date to 1 August in 2011

It is unknown, whether the power canal may, through potential mechanism(s) of delay due to its configuration or operation, cause out-migrating juvenile shad to accumulate in the canal. This information gap leads to concerns that migrant numbers may be elevated beyond simple extrapolations of surface area comparison in the canal to main stem habitat. In the PAD, FLP indicates that the Cabot Station forebay in the vicinity of the intake has a maximum depth of 60 feet, while the existing near-surface downstream bypass structure at the Cabot Station is designed to operate only within a depth of six feet of the surface. As a result, the downstream bypass only operates effectively for a short period during the drawdown period (timing of this is unknown). The only points of egress, once the bypass becomes unavailable, are through the turbines at Cabot as well as at Station 1, and eventually at the Keith Street gate located well upstream from the Cabot Station intakes. It is unknown what the survival rates are for these passage routes, what proportion of fish are using each route, what number may become stranded and their survival rates, and how many fish are subjected to this situation. The related Study Requests on downstream juvenile shad outmigration and American eel outmigration outline objectives that would address some of these information gaps.

There is also a paucity of information relative to the disposition of fish moving downstream in the impoundment during the canal drawdown. Once the Turners Falls Gatehouse closes its gates, all inflow passes over the dam; a situation unique to this brief one week annual time period. Survival rates for outmigrating juvenile American shad and adult American eel moving past the project during the period of spill are not known.

Lastly, there exists an information gap regarding the fate of juvenile sea-lamprey (known as ammocetes) that reside in the soft substrate materials located in much of the lower or downstream end of the canal (personal communication, Boyd Kynard). In previous drawdowns, thousands to tens of thousands of dessicated ammocetes have been observed (Matt O'Donnell, personal communication, USGS Conte Lab). However, the distribution and abundance of ammocetes in the canal as well as mortality rates for ammocetes during the drawdown period has not been quantitatively determined.

Nexus to Project
Previous studies at Cabot Station have documented that juvenile American shad and American eel migrate through the project area during the canal drawdown period. During normal operations (where canal water level elevations are stable), downstream migrants are able to utilize the Cabot bypass facility; however, as the canal water level is drawn down, the bypass is no longer available, and the only routes of egress are through the turbines at Cabot Station and Station 1, unless the Cabot Station spill gates are utilized (the spill gates have a canal depth limitation of approximately 16 feet). Turbine entrainment at hydropower projects has been shown to cause injury and mortality to fishes.

The annual canal drawdown was formerly conducted in July. In response to ISO-NE's request that FL conduct the drawdown outside of the June through August period, FL moved the drawdown to a period of time when diadromous fishes are known to be moving through the project area.

Once the canal has been drawn down, isolated shallow pools are left standing until the canal is refilled. During this period, fish (including lamprey ammocetes), amphibians, and benthic invertebrates are prone to dessication, predation or other sources of mortality or impact.

Methodology Consistent with Accepted Practice
The methods presented here are consistent with the study requests addressing downstream juvenile American shad passage and downstream American eel passage, with an emphasis on addressing survival and movement immediately prior to and during the canal draw down. Hydroacoustic monitoring immediately upstream of the Turners Falls Gatehouse, as well as upstream of opened dam gates for spill, will provide data on the timing, frequency and magnitude of natural wild juvenile shad movement into these areas, particularly the power canal. The abundance of juvenile shad moving into the canal can be derived and compared with similar data obtained with hydroacoustic equipment monitoring upstream of the Cabot Station intake and bypass, for comparisons. Juvenile shad will be PIT tagged, released, and monitored in the canal, for movements, timing and location including Station 1 canal and forebay. PIT tagged fish will be detected at the Cabot Bypass Sluice sampler. Juvenile fish should be specifically targeted for release immediately prior to drawdown to assess survival and movement in and through the canal. Surveys of sea lamprey ammocetes should be conducted by a stratified sampling design based upon substrate.

Lamprey density surveys, immediately after drawdown and in a subsequent later survey, may derive rates of change in observed densities and their status (live, moribund, dead); appropriate methods would need to be discussed. Surveys of remaining ponded water should be conducted immediately following drawdown and at later intervals (mid- week and end of week) to compare species occurrence and densities (relative abundance) which will be used to develop catch-curve analyses that can inform rates of mortality to the observed populations.

Assessments of freshwater mussels should also be conducted to quantify drawdown impacts. As with lamprey, the assessment can be based on sampling identified habitats in a stratified, random design, over the three time periods noted (initial drawdown, mid week, and end of week), tracking changes in densities and status of observed individuals among areas. Sub-sampling, with sufficient repeated measures to determine variability and acceptable level of precision of data will inform the required sampling intensity that will be needed. This sampling intensity will be determined as the study occurs and may vary among identified species. Comparisons among the three time periods for measures of density and status will inform the evaluation of project effects for juvenile shad, sea lamprey ammocetes, freshwater mussels and mudpuppies

The canal drawdown mitigation assessment involves evaluating alternative drawdown protocols to minimize impacts to resident and migratory fish, mussels and amphibians inhabiting the canal. Alternatives should include: (1) moving the drawdown to a time of year outside of migration seasons; (2) keeping or moving the timing of the drawdown, but utilize technologies to keep the majority of the canal wetted during the drawdown (e.g., portadams in the forebay immediately upstream of the trashracks and at other canal intakes in need of maintenance); and (3) in combination with alternative #2, assess whether other existing infrastructure within the forebay could be used to pass fish safely out of the canal (e.g., low level outlets, deep gates, side spillway boards, etc.). The assessment should compare the merits and drawbacks of each alternative and provide an order of magnitude cost estimate for implementation.

Level of Effort/Cost, and Why Alternative Studies will not suffice
This Study Request has many elements that overlap directly with a larger scale downstream juvenile American shad passage and downstream American eel passage study requests. With equipment costs principally covered in those requests, many components of what has already been proposed will be used in this study. However this request does include some specific elements not specified in the other two larger requests. The study cost and effort are expected to be low to moderate. Some additional radio tags and balloon tags with additive days of field work to accurately assess impacts specific to the drawdown period will be required. Surveys for identified aquatic organisms will take several days during the drawdown period as well.

The canal drawdown mitigation assessment should require a low to moderate level of effort and cost. One staff person would evaluate alternative drawdown protocols. This should take less than one week to complete.

The applicant did not propose any studies to meet this need in the PAD.

Literature Cited:

Atlantic States Marine Fisheries Commission. 2010. Amendment #3 to the interstate fishery management plan for shad and river herring (American shad management). Washington, D.C.

CRASC (Connecticut River Atlantic Salmon Commission). 1992. A management plan for American shad in the Connecticut River basin. Sunderland, MA.

O'Donnell, M and B. H. Letcher. 2008. Size and age distributions of juvenile Connecticut River American shad above Hadley Falls: influence on outmigration representation and timing. River Research Applications #24: 929-940.

Requested Study No. 18.
Climate Change as it Relates to Continued Operation of the Northfield Mountain Pumped Storage, and Turners Falls Projects

Goals and Objectives

This study should relate to the cumulative impacts of the five Connecticut River projects being relicensed at this time. The goal of this study is to determine how climate change relates to the continued operation of the Vernon, Bellows Falls, Wilder, Northfield Mountain Pumped Storage, and Turners Falls projects.

The objectives of this study are:

1. Quantify the amount of thermal loading contributed by each respective impoundment (including the NMPS upper reservoir).
2. Using climate change prediction models, calculate how much warmer the project impoundments are projected to get in the next 30-50 years.
3. Model the effect of various project modifications on river temperature under current conditions and climate change predictions (e.g., converting to run-of-river, deep-water releases, dam removal, large-scale riparian revegetation, etc.).
4. Using climate change prediction models, determine if the projects actually provide an environmental benefit with respect to mitigating against climate change impacts (vis a vis warming of air and water temperatures) by producing low greenhouse gas emitting energy. The Northfield Mountain Pump Storage assessment must be based on net energy production (i.e., NMPS generates1,143,038 MWh annually, but consumes 1,567,506 in its pumping operations; for a net consumption of 424,468 MWh annually).
5. Determine how climate change predictions will impact management of high flow events at the three projects and evaluate if changes to dam structures would mitigate adverse impacts of the existing flood management protocols.

Resource Management Goals

The Division seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

- Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
- Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to climate change, the Division's goals are:

- Minimize current and potential negative project operation effects that could hinder management goals and objectives.
- Minimize deep headpond drawdowns associated with the loss of stanchion logs during high flow events, which are predicted to increase due to climate change.
- Minimize project-related sources of thermal increases to Connecticut River waters to mitigate against predicted climate change impacts.

In September 2011 The MA Executive Office of Energy and Environmental Affairs published the *Massachusetts Climate Change Adaptation Report*. Strategies identified in this report include measures that preserve, protect, and restore natural habitats and the hydrology of watersheds. These strategies strive to integrate the protection of rivers, streams, lakes, riparian areas, floodplains, and wetlands with comprehensive land-use, watershed, and floodplain/buffer management, and targeted land acquisition. Strategies include:

- Land Protection
- Develop streamflow criteria and regulations to encourage re-establishment of natural flow regimes in rivers and streams.
- Identify vulnerable river reaches, establish and protect belt-width-based river corridors, restore floodplains, and increase use of bioengineering techniques for bank stabilization.
- Seek to reconnect high quality habitats by removing in-stream barriers and re-establishing in-stream flows.

- Identify and implement strategies for early detection, rapid response, and prevention of invasive exotic plants and animals that out-compete native species and gradually reduce the diversity of species composition.
- Through geomorphic assessment, identify vulnerable river reaches and monitor rivers for disconnection from floodplains.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), and the Federal Power Act (16 U.S.C. §791a, *et seq*.).

Public Interest

The requester is a resource agency.

Existing Information

The PADs contains no information relative to climate change and how climate change predictions may impact future operation of the hydroelectric plants, nor of how the projects either mitigate for or exacerbate predicted climate change impacts to freshwater ecosystems.

TransCanada's PADs provide a summary of water quality data collected in 2012. Table 1 below is a synthesis of the temperature data collected by TransCanada. It should be noted that the upper and mid-impoundment stations at each project represent the average of temperature readings taken over the entire water column, while the continuous loggers (Lower Cont. and TR) were located near the water surface. These data indicate that from the upstream end of the Wilder headpond to the Vernon tailrace, water temperature increased approximately 6°C.

Table 1. Median water temperature at monitoring stations located within the impoundments and tailraces of the three hydropower projects.

	Median Water Temperature °C			
Project	Upper Imp.	Mid-Imp.	Lower Cont.	TR
Wilder	20.86	21.83	24.08	23.59
BF	22.43	23.67	24.86	24.38
Vernon	23.81	24.49	26.73	26.35

Relative to existing flood management protocols at each station, TransCanada's PADs identify that all three dams utilize stanchion bays (two at Vernon, three at Bellows Falls, and four at Wilder). When inflows to each dam reach certain levels, the stanchion bays are removed, and cannot be replaced until inflows subside. The depth of these bays and the flows they are removed at are outlined in Table 2, below.

Table 2. Summary of pertinent stanchion bay Information for the Vernon, Bellows Falls, and Wilder projects.

Project	Stanchion Height (feet)	Flow Triggering Complete Stanchion Removal
Wilder	17	145,000 cfs
BF	13	50,000 cfs
Vernon	10	105,000 cfs

The PADs provide no information on the history of stanchion removal at any of the projects (frequency, duration, timing), nor a discussion of how predicted climate change might alter management of the stanchion bays in the future (with respect to the frequency and seasonality of occurrence). There also is no discussion of potential impacts to headpond resources that occurs as a result of stanchion bay removal. These information gaps need to be filled so resource agencies can assess the relative and cumulative impact of project operations with respect to the Division's management goals and objectives, including those identified in the Massachusetts Climate Change Adaptation Report.

Data provided by the National Oceanic and Atmospheric Administration, Climate Data Center, illustrates long-term increasing air temperatures in the Northeast (Figure 1). Long-term, monthly mean water temperature data for the Vernon Dam impoundment, monitored by Vermont Yankee, has shown significant differences over time (ANOVA analyses, $P < 0.05$) that when plotted and further analyzed by linear regression, show a significant increasing trend for the period 1974 – 2011 for the months of January, September, and October (Figure 2). These analyses were performed with data from Vermont Yankee, analyzed by the Massachusetts Department of Environmental Protection.

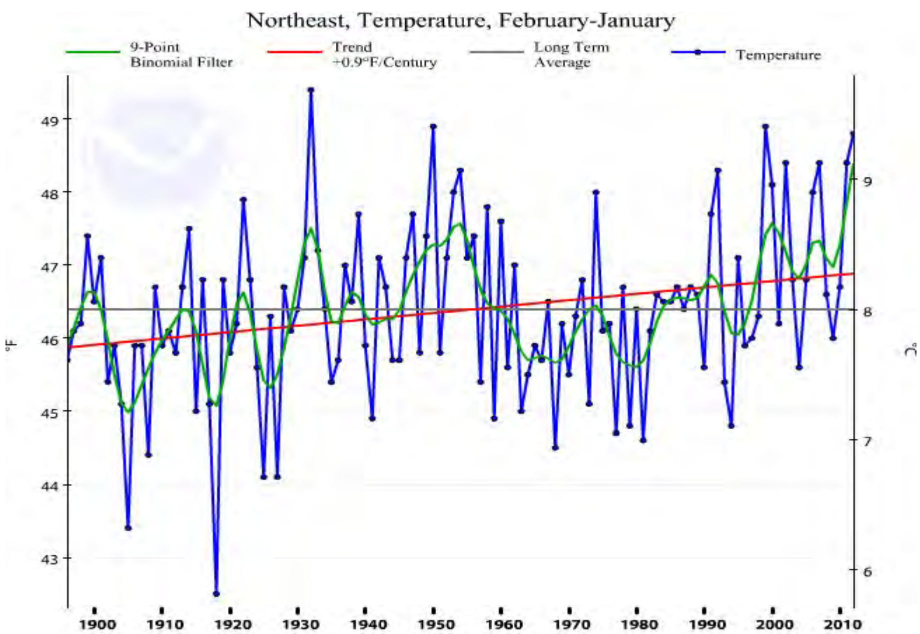

Figure 1. NOAA National Climate Data Center, Northeast 12-month average temperature for the period 1896 through 2012 (October).

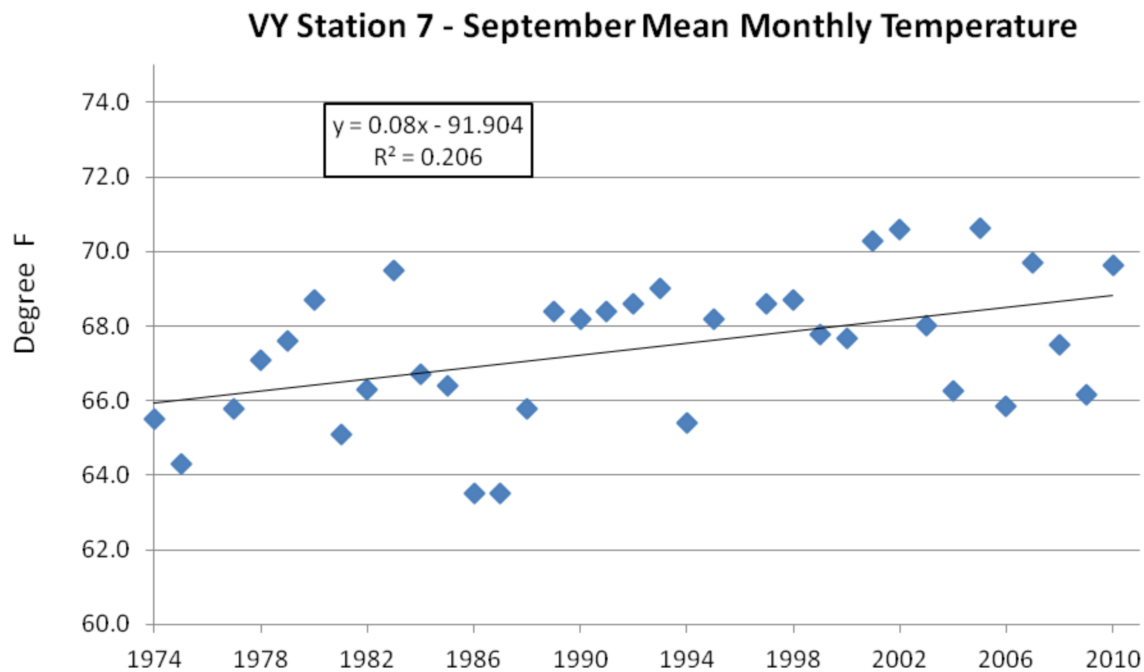

Figure 2. A plot of September's mean temperatures for Vermont Yankees' Station 7 (excludes outlier 1996 data point) for the period 1974 through 2011.

The PAD for Turners Falls and Northfield Mountain Pump Storage projects provides a summary of existing water quality data compiled by FirstLight, including water temperature data obtained from the U.S. Fish and Wildlife Service. The PAD also notes a 1991 study by the former licensee that modeled thermal effects of pumping to the upper reservoir. That model reported a maximum temperature difference attributable to NMPS operation of 0.21°C in the Turners Falls reach of the Connecticut River in low flow (4,000 CFS) simulation.

Nexus to Project

The four mainstem projects have very long impoundments capable of storing large volumes of water (Table 3, below). These impoundments effectively have converted large portions of the Connecticut River into a series of in-river "lakes." Because water velocities slow in these impounded sections of river, it allows for increased thermal loading and resultant higher water surface temperatures than in free-flowing sections of river.

Table 3. Relevant characteristics of the reservoirs behind the Wilder, Bellows Falls, Vernon, Turners Falls dams and NMPS.

Project	Headpond Length (miles)	Gross Storage Volume (acre-ft.)	Average Depth (ft.)	Surface Area (acres)	Flushing Rate (days)
Wilder	45	34,350	11	3,100	3
BF	26	26,900	10	2,804	<2
Vernon	26	40,000	16	2,550	2
Turners	20	21,500		2,110	
NMPS	n.a.	17,,050		246	n.a.

Depending on where the hydropower intakes withdraw water, these warmer surface waters may be discharged downstream, raising the temperature of those waters as well (the data in Table 1 above suggest that the projects do draw water from the upper levels of the reservoirs). This effect may be felt for miles downstream. If there are a series of impoundments (like on the Connecticut River), the cumulative impact is an overall warming of the river. Even small run-of-river dams have been shown to elevate downstream water temperature (Lessard and Hayes 2003; Saila et al. 2005). The most recent climate change prediction models specific to the northeast forecast warmer air temperatures, more frequent high precipitation events, more heat waves, and an increase in the incidence of short term droughts (Karl et al. 2009).

Resource concerns related to this project effect include the potential impacts to populations (reductions in abundance, structure, condition) or loss of species not tolerant of increases in temperature and other effects related to physiology such as energetic costs with warmer temperatures (Leggett 2004). As one example, American shad restoration target numbers for fish passage at mainstem dams into upstream historic habitat could be negatively impacted from artificially increased water temperatures. Water temperature has been identified as a factor in the timing (i.e., duration) of this species migration, as well as its role in gonad development and spawning (Glebe and Leggett 1981; Leggett 2004). These factors can be logical reasoned to potentially result in accelerated rates of energy reserve use and a reduced migration window, possibly reducing the ability of fish to reach up-river habitats and further reducing the ability to survive downstream outmigration.

With respect to project operations during high flow events, all TransCanada projects have stanchion bays that are used to manage water during high flow events. Each time these stanchion bays are removed, the headponds are lowered substantially (from 10 to 17 feet, depending on the project) and must remain lowered until inflows subside. Depending on the timing and duration of these deep drawdowns, headpond resources could be negatively impacted.

All of the dams also contain other mechanisms for managing flows, such as tainter gates, sluice gates, roller gates, skimmer gates and hydraulic flood gates. All of these gates have an advantage over stanchion bays in that they do not require flows to subside significantly before they can be closed to return impoundment levels back to normal. One climate change prediction for the northeast is that we will see more frequent high precipitation events which will result in high flow conditions on rivers. Therefore, it is likely that the stanchion bay removal protocol will have to be employed more frequently in the future.

Methodology Consistent with Accepted Practice

- In order to quantify the amount of thermal loading contributed by each respective impoundment, detailed bathymetry will need to be collected. This bathymetry, combined with storage volume, tributary hydrology, and project operations, should be used to calculate the thermal loading of each headpond. The individual and cumulative increase in surface water temperature due to the impoundments should then be used to predict future warming based on climate change models.
- Analyze different mitigation strategies to understand which have the greatest benefit in terms of building resilience against the impacts of climate change on water temperature. Potential scenarios to analyze include converting the projects to run-of-river, implementing deep-water releases, removing one or more dams, conducting large-scale riparian revegetation, etc.).
- Input to climate change models the amount of GHG emissions that would be generated if fossil fuel plants were producing the equivalent amount of net energy as the five hydropower projects to determine the impact on air and surface water temperatures.
- Climate change prediction model output should be assessed to determine if the frequency and timing of high flow events is likely to change in the future. If high flow events that necessitate initiating the stanchion bay removal protocol are predicted to increase in frequency and/or shift in timing, the applicant should evaluate structural and/or operational alternatives that would mitigate adverse impacts of the existing flood management protocols.

Level of Effort/Cost, and Why Alternative Studies will not suffice

The level of cost and effort for the thermal loading analysis would be low to moderate. Collecting bathymetry in the three TransCanada headponds would take two staff less than one week to collect (it took the Kansas Biological Survey two days to collect bathymetry at a 3,500 acre lake; Jakubauskas et al. 2011). Bathymetry for the Turners

Falls pool and NMPS upper reservoir already exist. The remaining work would be desk-based; loading relevant information into an appropriate thermal loading model to compute the estimated thermal loading of each headpond and then comparing this information to surface water data from climate change prediction models.

The high flow flood protocol study is a desktop analysis that should require low cost and effort. Climate change models already exist and that output would be downloaded and analyzed. The remaining analysis requires a review of alternative means of managing flows without the use of stanchion bays.

The applicants did not propose any studies to meet this need in the PAD.

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Requested Study No. 19.
Integrate Modeled River Flows and Water Levels with Habitat Assessment for State-listed Riparian Invertebrate Species

Goals and Objectives

The goal of this study is to develop a river flow model(s) that evaluates hydrologic changes in the Connecticut River caused by the physical presence and operation of the Turners Falls Dam (TFD) Hydroelectric Project, the Northfield Mountain Pumped Storage Project, the Vernon Hydroelectric Project (P-1855), the Holyoke Dam, and river flows. The model should specifically assess the influence of existing and proposed Project operations on water levels at both known populations and potential habitats for state-listed invertebrate species - including the Cobblestone Tiger Beetle (*Cicindela marginipennis),* state-listed as “Endangered,” and the Puritan Tiger Beetle (*Cicindela puritana*), state-listed as “Endangered” and federally-listed as “Threatened” – and assess how Project operations may be modified to conserve and enhance existing populations and potential habitats.

The specific objectives of this study are to:

A. Conduct quantitative modeling of the hydrologic influences and interactions that exist between water surface elevations within the TFD Impoundment, discharges from the TFD (and its associated generating facilities), and both up- and downstream hydroelectric projects. Data inputs to and outputs from the model(s) should include:

   a. Withdrawals from and discharges to the TFD Impoundment from the Northfield Mountain Pumped Storage Project.
   b. Discharges into the TFD Impoundment from the Vernon Hydroelectric Project and other sources.
   c. Existing and potential water level fluctuation restrictions (maximum and minimum pond levels) of the TFD Impoundment and downstream flows.
   d. Existing and potential discharges from the TFD and its associated generating facilities and spill flows.

B. Assess how water level fluctuations within the TFD Impoundment affect potential habitat for state-listed invertebrate species, and assess what changes would be needed to Project operations to stabilize water levels and maintain/enhance said habitats.

C. Assess how Project operations affect potential habitat for state-listed invertebrate species downstream from the TFD - with an emphasis on the influence of water levels on known habitat for the state-listed Cobblestone Tiger Beetle - and assess what changes would be needed to Project operations to stabilize water levels and maintain/enhance said habitats.

D. Assess how Project operations affect water levels within the Holyoke Dam Impoundment - with emphasis on the influence of water levels on known habitat for the state- and federally-listed Puritan Tiger Beetle - and assess what changes would be needed to Project operations to stabilize water levels at Rainbow Beach.

Relevant Resource Management Goals

The conservation and protection of species state-listed as Endangered, Threatened, or of Special Concern under the Massachusetts Endangered Species Act (MESA) (M.G.L. c. 131A) is an important objective of the Natural Heritage & Endangered Species Program of the Massachusetts Division of Fisheries and Wildlife. State-listed species and their habitats are protected pursuant to the MESA and its implementing regulations (321 CMR 10.00), as well as the rare wildlife species provisions of the Massachusetts Wetlands Protection Act (WPA) (310 CMR 10.59). The Division seeks to accomplish the resource goals and regulatory requirements of the MESA in order to:

- Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and meet MESA requirements for the Project.
- Conserve, protect, and enhance the habitats for state-listed species that will be affected by Project operations

Our study requests are intended to facilitate the collection of information necessary to conduct impact analyses and develop reasonable conservation, protection, mitigation and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), the Clean Water Act (33 U.S.C. §1251 *et seq*.), the MESA, and the WPA.

Public Interest
The requestor is a fish and wildlife resource agency, with regulatory authority under the MESA and the WPA.

Background and Existing Information
The PAD does not indicate how Project operations have or will alter hydrology in the Connecticut River from below the Vernon Hydroelectric Project downstream to the Holyoke Dam, or how operations have or may affect known populations and potential habitats for state-listed invertebrate species, including the Puritan and Cobblestone Tiger Beetles. However, the daily peaking mode of current Project operations are widely believed to negatively affect known populations; it is also likely that Project operations reduce the extent and quality of potential habitat for these species within the Connecticut River more broadly. However, the Division is not currently aware of any studies that have evaluated the relationship between Project operations, river hydrology, known populations, and potentially suitable habitat.

Puritan Tiger Beetle is among the most imperiled species in the United States, and populations of both the Puritan and Cobblestone Tiger Beetles are severely limited in Massachusetts. The only known population of each species is found along the Connecticut River, with Puritan Tiger Beetle known from a single site in Northampton, MA and Cobblestone Tiger Beetle known from a single site in Montague, MA, first observed in 2000. Annual reports from the monitoring of Puritan Tiger Beetle adults and larvae have documented the negative effects of flooding on the known Massachusetts population (Davis 2002-2012, unpublished).

Nexus to Project
The TFD is currently operated with a seasonally-varying minimum bypass flow (400 cfs from 5/1 through 7/15, then 120 cfs through the winter until river temperature rises to ≥ 7°C) and year-round minimum flows below the TFD of 1,433 cfs. The Project operates on a daily peaking mode, often with large, rapid, downstream daily flow fluctuations between this minimum and Project capacity (15,928 cfs) as well as fluctuations in headpond elevation (175' to 186' MSL). Large, rapid changes in flow releases from hydropower dams are known to cause adverse effects on habitat and biota both up- and downstream of such facilities. Further, existing and potential Project operations are influenced by operations at upstream peaking projects, including (primarily) the Vernon Hydroelectric Project and the Northfield Mountain Pumped Storage Project. Indeed, potential changes to the operations of any project could affect the ability to achieve desired operational changes of other projects. Results of river flow analyses should be combined with field assessments of potentially suitable habitats to determine appropriate flow recommendations that will protect and/or enhance known populations as well as potential habitats for state-listed invertebrate species.

Proposed Methodology
River hydrology statistics and modeling are commonly employed at hydroelectric projects to assess the effects of project operations on the river environment. Field assessments are also common in developing operational regimes that will reduce impacts or enhance habitat conditions up- and downstream of hydroelectric projects. Field assessments should involve collecting flood depth, timing, duration, as well as frequency and changes to substrate characteristics along the mainstem of the Connecticut River sufficient to permit assessment of how the quality, extent, and location of existing and potentially suitable habitat changes over a range of flows. The measurements should be taken over a range of test flows, between the existing minimum flow and maximum project generation flows. This information should be synthesized to quantify habitat suitability for each species under each test flow.

Level of Effort and Cost
Level of effort and cost of model development are expected to be moderate, but in order to be valuable in developing revised license conditions, the model(s) should be run under a suite of various scenarios throughout the relicensing process to assess the implications of changes to the operations of any project on other projects and target natural resources. The modeling exercise will also require coordination and cooperation between FirstLight and the upstream licensee to assure that model inputs and outputs can be accurately related. Field work for habitat

assessment studies can be reasonably extensive, but will depend on further consultation with the Division regarding study methodology and on-site decisions for the locations and the number of data replicates. Post-fieldwork data analysis would be of moderate cost and effort.

We would anticipate that the expected level of effort and anticipated costs will be comparable to that experienced on similar FERC relicensing projects of this size (e.g., Conowingo, FERC No. 405).

Requested Study No. 20.
Habitat Assessment, Surveys, and Modeling of Suitable Habitat for State-listed Mussel Species in the Connecticut River

Goals and Objectives

The goal of this study is to conduct an instream flow habitat study and field surveys to assess the impacts of existing and proposed discharges from the Turners Falls Dam (TFD) Hydroelectric Project on suitable habitat and existing populations of state-listed mussel species downstream of the TFD, if any, of the Yellow Lampmussel (*Lampsilis cariosa)*, state-listed as "Endangered," and the Eastern Pondmussel, state-listed as "Special Concern." In addition, the results of the study can be used to assess how Project operations may be modified to conserve and enhance these populations/habitats.

The specific objectives of this study are to:

A. Delineate, through field survey, populations of state-listed mussels downstream of Cabot Station and determine their distribution, abundance, and age-distribution within and between populations.
B. Delineate, through field survey, parameters of habitat suitability for each state-listed mussel species.
C. Evaluate the effects of existing and potential flow regimes on suitable habitats for the state-listed Yellow Lampmussel and Eastern Pondmussel, and determine an appropriate flow regime that will protect and enhance existing populations and suitable habitats in the Connecticut River.

Relevant Resource Management Goals

The conservation and protection of species state-listed as Endangered, Threatened, or of Special Concern under the Massachusetts Endangered Species Act (MESA) (M.G.L. c. 131A) is an important objective of the Natural Heritage & Endangered Species Program of the Massachusetts Division of Fisheries and Wildlife. State-listed species and their habitats are protected pursuant to the MESA and its implementing regulations (321 CMR 10.00), as well as the rare wildlife species provisions of the Massachusetts Wetlands Protection Act (WPA) (310 CMR 10.59). The Division seeks to accomplish the resource goals and regulatory requirements of the MESA in order to:

- Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and meet MESA requirements for the Project.
- Conserve, protect, and enhance the habitats for state-listed species that will be affected by Project operations

Our study requests are intended to facilitate the collection of information necessary to conduct impact analyses and develop reasonable conservation, protection, mitigation and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), the Clean Water Act (33 U.S.C. §1251 *et seq*.), the MESA, and the WPA. Specific to state-listed mussels, the Divisions goals are to:

- Protect, enhance, or restore diverse high quality aquatic habitats for state-listed mussel species in the Connecticut River watershed and mitigate for any loss or degradation of these habitats.
- Minimize current and potentially negative effects of Project operations on state-listed mussels and their habitats.

Public Interest

The requestor is a fish and wildlife resource agency, with regulatory authority under the MESA and the WPA.

Background and Existing Information

It has been well documented that the damming of rivers can have detrimental impacts on mussel communities inhabiting areas both upstream and downstream of dams (Watters 1999, Layzer et. al. 1993, Moog 1993). The PAD provides a list of plant and wildlife species whose native ranges overlap with the Project area. In 2011, FirstLight facilitated surveys for state- and federally-listed mussel species within the 19.5-mile TFD Impoundment, the 3.5-

mile long bypass reach of the TFD, and the facility's 2.2-mile long power canal by Biodrawversity, LLC. No state- or federally-listed mussel species were found by these surveys. This survey was semi-quantitative, the main goal being to assess the distribution, abundance, demographics, and habitat of state- and federally-listed mussels in the 2011 study area. However, the study did not assess all suitable habitats and flow conditions or perform mussel surveys in the free-flowing reaches of the Connecticut River downstream of Cabot Station, in which populations of Yellow Lampmussel and Eastern Pondmussel have been documented and which are potentially impacted by existing and proposed Project operations. Studies to date have also not assessed how existing and proposed Project flows affect glochidial settlement of state-listed freshwater mussel species.

The range of the Yellow Lampmussel in New England is limited to four major watersheds, three of which occur in Maine and the fourth in the Connecticut River (Massachusetts and Connecticut) (Nedeau et al. 2000, Nedeau 2008). In Massachusetts, extant populations are limited to the mainstem of the Connecticut River south of the TFD, although historic records exist from reaches in Northfield (Nedeau 2008). Populations of the Eastern Pondmussel are known from the mainstem of the Connecticut River and some low-gradient tributaries.

FirstLight is required to release a minimum of 1,433 cfs into the Connecticut River below the TFD; however, the Project currently generates power in a peaking mode, resulting in significant within-day flow fluctuations between the minimum release and project capacity on an hourly or daily basis. These large and rapid changes in water elevations and flow dynamics, out of synch with expected seasonal variation, may cause adverse effects to state-listed mussels, their habitats, and their long-term viability in the Connecticut River. The Division is not aware of any studies that have evaluated these effects. Finally, information included in the PAD does not provide a detailed description of how the selected minimum flow was established, or how minimum flow relates to flows necessary for the conservation and protection of rare species.

Nexus to Project

The Project currently operates with minimum flow releases and flow regimes that do not appear to have been based on biological criteria or field study and do not mimic natural fluctuations. The timing, rate, and magnitude of releases from the TFD may have direct, adverse effects on rare mussel populations and their habitats, although the degree and character of these effects is unknown. However, before an evaluation of effects can be made a better understanding of the distribution and abundance of state-listed mussel species and their habitats is required. Therefore, in order to fill this important information gap, field surveys to establish baseline population information and suitable monitoring sites is needed. Additionally, an empirical study is needed to provide information on the relationship between the proposed mode(s) of operation and rare mussel species and their habitats in the Connecticut River downstream of Cabot Station. Results will be used to assess proposed flow regimes on existing populations (if any) and potentially suitable state-listed mussel habitat, and to determine appropriate recommendations that will protect and/or enhance state-listed mussels and their habitats.

Proposed Methodology

A. *Habitat assessments* should be conducted during suitable water visibility and depths to afford a clear view of the river bottom between 1 June and 25 September (similar to those outlined within Biodrawversity and LBG 2012). This field work and analysis was performed on the mussel community inhabiting the lower Osage River in Missouri as part of the relicensing process of the Osage Hydroelectric Project (FERC No. 459) (ESI 2003). Surveys should provide systematic and sufficient coverage of potential habitats downstream of Cabot Station to detect occupied and unoccupied patches of suitable habitat.

   Habitat should be classified regarding occupancy by state-listed mussels. Methods for the habitat assessment portion of the study should include the use of snorkel, view bucket, and scuba, as necessary, based on water depth and clarity; shoreline-based surveys are not suitable alternatives. Occupied habitat patches will be utilized as a minimum habitat condition benchmark and data collection will include macro-scale (e.g., stream gradient, distance from Cabot Station, reach habitat mapping) and micro-scale features (e.g., depth profile, velocity profile, stability of patch, substrate, temperature, aquatic vegetation and other key features). Using these measured parameters, the habitat assessment should then locate and map patches of suitable but currently unoccupied habitat, if present. The requested habitat assessment will provide habitat descriptions and mapping to adequately describe the relative amount, distribution, and quality of suitable habitat for the Yellow Lampmussel and Eastern Pondmussel in Project-affected portions of the

Connecticut River that were not surveyed as part of the 2011 study referenced above . The Division will work with FirstLight to develop and refine a habitat assessment protocol.

B. *Mussel Surveys. S*imultaneous with the habitat assessment, state-listed mussels will be surveyed and population parameters measured and quantified. Surveys, in conformance with Massachusetts protocols for state-listed mussel species, include:

1) Use SCUBA in depths over 3 feet and snorkeling in depths less than 3 feet. Mucket buckets and hand surveys may be used in very shallow or turbid waters.
2) Conduct subsurface exploration in ten percent (10%) of the survey area if state-listed mussels are encountered, and/or in areas where juveniles are encountered or juvenile habitat exists (e.g., depositional areas behind rocks, along streambanks, sandbars, etc.) (Yeager et al. 1994). Substrate sediments shall be excavated using $0.25m^2$ quadrats to a depth of 10cm and sieved through a mesh screen with openings of 4-6mm to detect juvenile mussels.
3) Count and identify all state-listed mussels to species.
4) Collect all standard morphometeric (e.g., species, size, shell injury/erosion etc.) and site data (location, extent, elevation, and age class structure). Length (millimeters) of the first 100 state-listed mussel individuals per species should be recorded to help assess recruitment length of <u>all</u> state-listed specimens less than 40mm. The first 50 specimens of all common species should be counted and identified; overall common species abundance (e.g., abundant, scattered, infrequent) should be estimated.
5) Use the Catch per Unit Effort (CPUE) method to qualitatively assess mussel species abundance. Estimate density at each site using number of mussels found per species per square meter of survey area.
6) Collect photographs of representatives for each state-listed species per site to document and confirm identity; photos should show a lateral view. If underwater cameras are available, photos of mussels while siphoning can help confirm identification.
7) Collect a representative sample of spent shells (for each species) that shall be forwarded to the Division for documentation and identification purposes.
8) Return any mussels removed from the substrate to the same area and carefully re-bed into the sediment in their original orientation; anteriorly into the substrate, posterior end up.

The Division will work with FirstLight to develop and refine the survey protocols outlined above. The Division must pre-approve the candidate mussel biologist who can demonstrate adequate field experience. The ability to locate and identify state-listed freshwater mussel species and their habitat(s) is required for an adequate freshwater mussel habitat assessment, and the Division may reject assessments that are not conducted by qualified individuals. The mussel biologist is required to obtain a Scientific Collection Permit from the Division, pursuant to 321 CMR 10.04, to handle dead or live state-listed mussels. If federally-listed mussel species are present, the mussel biologist may also need a permit from the USFWS (e.g., to collect vouchers).

C. An *instream flow habitat study* should be conducted in order to collect wetted perimeter, point-velocities, and substrate data along transects located in reaches of the Connecticut River downstream of Cabot Station. The data collected by the habitat assessment portion of the study will allow for application of the instream flow habitat model to the assessment of both occupied and unoccupied patches of suitable habitat. Flow measurements should be taken in each transect and at a subset of occupied and unoccupied habitat patches over a range of test flows. Additionally, flow conditions should be evaluated to determine potential effects of current and proposed Project operations on glochidial settlement into suitable patches, using an assumed range of sizes for larval mussels. At a subset of occupied patches, an assessment of flow-effects on mussel behavior should also be conducted. The requested *instream flow habitat study* will provide habitat descriptions and mapping to adequately describe the flow conditions, relative amount, distribution, and quality of suitable habitat for the Yellow Lampmussel and Eastern Pondmussel within suitable habitat at each test flow. The types of data collected should be sufficient to permit assessment of how quality, quantity, and location of habitat changes over a range of flows between existing minimum flow, peak flows, and maximum project generation flows. Similar methods are being employed to evaluate persistence of Dwarf Wedgemussel habitat on the Delaware (Maloney et. al. 2012) and Susquehanna (T. Moburg, The Nature Conservancy, personal communication) rivers, although these studies did not include the requested patch-level velocity analysis.

Level of Effort and Cost

Field work for instream flow studies may be reasonably extensive, but will depend on consultation between the applicant and the Division on study methodology and on-site decisions regarding locations for data collection and the number of collection locations. Additionally, there may be potential to combine assessment of habitat with broader in-stream flow habitat assessments requested for other target species, which would reduce costs associated with the habitat assessment component of the study. Post-fieldwork data analysis would be a moderate cost and effort. The methods proposed by the Division are widely accepted methods to assess habitat and conduct mussel surveys, and surveys of this nature are comparable to other FERC projects where state-listed mussels have been investigated.

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Requested Study No. 21.
Fish Assemblage Assessment and Glochidia Surveys in the Connecticut River

Goals and Objectives

The goal of this study is to determine the occurrence, distribution, and relative abundance of fish species in the Connecticut River up- and downstream of the Turners Falls Dam (TFD) Hydroelectric Project, including state-listed fish species as well as host fish species of the Dwarf Wedgemussel (*Alasmidonta heterodon*), federally- and state-listed as "Endangered," the Yellow Lampmussel (*Lampsilis cariosa)*, state-listed as "Endangered," and the Eastern Pondmussel (*Ligumia nasuta*), state-listed as "Special Concern." The study should also assess the occurrence and abundance of mussel larvae on resident host fish.

The specific objectives of this study are to:

A. Document fish species occurrence, distribution and abundance within the Project-affected area along spatial and temporal gradients.
B. Compare study results to historical records of fish species occurrence in the Project-affected.
C. Assess the occurrence and abundance of state-listed freshwater mussel larvae (glochidia) on host fish species.

Relevant Resource Management Goals

The conservation and protection of species state-listed as Endangered, Threatened, or of Special Concern under the Massachusetts Endangered Species Act (MESA) (M.G.L. c. 131A) is an important objective of the Natural Heritage & Endangered Species Program of the Massachusetts Division of Fisheries and Wildlife. State-listed species and their habitats are protected pursuant to the MESA and its implementing regulations (321 CMR 10.00), as well as the rare wildlife species provisions of the Massachusetts Wetlands Protection Act (WPA) (310 CMR 10.59). The Division seeks to accomplish the resource goals and regulatory requirements of the MESA in order to:

- Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and meet MESA requirements for the Project.
- Conserve, protect, and enhance the habitats for state-listed species that will be affected by Project operations

Our study requests are intended to facilitate the collection of information necessary to conduct impact analyses and develop reasonable conservation, protection, mitigation and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), the Clean Water Act (33 U.S.C. §1251 *et seq*.), the MESA, and the WPA. Specific to state-listed fish and mussel species, the Divisions goals are to:

- Protect, enhance, or restore diverse high quality aquatic habitats in the Connecticut River watershed and mitigate for the loss or degradation of these habitats.
- Minimize current and potentially negative effects of Project operations on state-listed species and their habitats.

Determining species occurrence, distribution, and abundance of fish species more generally will better clarify what species occur in the project area both spatially and temporally relative to habitats which may be affected by Project operations. This information will better inform results from other study requests that will be examining the effects of Project operation on various aquatic habitats, water quality and other related concerns. This information will be used to make recommendations and enable full consideration for all species, including those that might not otherwise be known to occur in the Project-affected area and impacts that may affect their population status through direct or indirect effects of Project operations.

Public Interest

The requestor is a fish and wildlife resource agency, with regulatory authority under the MESA and the WPA.

Background and Existing Information

The PAD identifies a total of twenty-two fish species in the Project area, but omits any reference to the presence or absence of the tessellated darter. The PAD does note that resident fish surveys were conducted by the Commonwealth of Massachusetts in the early- to mid-1970s, and the Division is aware of a limited sampling effort by Midwest Biodiversity Institute (contracted by the U.S. Environmental Protection Agency) conducted in 2008 (Yoder et al., 2009), which represents the most relevant and recent study related to Project-affected areas. While some sampling was conducted in the Project areas during the course of the 2008 survey, it did not have the same goals and objectives as those outlined above. Although species presence was documented by this study, it did not assess the structure, distribution and abundance of species within the Project-affected areas nor estimate change in these parameters over time. The design of the study, limitations in geographic/habitat type coverage both spatially and temporally, and the use of a single gear type limits the use of this study, which may not fully represent species occurrence in Project-affected areas. It follows that since information is limited regarding the composition of fish communities and their use of habitats in the Project-affected areas, the impacts of current and proposed Project operations on fish species are also unknown. Because FirstLight has not proposed any studies specifically addressing the goals and objectives outlined above, we request a thorough and comprehensive assessment of fish assemblages in the Project areas.

As referenced in the PAD, two state-listed fish species are known to occur in the Connecticut River, including the Eastern Silvery Minnow (*Hybognathus regius*) and Burbot (*Lota lota*), both of which are state-listed as “Special Concern.” Currently, there are only two known populations of the Eastern Silvery Minnow in Massachusetts, both located in the Connecticut River. Eastern Silvery Minnow use aquatic vegetation as habitat, and therefore, are sensitive to flow alterations, erosion, sedimentation, and other factors that may reduce the quality and quantity of their habitat. Burbot are also rare in Massachusetts, with only a few individuals having been collected in the Connecticut River watershed, and, historically (records >25 years old), in the Housatonic River watershed. However, like many small bodied fishes, neither of these species are effectively sampled through boat-based electroshocking. Therefore, a fish assemblage study should be designed to ensure that small bodied fishes are adequately sampled.

Further, seven percent of unionid species are listed as possibly extinct in North America (Strayer et al. 2004, Williams et al. 1993). Watters (1996) found that 30-60% of all native mussels were negatively impacted by damming of rives from shore erosion and siltation, which suffocates mussels and impairs their reproductive cycle through the loss of (Bogan 1993) or access to host species through impediments to fish passage. Documenting the resident and transient fish assemblages in the Project-affected areas is critical to understanding potential impacts to freshwater mussel populations, including state- and federally-listed freshwater mussel species such as the Dwarf Wedgemussel, Yellow Lampmussel, and Eastern Pondmussel. The larvae of freshwater mussels must attach to the gills or fins of a suitable fish host in order to develop into juveniles. The suitability of the host fish is a complex relationship between mussels and fish, and research has found that even closely related fish species do not enable adequate survival of mussel glochidia.

Freshwater Mussel	Glochidial Host Fish
Dwarf Wedgemussel	Tesselated darter, Johnny darter*, mottled sculpin*, slimy sculpin, (Michaelson & Neves 1995); juvenile and parr Atlantic salmon (B. Wicklow, Saint Anselm College, unpublished data)
Yellow Lampmussel	White perch, yellow perch; recent studies have suggested that banded killifish, chain pickerel, white sucker, smallmouth bass, and largemouth bass may serve as potential hosts (Kneeland and Rhymer 2008)
Eastern Pondmussel	Unknown; reported to parasitize centrarchids (sunfishes and bass) as well as banded killifish

*Fish species not found in Massachusetts

As adult mussels are largely sessile, and some amount of glochidia drift in the currents (Schwalb et al. 2010), the transportation of the glochidia via the host fish is believed to be a critical element of ensuring genetic flux between populations and colonization/re-colonization.

The tessellated darter is one of only three fish species in the Upper Connecticut River that serve as hosts for the glochidia of Dwarf Wedgemussel, the others being the slimy sculpin (*Cottus cognatus*) and the Atlantic salmon (*Salmo salar*) (Nedeau 2008). Tessellated darters are a relatively sedentary benthic insectivorous fish with small home ranges and short, fast bursts of speed. Tessellated darters may become the most important hosts for the Dwarf Wedgemussel in the Upper Connecticut, as both USFWS and the Division have or are in the process of ending their programs of stocking hatchery-reared salmon in the River. The Atlantic salmon was extremely rare in the Upper Connecticut River prior to stocking; in the future, even fewer juveniles and parr will be available as hosts.

Nexus to Project
Project operations have the potential to directly impact fish species life history requirements, biological interactions, and habitat quantity and quality. For example, headpond and tailwater water level fluctuations could dewater important spawning areas, limiting productivity of fish species by direct impacts to their spawning success and indirectly limiting the spawning success of forage fish species. Accordingly, a thorough understanding of the current fish assemblage structure and associated metrics are needed in order to examine potential Project impacts. Determining species distribution and abundance will better clarify what species occur in the Project area, spatially and temporally, relative to habitats that may be affected by Project operations.

In addition to direct impacts to state-listed fish species, both current and proposed Project operations have the potential to indirectly affect state-listed mussel populations by affecting the abundance, distribution, and movements of their glochidial fish hosts. This is especially true given that the TFD and its associated operations may act as a barrier to the dispersal of resident fish species; indeed, studies have consistently demonstrated that passage through the Cabot and Spillway fishway structures is poor (Kenneth Sprankle, USFWS, personal communication). The tessellated darter, in particular, does not typically disperse great distances, which suggests that the TFD may significantly impact the ability of Dwarf Wedgemussel to recolonize and sustain populations in otherwise suitable riverine habitats. It is likely that the maintenance and recovery of rare mussel populations in the Upper Connecticut River more broadly may depend on facilitating effective passage of host fish species.

The information requested through this study will help assess how the Project has and will affect the structure, distribution and abundance of state-listed fish and freshwater mussel species, and help the Division develop recommendations that will protect and/or enhance populations of each species.

Proposed Methodology
An accepted and robust field sampling design (e.g., as described in Pollock et al. 2002 or MacKenzie et al. 2006) and accepted methods for collecting fish species likely to be present in the Project-affected areas (Bonar et al. 2009) should be used to conduct field surveys. Randomly sampling multiple habitat types using a multi-gear approach will be required to ensure that all fish species present are sampled. The spatial scope of the study will be from the headwaters of the Turners Falls Impoundment downstream to Sunderland, Massachusetts, but may omit the Upper Reservoir of Northfield Mountain Pump Storage Project. Sampling should occur at each selected site across multiple seasons (spring, summer, and fall). Digital photographs should be taken to avoid misidentification of certain species, such as Cyprinids. This will be a one year study provided river discharge conditions fall within 25th to 75th percentile for weekly averages. Based upon this study's results, and the additional information obtained on requests to survey aquatic habitats and littoral zone fish spawning, an additional study may be required if evidence of project operation affects on population status or habitat for identified species.

The sampling design should include replicate samples for estimation of species detection probability. Sample replicates may be gathered temporally, using different methods, by independent observers, or by randomly sampled spatial replicates (MacKenzie et al. 2006). For each replicate sample, data that may be important for describing variation in species occurrence and presence/absence should be collected and recorded, such as gear type, mesohabitat type, depth, velocity, flow, water temperature, substrate, time of day, day of year, presence of cover, proportion of vegetation cover, size of individuals collected (juveniles may select different habitat), and/or other factors as determined by a qualified biologist. Species detection, occurrence, and/or abundance and related habitat measures on these parameters should be estimated using methods as described by Kery et al. (2005), MacKenzie et al. (2006), Wenger and Freeman (2008), or Zipkin et al. (2010).

Sampling to assess the occurrence and abundance of encysted larvae of state-listed mussel species on known and potential host fishes will require collection and analyzing gill samples. Sampling across multiple seasons is necessary in order to capture the variable timing of glochidial release, which differs seasonally between target mussel species. Collection may occur in conjunction with fish assemblage field surveys, as described above, from both above and below the TFD. Identification of mussel larvae to species level would require additional lab analysis of fish gill samples, and can utilize techniques based on morphological analysis (Kennedy & Haag, 2005; Zieritz and Aldridge 2009; Zieritz et al. 2010; Zieritz and Aldridge 2011), or molecular analysis, such as DNA barcoding or identification keys based on restriction fragment length polymorphisms (RFLP) (Zieritz et al. 2012). Field-samples of glochidia should be field-collected from gravid females of each target species to serve as references for identification, which can be collected concurrent with the requested mussel survey (see Study Request No. 20).

Level of Effort and Cost
The cost of the fish assemblage study will be moderate to high as seasonal sampling with several types of gear will be required. However, cost will also be partially dependent on the number of sites sampled, the number of sample replicates, and the extent of the covariate data that are measured, all which may be flexible. Based on first year study results, a second year of sampling or specific studies examining impacts of project operations on specific fish species may be needed and requested. Provided the collected data are of high quality, analysis and synthesis should take approximately 10-20 days.

The cost of the glochidia assessment will likely be moderate. Portions of this study (collection of fish samples) can be performed in conjunction with the broader fish assemblage study, which may reduce overall cost. Assessment and identification of mussel glochidia will depend on the number of sample replicates, which may be flexible, and technique selected for identification. Studies should be developed in consultation with the Division.

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Requested Study No. 22.
Assessing Operational Impacts on Emergence of State-listed Odonates in the Connecticut River and Northfield Mountain Upper Reservoir

Goals and Objectives

The goal of this study is to quantify the impacts of water level fluctuation on emerging teneral odonates in the Northfield Mountain Pumped Storage Project's Upper Reservoir, the Turners Falls Dam (TFD) Impoundment, and the 13+ miles of riverine habitat below the TFD (to the Rt. 116 Bridge in Sunderland). Study should include both field surveys as well as a river flow model(s) that evaluate the relationship between Project operations and water surface elevations. The specific objectives of this study are:

A. To obtain baseline information on which state-listed odonates inhabit and are emerging within the Northfield Mountain's Upper Reservoir, the TFD Impoundment, and the 13+ miles of riverine habitat below the TFD.

B. To determine if current water level fluctuations permitted under the TFD and Northfield Mountain Project licenses affect the abundance, composition, and distribution of state-listed rare odonate populations, and whether these populations can be protected and/or enhanced through modifications to Project operations or other mitigation measures.

Relevant Resource Management Goals

The conservation and protection of odonate species state-listed as Endangered, Threatened, or of Special Concern under the Massachusetts Endangered Species Act (MESA) (M.G.L. c. 131A) is an important objective of the Natural Heritage & Endangered Species Program of the Massachusetts Division of Fisheries and Wildlife. State-listed species and their habitats are protected pursuant to the MESA and its implementing regulations (321 CMR 10.00), as well as the rare wildlife species provisions of the Massachusetts Wetlands Protection Act (WPA) (310 CMR 10.59). The Division seeks to accomplish the resource goals and regulatory requirements of the MESA in order to:

- Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and meet MESA requirements for the Project.
- Conserve, protect, and enhance the habitats for state-listed species that will be affected by Project operations

Our study requests are intended to facilitate the collection of information necessary to conduct impact analyses and develop reasonable conservation, protection, mitigation and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), the Clean Water Act (33 U.S.C. §1251 *et seq*.), the MESA, and the WPA.

Public Interest

The requestor is a fish and wildlife resource agency, with regulatory authority under the MESA and the WPA.

Background and Existing Information

The Project generates power in a peaking mode resulting in significant within-day flow fluctuations between minimum release and project capacity on an hourly and daily basis. The current license also permits up to a nine (9) foot change in pool elevation within the TFD Impoundment. The PAD notes that FirstLight would like to expand its Upper Reservoir capacity (by up to 24%), but it is not known how this may affect the magnitude and rate of water level fluctuations. The PAD also notes that water is typically pumped to the Upper Reservoir in the evening and then is directed back to the Connecticut River once or twice daily (during the day), based upon power needs and value. Provided that set thresholds for minimum flow and TFD Impoundment elevations are met, Northfield Mountain Power Station may operate with no restrictions on the timing, frequency, or magnitude of pumping, generation, or pool elevation within the Upper Reservoir.

Previous surveys on the Connecticut River in Northfield and adjacent towns in Massachusetts have established that rapid water level changes resulting from motorboat wakes and other factors can wash away or damage emerging odonate tenerals. There is limited data available regarding the details of emergence, including how high above the water emergence takes place, how long the process takes, what substrates are typically used, and how these factors differ by species or family groups. It is known, however, that emergence from larval wetlands is considered one of the most perilous stages of the odonate life cycle. Therefore, it is likely that large, rapid changes in water elevation and/or flow dynamics – where the magnitude and rate of water level increase exceeds the capacity of tenerals to successfully complete the emergence process - may cause adverse effects to the life cycle of state-listed odonates, and particularly, the emergence of tenerals. This, in turn, may impact the abundance, composition, and distribution of state-listed odonate populations in the central Connecticut River.

It is generally known which state-listed odonate species inhabit the Connecticut River in the vicinity of the TFD as larvae. However, it is not known exactly which species inhabit stretches of the River as differentiated by depth, substrate, speed, and other factors, such as the deep, ponded stretch immediately above the TFD in Barton's Cove or the fast, rocky, relatively shallow stretches below the TFD. Nothing is currently known about which odonate species, whether rare or common, inhabit the Upper Reservoir as either larvae or adults.

Nexus to Project

The Project is currently operated with minimum flow releases and head pond fluctuations that were not based on biological criteria or field study. The timing, rate, and magnitude of releases from the TFD, including water level fluctuations within the TFD Impoundment and the Northfield Mountain's Upper Reservoir, may have direct, adverse effects on emerging odonate tenerals. In order to fill this important information gap, an empirical study is needed to provide information on the relationship between the proposed mode(s) of operation and the effects of water level changes on emerging odonate tenerals. Results will be used by the Division to determine appropriate recommendations to protect and/or enhance state-listed odonates and their habitats.

Proposed Methodology

Surveys of larval odonates via exuviae collection, dredging, and visual surveys are standard methodologies for studying odonate populations. In the Upper Reservoir, the Impoundment, and downstream of the TFD on the river, these surveys will concentrate on exuviae collection and dredging for nymphs. In the Upper Reservoir, surveys will also include visual searches for recently emerged odonates, especially damselflies, near the water's edge.

Surveying for exuviae involves methodical visual searches of appropriate substrates near (typically, within 10 feet) the river's edge. Appropriate substrates vary by species, and because there is some degree of within-species variability, these may include sand, silt, rocks, trees, coarse woody debris, undercut banks, tree / plant roots, and anthropogenic structures such as bridge abutments or walls. Visual surveys should be carried out every day, starting at dawn. Most odonates emerge at night, and wind, rain or water level changes can remove exuviae quickly if they're not located in protected sites. Surveying for nymphs via dredging also depends on the species. Sand/silt/cobble dwellers can be adequately sampled for presence/absence by kick-netting. Species that cling to coarse woody debris or to rocks/concrete need to be sampled by visual inspection (which might involve diving). Surveying for recently emerged adults would involve visual surveys by a qualified biologist along the water's edge.

Qualified biologists will need to survey for odonates at a suite of sites up- and downstream of the TFD at several times during the field season to catch the emergence peaks of state-listed odonate species. Because odonate species may differentially emerge within different habitat types, surveys should assess emergence across a range of depths, substrates, water velocities, and other factors. Finally, to make the connection (if any exists) between Project operations and odonate emergence, the study will need to determine the elevation of nymphs relative to the water surface when they initiate emergence, how long emergence takes, and both the magnitude and rate of water level fluctuations.

The height of water levels will need to be cataloged during the field season, but the magnitude and rate of water level change will likely need to be addressed through the development of river hydrology statistics and modeling, which are commonly employed at hydroelectric projects to assess the effects of project operations on the river environment. Field survey results, as described above, should be combined with the results of a river flow model(s) that evaluate hydrologic changes in the Connecticut River due to existing and proposed Project operations, as requested in related studies by the Division. Modeling should enable the quantitative assessment of how water surface elevations within the Northfield Mountain's Upper Reservoir, the TFD Impoundment, and the reaches downstream of the TFD are affected by discharges from the TFD, pumping into the Upper Reservoir, and their associated generating facilities. Field assessments may be required to collect flood depth, timing, duration, frequency and changes to substrate to inform the model. Such measurements should be taken over a range of test flows, between existing minimum flows and maximum project generation flows, and should be synthesized to quantify how water surface elevations change.

Level of Effort and Cost

The field assessment portions of this study will be moderately time- and cost-intensive; the cost is entirely dependent on the number of sites, number of sample replicates, and the extent of the covariate data that are measured, all of which may be flexible and determined through consultation with the Division.

Level of effort and cost for model development are expected to be moderate, and running of various scenarios through the model(s) may be needed throughout the relicensing process to assess the implications of changes to Project operations. However, because similar models have been requested as part of other study requests, the modeling portion of this study may not represent a significant increase in effort.

Requested Study No. 23.
Assessing Operational Impacts on State-listed Rare Plants in the Connecticut River

Goals and Objectives

Conduct a study to quantify the impacts of water level fluctuations on state-listed rare plant species in the Turners Falls Dam (TFD) Impoundment, as well as current and proposed flow regimes in the 13+ miles of riverine habitat below the TFD (to the Rt. 116 Bridge in Sunderland)..

The specific objectives of this study are to:

A. Obtain baseline information, through field surveys, on the locations and population parameters of Massachusetts state-listed rare plant species in the TFD Impoundment and the 13+ miles of riverine habitat below the TFD (to the Rt. 116 Bridge in Sunderland).

B. Assess how current and proposed Project operations affect existing habitat for, and the growth, survival, and reproduction of state-listed plant species inhabiting mud flats, sand bars, and high energy shore and cobble island habitat types, including (but not limited to) the following:

1. Mountain Alder (*Alnus viridis ssp. crispa*) – “Threatened”
2. Tufted Hairgrass (*Deschampsia cespitosa ssp. glauca*) – “Endangered”
3. Wright’s Spike-rush (*Eleocharis diandra*) – “Endangered”
4. Intermediate Spike-sedge (*Eleocharis intermedia*) – “Threatened”
5. Ovate Spike-sedge (*Eleocharis ovate*) – “Endangered”
6. Frank’s Lovegrass (*Eragrostis frankii*) – “Special Concern”
7. Upland White Aster (*Oligoneuron album*) – “Endangered”
8. Sandbar Cherry (*Prunus pumila var. depressa*) – “Threatened”
9. Sandbar Willow (*Salix exigua ssp. interior*) – “Threatened”
10. Tradescant’s Aster (*Symphyotrichum tradescantii*) – “Threatened”

C. Assess how current and proposed Project operations affect potential habitats for state-listed plant species exhibiting meta-population dynamics, as further described below, including Wright’s Spike-rush, Intermediate Spike-sedge, Ovate Spike-sedge, Frank’s Lovegrass, and Tufted Hairgrass.

Relevant Resource Management Goals

The conservation and protection of populations and habitats for the 256 species of plants state-listed as Endangered, Threatened, or of Special Concern under the Massachusetts Endangered Species Act is an important objective of the Natural Heritage & Endangered Species Program of the Massachusetts Division of Fisheries and Wildlife. State-listed species and their habitats are protected pursuant to the MESA and its implementing regulations (321 CMR 10.00), and the Division seeks to accomplish the resource goals and regulatory requirements of the MESA in order to:

- Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and meet MESA requirements for the Project.
- Conserve, protect, and enhance the habitats for state-listed species that will be affected by Project operations.

Our study requests are intended to facilitate the collection of information necessary to conduct impact analyses and develop reasonable conservation, protection, and mitigation measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), the Clean Water Act (33 U.S.C. §1251 *et seq*.), and the MESA.

Public Interest

The requester is a state natural resource agency, with regulatory authority under the MESA.

Background and Existing Information

It is generally known which state-listed plant species inhabit the Connecticut River in the vicinity of the TFD. The PAD provides a list of plant and wildlife species whose native ranges overlap with the Project-affected area, but it does not provide baseline information on known occurrences of state-listed plant species. Several surveys along this stretch of the River by professional and volunteer botanists have shown that many of these species are dynamic; local populations often display meta-population dynamics, changing in size and location from year to year. This is particularly true of plants species inhabiting sand bars and high energy shore and cobble islands, including (but not limited to) the state-listed Wright's Spike-rush, Intermediate Spike-sedge, Ovate Spike-sedge, Frank's Lovegrass, and Tufted Hairgrass.

Large and/or rapid changes in water elevation and/or flow dynamics may cause adverse effects to existing and potential habitat for state-listed plants. More broadly, Project operations may also adversely affect the life cycle of state-listed plants, and in particular, the germination, growth, and dispersal of species inhabiting mudflats, sand bars and cobble islands. However, these effects are poorly understood and the Division is not aware of any studies that have evaluated these effects.

Nexus to Project

The Project is currently operated with minimum flow releases and head pond fluctuations that are not based on biological criteria or field study. Large, rapid changes in flow releases from hydropower dams are known to cause adverse effects on habitat and biota downstream of such facilities. The timing, rate, and magnitude of releases from the TFD, and the water level fluctuations in the TFD Impoundment, may have direct, adverse effects on rare plant populations and their habitats. In order to fill this important information gap, an empirical study is needed to provide information on the relationship between the proposed mode(s) of Project operations and the quantity and quality of state-listed plant habitat in the Connecticut River. Results will be used by the Division to determine appropriate operational recommendations to protect and/or enhance state-listed plants and their habitats.

Proposed Methodology

Field surveys, within appropriate habitat types, should involve visual surveys during appropriate phenological windows via transects, meander survey, or fixed plots. In addition, the rate and height of water level changes resulting from Project operations during the field season will need to be cataloged. Surveys should collect information regarding location, elevation, and population size, extent and condition, and should occur monthly in order to assess the effects of seasonal flow dynamics on documented individuals and populations. To make the connection (if any exists) between Project operations and the life-cycle of rare plant populations, biologists will need to determine when rare plants start growth and assess how long it takes for maturation and seed dispersal to occur.

River hydrology statistics and modeling are commonly employed at hydroelectric projects to assess the effects of project operations on the river environment. Habitat assessments are also a common tool in developing operational regimes that will reduce impacts or enhance habitat conditions up- and down-stream of hydroelectric projects. Field assessments should involve collecting flood depth, timing, duration, frequency and changes to substrate characteristics along the mainstem of the Connecticut River. Data collected should be sufficient to permit assessment of how the quality, extent, and location of existing and potentially suitable habitat for known populations – and for species exhibiting meta-population dynamics, as described above - changes over a range of flows. The measurements should be taken over a range of test flows, between existing minimum flow and maximum project generation flows, and synthesized to quantify habitat suitability under each test flow.

Level of Effort and Cost

In the PAD, FirstLight identified impacts of the Project operations on wetlands, riparian and littoral zone habitat as a potential issue to be addressed in relicensing. However, additional analyses are needed to understand the impacts of the Project on rare plants and their habitats more broadly. The study proposed here will be moderately time- and cost-intensive. However, the cost is entirely dependent on the number of sample replicates that will be surveyed and measured, all of which should be determined in consultation with the Division.

P-1889-081
P-2485-063

Low water hampers use of Connecticut River

Jeopardizes potential river rescue response

By CHRIS CURTIS
Recorder Staff

TURNERS FALLS — Shallow water on the Connecticut River annoyed boaters and worried emergency responders Sunday.

The Northfield Dive and Rescue Team's annual lobster bake fundraiser brought together both categories of river-users at the Turners Falls Rod and Gun Club.

The club facility, at 15 Deep Hole Drive on the bank of the Connecticut River, includes two docks for members and a slope cleared for use as a boat ramp.

Much of the slight cove by the club had the look of a mossy field Sunday morning and afternoon, with aquatic plants and normally submerged stumps left high and relatively dry.

See LOW Page C3

Photo/Chris Curtis

Turners Falls Rod and Gun Club member Bruce Merriam of Turners Falls stands in front of the channel from the club boat ramp to the Connecticut River. Unusually low water blocked members from using the river Sunday.

Low: Down 5 feet

From Page C1

Water remained in the channel but club member Bruce Merriam said his power boat could never cross the shallow stretch to the river.

Merriam, of Turners Falls, blamed FirstLight Power Resources, the utility operating the nearby dam.

"They ruined one day of boating for me and boating season is short in New England," Merriam said.

Merriam estimated the water level was down about five feet, not the lowest he had seen in his years with the club but the lowest for the year.

Rescue response time

Bill Ryan of the Northfield Dive and Rescue Team said the low water could slow a potential rescue.

"It's not like we couldn't access the river but it would slow things down," Ryan said. "When you do a water rescue timing is everything, so every second counts."

Ryan said the ramp is one of two used by his group, the other being the public boat ramp in Gill.

Turners Falls Fire Capt. Leon Ambo said his department usually launches their rescue boat from the club ramp and was not confident the boat could clear the channel.

Ambo said he had seen the water level on a Sunday afternoon news broadcast, and had never seen the water so low.

"After seeing that on the news, I probably would head over to Gill," Ambo said. "If it was an emergency call, I don't think we would try it."

By 8 p.m., Ambo said the water level had risen sufficiently to launch.

Ryan said water levels are significantly lowered several times a year and the low levels have so far never coincided with one of the group's dozen or so annual rescue responses.

Ambo and Ryan said the utility does not notify them when lowering water levels via the power canal or dam, and Ambo said he does not believe the company has any obligation to do so.

FirstLight representatives could not be reached for comment Sunday.

You can reach Chris Curtis at:
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P-1892-026
P-1855-045
P-1904-073
P-1889-081
P-2485-063

Comments from the **Appalachian Mountain Club**, headquartered in Boston, Mass., on riverwide issues in the proposed relicensing Connecticut River facilities.

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Since 1876, the Appalachian Mountain Club has promoted the protection, enjoyment, and understanding of the mountains, forests, waters, and trails of the Appalachian region. It is the largest conservation and recreation organization in the Northeast with more than 90,000 members.

Riverwide issues: cumulatively effected resources and incremental effect of licensing the five Connecticut River projects with other past, present and reasonably foreseeable future actions within the Connecticut River Basin. Comments and suggestions on issues and alternatives to be addressed in the EIS and studies that will help provide a framework for collecting pertinent information on the resource areas.

The AMC's interests in hydropower relicensing are mainly in the areas of conservation and recreation. We want to help TransCanada and FirstLight in preparing their license applications by improving their contributions to conservation and recreation.

We have an interest in the creation of improved opportunities for multiple-day canoe and kayak trips on the Connecticut River. New England generally does not have a lot of opportunities for multiple-day canoe trips when compared to other regions of the country, with the exception of areas of northern Maine such as the St. John and Allagash Rivers, which are many hours from population centers. The Connecticut River runs from northern New Hampshire to Long Island Sound. It passes through several population centers and is easily accessible from all the major cities in New England with populations in the millions.

The most serious obstacles to multiple-day trips are the hydropower dams themselves. The existing portage routes around the dams are grossly inadequate, too long, and dangerous. For example, the Bellow's Falls portage route is 1.5 miles long and for much of that distance follows the breakdown lane of a high-speed state highway. The only portage around Turner's Falls comes from calling the power company and requesting a truck. Campsites are scarce in Massachusetts. Access areas are closed for much of the year.

We need a study of the facilities that are necessary for canoe access to the river. Most of the existing facilities were designed for day use by motorboats. The ramps and other facilities are not particularly suited to canoeists, particularly those using wood-and-canvas canoes. Campsites are sometimes completely filled up by parties that arrive in motorboats and stay for a week.

We recommend a study of the quantity, quality, and adequacy of the land-based facilities associated with boating on the Connecticut River. This interest involves all of the facilities that are being relicensed. The study should coordinate all the facilities even though there are two hydropower owners. Flow changes that benefit recreation might have a generational impact on all the dams lower on the river. This study should examine put-in and take-out facilities especially for canoeing and kayaking, portage routes, campsites, parking and road access, seasons of operation, maintenance, and sanitary facilities. The study should include a projection of usage during the 30-year life of the licenses, and the opportunities for the project owners to buy land in order to increase recreational benefits.

In association with the above study, a study of the creation of the Connecticut River and Watershed National Blueway should be done, along with ways that the existing hydropower facilities can contribute to that effort.

On May 24, 2012, Secretary of the Interior Ken Salazar designated the Connecticut River and Watershed as the nation's first National Blueway. A Memorandum of Understanding signed in August by the departments of Interior, Agriculture, and the Army has as one objective "providing opportunities for scientific research, environmental education and outdoor recreation and access within the National Blueway to the extent compatible with agency missions." The National Blueway concept takes a watershed viewpoint and addresses the river from its source to the sea. The National Blueways System has as its goal "to advance a whole river and watershed-wide approach to conservation, outdoor recreation, education, and sustainable economic opportunities in the watersheds in which we live, work, and play." The National Blueway designation includes all the tributaries in the watershed and involves several federal agencies.

The National Blueway engages several federal agencies including the U.S. Army Corps of Engineers, the Silvio Conte Refuge, U.S. Fish and Wildlife Service, the National Park Service, and the States of Connecticut, Vermont, New Hampshire, and the Commonwealth of Massachusetts, which have prioritized conservation, recreation, and restoration in the 7.2 million-acre Connecticut River Watershed.

Off-site mitigation for the loss of whitewater habitat by these four dams on the mainstem Connecticut River might take place on tributaries such as the West River, where the U.S. Army Corps of Engineers controls the flows. According to an MOU among Interior, Agriculture, and the Army signed in August, the Corps of Engineers "owns and operates 14 flood control dams and manages about 20,000 acres in the watershed to better manage the water supply, provide flood control and hydropower generation, and support recreation and environmental stewardship." Opportunities to engage these federal agencies and help them meet their obligations under the National Blueway System should be part of this study.

The Connecticut River Paddlers Trail and the Connecticut River Birding Trail cross several project boundaries. Their interests should be part of a framework that takes a river-wide viewpoint.

We have an interest in trails nearby and associated with project lands. A study should evaluate the adequacy and maintenance of existing trail systems for the next 30 years, and determine opportunities for additional hiking trails on project lands, and linking those trails to existing trails. Such trails in the watershed could cross project boundaries, and adding to them could involve requiring the Licensees to purchase additional land.

February 28, 2013
e-filing

The Honorable Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
Room 1A East 888 First Street, N.E.
Washington, D.C. 20426

Re: Electronic Filing: Appalachian Mountain Club, Vermont River Conservancy, and Friends of the Connecticut River Paddlers' Trail's Comments and Study Request for First Light Power Resources Turners Falls Project (FERC Project No. 1889-081) and Northfield Mountain Pumped Storage Project (FERC Project No. 2485-063)

Dear Secretary Bose:

Enclosed are the Appalachian Mountain Club (AMC), Vermont River Conservancy, and Friends of the Connecticut River Paddlers' Trail's comments and study requests for the above referenced proceedings, submitted by electronic filing and distributed electronically or by U.S. Mail to persons identified on the Commission's Service List for this proceeding. Please add those identified below as our respective organization's representatives to the Commission's official service list for this project. Thank you.

Sincerely,
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UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

FirstLight Power Resources	Turners Falls Project No. 1889-081 Northfield Mountain Pumped Storage Project No. 2485-063

APPALACHIAN MOUNTAIN CLUB, VERMONT RIVER CONSERVANCY, AND THE FRIENDS OF THE CONNECTICUT RIVER PADDLERS' TRAIL'S COMMENTS AND STUDY REQUESTS IN RESPONSE TO THE NOTICE OF INTENT TO FILE LICENSE APPLICATION, FILING OF PRE-APPLICATION DOCUMENT (PAD), COMMENCEMENT OF PRE-FILING PROCESS, AND SCOPING: REQUEST FOR COMMENTS ON THE PAD AND SCOPING DOCUMENT, AND INDENTIFICATION OF ISSUES AND ASSOCIATED STUDY REQUESTS REGARDING THE TURNERS FALLS HYDROELECTRIC PROJECT, FERC PROJECT NO.1889-081, AND THE NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT, FERC PROJECT NO. 2485-063.

Since 1876, the Appalachian Mountain Club (AMC) has promoted the protection, enjoyment, and understanding of the mountains, forests, waters, and trails of the Appalachian region. The AMC is a steering committee member of the Hydropower Reform Coalition based in Washington, D. C. The AMC is the largest conservation and recreation organization in the Northeast with more than 90,000 members, many of whom live within three hours of the Connecticut River and would enjoy this section as a daylong or longer trip. The AMC's interests in hydropower relicensing are mainly in the areas of conservation and recreation.

The Vermont River Conservancy protects public access, wildlife habitat, clean waters, scenic natural beauty and ecological integrity by conserving undeveloped land along rivers, lakes and wetlands of Vermont. Since 1995, working in cooperation with state and federal agencies, municipalities and other conservation organizations, VRC has completed projects at over 45 popular local swimming holes, gorges and waterfalls, fishing and boating accesses, protecting paddlers' trails and meandering river corridors for all to enjoy.

The Friends of the Connecticut River Paddlers' Trail is dedicated to building and stewarding primitive campsites, access points, and portage trails along the Connecticut River. The organization manages over 30 campsites and 70 access points that reach from the Connecticut River's headwaters south to the Massachusetts border. Efforts are underway to expand the trail into Massachusetts and Connecticut. The group includes representatives from conservation organizations, state and federal agencies, hydroelectric companies, and town conservation commissions that recognize the region's rich ecology and productive working landscape and seek to facilitate recreational use compatible with the Refuge's natural, social, and historic character.

Currently five hydropower projects on the Connecticut River are up for new federal licenses, with Turners Falls Dam the farthest south. These five facilities influence about 168 miles of the longest river in New England, including creating 91 miles of reservoir that have fragmented the river and converted whitewater rapids into impoundments. The impacts stretch from the upper reaches of the 45-mile long Wilder Project reservoir in New Hampshire and Vermont down to about Northampton, or possibly the Holyoke Dam reservoir, in Massachusetts. The watershed surrounding these projects encompasses a significant portion of the 7.2 million acres in the Connecticut River and Watershed National Blueway. The main stem is of sufficient size for canoeing, kayaking and rowing for multiple-day trips, and flows through beautiful Appalachian countryside.

Rather than repeating some requests here, the AMC co-signed onto American Whitewater and New England FLOW's study requests for whitewater recreation and contingent valuation economic studies and hereby references them without repeating them in detail for brevity's sake. This includes controlled-flow studies as have been done on dozens of FERC projects, specifically at the bypass reach below the Turners Falls Dam. The recreational values there would be improved by scheduled releases. On- or off-site mitigation for loss of whitewater should also be evaluated in relation to the loss of whitewater above the Turners Falls Dam, whose reservoir reaches all the way to Vernon Dam in Vermont and New Hampshire.

In the following study requests, we additionally address impacts of and study needs for the Turners Falls and Northfield Mountain Projects, including issues of multiple-day river trips, flow diversion issues, historical and cultural resources, recreational concerns, and the financial health of the operator and decommissioning funds.

All studies requested here should contain projections for use by the public during the 30-year life of the proposed license, and the adequacy of all facilities and mitigation for that time period, as well as how existing impediments discourage public use currently.

In addition to recreation and aesthetics, we recognize that flow-related decisions also affect economic factors related to power generation and other environmental variables. We look forward to exploring how all flow values relate to one another through participation in this relicensing process.

Our study requests address impacts of the Turners Falls and Northfield Mountain projects, including issues of multiple-day river trips including the lack of the portage trail, the opportunities for whitewater recreation in the bypass reach, historical and cultural resources, recreational resources at Northfield Mountain, and the financial health of the facilities and decommissioning funds.

Issue #1: Impacts of Project Dams on Multiple-Day Self-Propelled Trips on the Connecticut River.

In the scoping area of recreation, the AMC has an interest in the creation of improved opportunities for multiple-day canoe and kayak trips on the Connecticut River, along with facilities that would also accommodate rowing shells. When compared to other regions of the country, New England generally does not have a lot of opportunities for multiple-day canoe trips with the exception of several rivers in far northern Maine, such as the St. John and Allagash, which are many hours from population centers. The Connecticut River runs from northern New Hampshire to Long Island Sound. It passes through several major population centers and is easily accessible from all the cities in New England as well as the greater New York City area with populations in the millions.

The most serious obstacles to multiple-day trips on the Connecticut River are the hydropower dams themselves. The Turners Falls dam owned by FirstLight blocks the river to downstream navigation. Access points and campsites are inadequate. Additional land-based amenities should be added such as potable water, toilets, and campsites that would be used by paddlers engaged in multiple-day trips on the river.

One could say there is no portage pathway around the dam, or that it is conspicuously bad. The current portage route is unmarked and the longest along the river. The boat launch at Barton Cove is also the take-out location for the portage around Turner's Falls Dam. It is a 3.5-mile portage that requires traveling on busy highways with guide signs. The power company will provide a free shuttle to those who call ahead, but information about this shuttle service is limited. In addition, the frequency of this service is somewhat limited. It is also necessary to develop a safe and signed portage trail route for paddlers seeking to self-shuttle.

Access below the Turner's Falls Dam is inadequate. The official launch (Popular Street Launch) is a steep, eroding slope that is a hazard to paddlers. Most locals choose instead to launch on adjacent, private property where access is much easier. However, this land is posted, private land. Further work is needed to improve the situation here.

First Light provides two camping facilities along the river. These facilities are inadequate to meet the growing demand. There is a need to establish additional campsites, especially in the 65-mile section below Turners Falls where no official campsites have been developed.

In preliminary application documents, the Licensee cited the Massachusetts SCORP (2006-2011), which indicated a need for "water-based" activities. Multiple-day canoe, kayak or rowing trips certainly meet the needs identified in the SCORP documents, but such trips are severely limited by the operations of the Turners Falls hydropower dam.

Facilities such as campsites and boat ramps do exist, as detailed in the PAD. But for multiple-day trips, or for paddlers or rowers seeking to navigate the length of the Connecticut River, the dams and lack of campsites discourage such travel. Fisheries biologists have suggested that migrating fish tire after the second fish ladder. Canoeists faced with the cumulative obstacles presented by the hydropower dams become similarly discouraged and abandon their efforts to migrate downriver.

River travelers find that the Turners Falls Dam is the largest impediment to through-travel. In addition, users are at the site of a major historical event in American life, yet the power company gives no indication of that. See Issue #3 below.

In its PAD, the Licensee proposes no enhancements to mitigate the project effects on multiple-day canoe and kayak recreational use.

Issue #2: Impacts of the Connecticut River Flow Diversion on Recreational Paddling at the Turners Falls Bypass Reach.

We recommend a controlled-flow study of whitewater in the Turners Falls bypass reach. The Turners Falls bypass section of the Connecticut River has the potential to offer quality whitewater paddling opportunities during scheduled events. At moderate and higher flows, a few boaters who can gain access to the river currently use the bypass reach to surf waves to paddle this 2.7-mile whitewater section.

In addition to kayaking, this reach has potential for rafting, guided kayaking, canoeing, instruction, and general paddling use. Collectively the recreational use of the resources at this project has the potential to add economic value to the region if the releases were scheduled and predictable. The bypass reach has close proximity to the University of Massachusetts, Holyoke and Greenfield Community Colleges, and the Northfield-Mt. Hermon School. Millions of people live within a three-hour drive of the Turners Falls facility.

Access to the bypass reach is extremely problematic. Fences have been installed to make access even more difficult. With enough scrambling, a kayaker can make it to the river left side, but the more desirable right side is steep, fenced off, and has little parking. No access stairs exist. Similarly, the take-out downstream at the confluence with the Deerfield River is steep, frequently muddy, and often unusable.

Any bypass reach such as this one presents aesthetic issues as well. A nearly dry natural riverbed is ugly. Daytime aesthetic flows during the spring, summer, and fall could give the public a glimpse of what the natural river looked like before the dam.

The current operation of the project eliminates valuable seasonal paddling opportunities. In the PAD, the Licensee proposes no flow enhancement to mitigate the project's effects on whitewater recreational use.

In addition to recreation and aesthetics, we recognize that flow-related decisions also affect economic factors related to power generation, fish passage, and other environmental variables. We look forward to exploring how all flow-related values relate to one another through participation in this relicensing process.

Issue #3: Cultural, Historical, and Educational Resources.

The Turners Falls Dam creates a number of special and distinctive issues that can be improved during relicensing. The reservoir covers much of the scene of a significant event in American history, yet the Licensee does not have educational and interpretative signs that would allow visitors to understand that history.

In May 1676, colonial forces under the command of Capt. William Turner attacked an Indian village across the river from the current town of Turners Falls. Many of the inhabitants were slaughtered, especially women and children. Some of the men escaped. They returned with friends and pursued the retreating English forces, killing Capt. Turner. Historical artifacts may still exist at the site, much of which has been submerged beneath the Turners Falls Dam reservoir. A study should be done to determine a variety of options for educating the public about the site, and to determine what actions should (or should not) be taken to preserve artifacts.

Informational signage and kiosks at project facilities should promote education about historical events as well as invasive species, water flows, the history of the area, who to call with problems, and what to do to get involved. Educational improvements should be coordinated with recreational improvements. Some people have suggested that a walkway be constructed on the north or river right side at Turners Falls with interpretative materials. Such a walkway could help solve two other major issues with the dam: the lack of a portage pathway around it, and the difficulty of accessing the bypass on river right.

A second historical issue involves the records of construction of the Turners Falls dams and the Northfield Mountain Pumped Storage facility. The engineering studies, drawings, and photographs taken during construction are of historical importance now and should be preserved. The first dam at Turners Falls was attempted in 1792 but washed away. A substantial timber-crib dam was constructed in 1865. The first concrete dam was built in 1909-1912. The current dam was built in 1969-71 on the Gill side and on the Turners Falls side the old dam was retrofitted with new gates. This relicensing offers perhaps a last chance to rescue important historical records held by the Licensee related to the design and construction of the hydropower facilities as well as historical, pre-project conditions. A study should determine what historical records remain, make suggestions for their safe storage, for how they can be made publicly accessible, and for improvements at the project to highlight the historical significance of the facilities to the public

Issue #4: Recreation at Northfield Mountain.

At the Northfield Mountain Pumped Storage project, the original Licensee created a wonderful recreation area. It has been perhaps the premier regional cross-country skiing site during the winter, when there is sufficient snow, and many activities take place during the warmer months. This is exactly the kind of facility that Licensees should be providing.

Unfortunately at Northfield Mountain cutbacks have trimmed the staff. The facilities along the river shut down way too soon in the fall and do not offer night skiing during the winter. Low-snow years have limited cross-country skiing. A study should be done to recommend improvements and additions that would return Northfield Mountain to the intent of its original license as well as providing for greater amenities for the future license.

A parent and manager of the nearby Amherst High School Nordic Ski Team began an email by saying, “Northfield Mt. is a treasure. There are beautiful hiking, snowshoeing and cross-country trails and the grooming of the ski trails is excellent.” But then she added, “The mountain needs lights for night skiing and the ability to make snow. Currently, the mountain is closed on Monday and Tuesdays and closes at 4:30 PM. Our team skis after school, arrives at Northfield around 3 PM and can only ski for an hour and half although there is adequate light to ski for longer. Often the mountain is closed when there is snow on upper trails, but not lower trails. Also, Northfield should be available to host high school Nordic ski meets. Currently they are unwilling to do this. Northfield Mt. would be an ideal place to make snow. There is no trouble accessing water and the lower trails are in the shade and would hold snow for a long period of time. A five kilometer loop of man-made snow would be ideal. This would allow for skiing throughout the season and would make Northfield Mt. a truly valuable resource for outdoor recreation in Massachusetts.”

The Applicant needs to analyze what operational hours will best meet users’ needs and expectations and consider snowmaking for early cross-country skiers before any big winter storms can cover the trails.

There are equally important issues at Northfield Mountain concerning trails of national significance. The New England Scenic Trail (NET) runs through project lands at Northfield Mountain. The New England National Scenic Trail is a 215-mile trail in Connecticut and Massachusetts that received federal designation in 2009. FirstLight has agreed that a relocation of the NET within project boundaries would provide an enhanced recreational experience and level of safety for the public. There are significant climbing areas nearby that would be more accessible after the relocation of the NET. A recreational study could provide assistance in both cases, possibly by recommending that the Licensee buy nearby land from willing sellers to preserve the climbing areas and provide the best route for the New England Trail.

Issue #5: Economic Health and Decommissioning.

Energy markets have changed dramatically in the past decade. The ownership turnover of energy facilities has been dramatic. Climate change may cause more frequent catastrophic and extraordinary events in coming years in the Connecticut River Valley, such as Tropical Storm/Hurricane Irene in 2011, which washed out some portion of almost every state highway in Vermont except the Interstates. With the possibilities of millennial weather events occurring with much greater frequency and the ongoing dramatic changes in the competiveness of current energy generating sources, we believe that a study should assess the need for escrowed decommissioning funds or trust funds for all hydroelectric facilities currently up for new licenses. Many outdated and derelict dam removals today are coming at the expense of public dollars.

We recommend a study to determine the appropriate decommissioning costs at the end of this project's lifetime and how such costs should be funded in escrow in advance. In an age of international ownership, deregulation, changing ownership, and climate change, the financial health of ownership can be brought into jeopardy by distant events or by weather-related catastrophic failure of a dam. The public should not be burdened with decommissioning costs.

We hereby request five studies per 18 CFR 5.9(b).

1. Study of Project Facilities to Support Multiple-day Self-Powered Boating Trips on the Connecticut River.

(1) Describe the goals and objectives of each study proposal and the information to be obtained.

We recommend a study of the quantity, quality, and adequacy of land-based recreational facilities operated by the Turners Falls and Northfield Mountain Licensee that are associated with boating on the Connecticut River. This study should examine put-in and take-out facilities especially for canoes, kayaks, rowing shells and other self-powered watercraft; the portage route at Turners Falls Dam; campsites; parking and road access; seasons of operation of the facilities to match with actual river use; maintenance; water supplies and other amenities at campsites; and trash and sanitary facilities. The study should include a projection of usage during the proposed 30-year life of the license, opportunities for the licensee to buy land from willing sellers in order to increase and safeguard recreational benefits for the project's tenure.

The study should examine the facilities that are necessary specifically for canoe, kayak and rowing shell access to the river. Information from the state SCORP study and from other river recreational interests suggests that interest in quiet water paddling is rising along with the sales of sea kayaks, rowing shells and canoes. Most of the existing facilities were designed for day use by motorboats. Motorboat launch ramps are not particularly suited to canoeists, kayakers, and rowers, especially those using wood-and-canvas or fiberglass boats (e.g., sand works better than concrete).

Paddlers who have attempted to follow the Connecticut River to the sea report that portages and camping can be difficult, and become even more difficult once they reach Massachusetts. Campsites become few and far between. Islands are often posted as off-limits. Many paddlers don't know that any campsites are available and end up camping on mudflats and on isolated portions of private lands. One landowner reported at a scoping meeting in Turners Falls, Mass., that he found a number of canoeists on his property one morning above the Turners Falls Dam. He shuttled them to below the dam, stopping en route to buy them breakfast at the Shady Glen diner in Turners Falls. The Licensee maintains two campsites, at Barton Cove and Munn's Ferry, both of which charge $22 per night for a tent site and require reservations and deposits. One source-to-sea paddler was very complimentary of the Munn's Ferry site, which is for boaters and canoeists only, except that it doesn't have potable water. Competition for campsites is not uncommon, and the study might look at ways to minimize such conflicts. In the Turners Falls reach, which extends from below the Vernon Dam in Vermont to as far downstream as Northampton or even the Holyoke Dam, there are not nearly enough campsites. The Connecticut River Paddlers' Trail organization states the ideal frequency of canoe campsites is one for every five river miles, accompanied by canoe and kayak access in every town. This project falls far short of that standard.

(Photo: Jeff Feldman)

The amenities provided by the Licensee at campsites should be standardized and, at a minimum, include good canoe landing sites, toilets, potable water, trash disposal, picnic tables, and tent platforms or three-sided shelters.

The Turners Falls Dam has no portage pathway around it. If paddlers arrive at Barton Cove during working hours and have a phone, they can call for a truck to pick them up. Paddlers report the Licensee is fairly prompt and courteous in providing that shuttle service. It drops paddlers off at the mouth of the Deerfield River, which is often an unusable put-in. Still, a trail is needed in the new license if someone wants to self portage. Two opportunities exist: one on river right that might also be used for educational displays; and one on river left along the power canal that now serves as a bike trail. A 3.5-mile portage trail is too long, and the locations of the take-out and put-in are important not only for portage reasons but also for safety reasons. This can be a tough problem and it should be closely examined in the study.

This portage problem can be a major discouragement to downriver paddlers. One through-paddler, who completed the entire river in five years by paddling one week a year, said he stopped at the Turners Falls Dam to avoid the portage. The next year he picked up below the dam.

Trails on both land and water should be studied. The Connecticut River Paddlers' Trail and the Connecticut River Birding Trail cross project boundaries. Their interests should be part of a study framework that takes a watershed viewpoint, especially as it involves trail networks and associated facilities. Trails of national significance pass through the Northfield Mountain Pumped Storage project lands in Massachusetts, including the New England National Scenic Trail (NET), a 215-mile trail in Connecticut and Massachusetts that received federal designation in 2009. FirstLight has agreed that a relocation of the NET within project boundaries would provide an enhanced recreational experience and level of safety for the public.

The ownership of project lands at all the facilities should be studied for recreational and conservation improvements. Some project lands could be added to existing park facilities, or placed under permanent conservation restrictions, in order to improve conservation and recreation. One example involves land at the Northfield Mountain Recreation Facility owned by FirstLight, where the relocation of the New England National Scenic Trail and the access it provides to popular climbing areas would benefit from the purchase of critical parcels to guarantee the long-term viability of the major recreational opportunities on or near the site. The public has an interest in trails in the vicinity of project lands. The study should evaluate the adequacy and maintenance of existing trail systems for the next 30 years, and determine opportunities for additional hiking trails on project lands, and for linking those trails to existing trails. Such trails in the watershed could cross project boundaries, and adding to them could involve requiring the Licensee to purchase additional land.

In association with this study, the creation of the Connecticut River and Watershed National Blueway should be taken into account, along with ways that the Turners Falls and Northfield Mountain projects can contribute to that effort. The study should take into consideration impacts on the entire watershed.

As part of this study, for example, a survey should seek to determine why people do NOT use this great public resource. The cumulative discouragement of recreation on the Connecticut River may displace use to other areas of the watershed. As with upstream migration of fish and downstream migration of canoeists, the survey might identify several discouraging aspects of project operations that could be corrected during relicensing.

(2) If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied;

None of the three requesters is a resource agency. However, several state and federal agencies have an interest in recreation and conservation on the Connecticut River.

The Commonwealth of Massachusetts owns and operates several river access areas on the Connecticut River in the vicinity of the Turners Falls Project, and thus has a clearly expressed interest in the public's ability to navigate the commonwealth's rivers.

The U. S. Fish & Wildlife Service (USF&W), National Marine Fisheries Service (NMFS) and the Massachusetts Department of Fisheries & Wildlife (MA-DF&W) have a clear interest in the passage of anadromous and other migratory fish through fish ladders at the Spillway, Station # 1 and Cabot at Turners Falls. In addition, the Conte Anadromous Fish Laboratory is located within the Turners Falls Project boundaries and is a founding organization in the National Blueway System. Although the federal Atlantic Salmon Restoration Program has been recently curtailed, some of the above agencies continue to study and promote the effective upstream and downstream passage of many endangered or threatened species.

Beyond the fisheries agencies, several federal agencies have an interest in recreation and conservation on the Connecticut River. On May 24, 2012, Secretary of the Interior Ken Salazar designated the Connecticut River and Watershed as the nation's first National Blueway. A Memorandum of Understanding signed in August 2012 by the departments of Interior, Agriculture, and the Army has as one objective "providing opportunities for scientific research, environmental education and outdoor recreation and access within the National Blueway to the extent compatible with agency missions." The National Blueway concept takes a watershed viewpoint and addresses the river from its source to the sea. The National Blueways System has as its goal "to advance a whole river and watershed-wide approach to conservation, outdoor recreation, education, and sustainable economic opportunities in the watersheds in which we live, work, and play." The National Blueway designation includes all the tributaries in the watershed and involves several federal and state agencies, including the U.S. Army Corps of Engineers, the Silvio Conte Refuge, U.S. Fish and Wildlife Service, the National Park Service, and the States of Connecticut, Vermont, New Hampshire, and the Commonwealth of Massachusetts, which have prioritized conservation, recreation, and restoration in the 7.2 million-acre Connecticut River Watershed.

(3) If the requester is a not resource agency, explain any relevant public interest considerations in regard to the proposed study.

The hydropower dams on the Connecticut River create obstacles to public navigation and recreation on the river. Conducting the necessary studies and implementing the measures needed to ensure the public has access to quality outdoor recreational resources are in the public interest. It is widely accepted that outdoor recreation has significant benefits to participants including health, well being, and quality-of-life. Outdoor recreation also has proven economic benefits for communities located near recreational resources.

Improvement in opportunities for multiple-day canoe, kayak and rowing trips on the Connecticut River has the potential to offer the region significant economic benefits.

Project operations have created serious aesthetic issues along the route of the Connecticut River. The dry bypass reach at Turners Falls is an aesthetic blight on the river. Even worse, the dams have substituted their industrial appearance for the naturally scenic rapids and falls that once graced the Connecticut River. The public has an interest in the scenic values of this major public resource.

1841 drawing of Great Falls (now Turners Falls) by Orra White Hitchcock (Courtesy Ed Gregory archive)

(4) Describe existing information concerning the subject of the study proposal, and the need for additional information.

There is an inconsistent body of knowledge regarding multiple-day trips on the Connecticut River. The PAD produced by the Licensee lists facilities that are not owned or operated by the Licensee, including commercial operations. There is a lack of consistency about those facilities in terms of their seasons of use and what amenities they provide for public recreational use and their long-term protection.

Several publications are widely used by paddlers and recreationalists. The primary source of information is *The Connecticut River Boating Guide: Source to Sea* (3^{rd} ed.) published by the Connecticut River Watershed Council (2007). Recreational maps and guides to the river have been published for some reaches by KM Digital Productions in South Hadley, Mass., and are available from the Connecticut River Watershed Council. These foldout river maps cover the reaches from Vernon, Vt., to Turners Falls, Mass. (2008). Three other similar maps cover segments from Turners Falls (2007) down to Hartford, Conn. (2010), which is about the extent of the tidal zone. Most of those maps are in need of updates. In 1991, New England Cartographics in Amherst, Mass., published the *Connecticut River Guide in Massachusetts* by Doug Greenfield and Christopher J. Ryan. The Connecticut River Birding Trail organization located in White River Junction, Vt., has published maps detailing the upper valley section, the northern section, and the southern section of the river.

The Connecticut River Paddlers' Trail prepared *The Connecticut River Paddlers' Trail MA-CT Expansion Feasibility Study* in 2013. In that document, Noah Pollock of the Vermont River Conservancy examined the Massachusetts and Connecticut reaches of the river. The *Connecticut River Paddlers' Trail MA-CT Expansion Feasibility Study* contained a map of the river in Massachusetts created by the Trust for Public Lands with dots indicating recommended locations for additional campsites. (See Appendix 1 attached.)

(5) Explain any nexus between Project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.

The Turners Falls Dam prevents navigation downstream on the main stem of the Connecticut River. Project owners have a responsibility to the public to provide adequate portage trails and facilities that promote public recreation on the river, including access points and campgrounds with necessary amenities.

This study will be the defining mechanism for identifying additional sites that can best be adapted for increasing public access and multiple-day paddling trips on the Connecticut River. License requirements may include having the Licensees purchase additional property to provide camping, trail sites, portages or other facilities to assist the public.

The study may also identify indirect effects if the hydropower facilities and their projects have discouraged public use of the Connecticut River or displaced recreation to other parts of the watershed.

Cumulative effects also need to be studied because it appears that the number of dams on the river discourage multiple-day trips and have fragmented the recreational experience. This study may result in license requirements or other mitigation for the Licensee regarding multiple-day trips on the Connecticut River.

(6) Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.

Studies of the adequacy of public resources are fairly standard in the planning field. Methodologies can be selected from among the recognized and accepted standards of the resource and public planning fields. Surveys of people who do NOT use the river or are displaced can employ randomized samples from several databases. Sufficient information is available from the guidebooks and maps of the river that identify access points and campsites, from the map done by the Paddlers' Trail for Massachusetts, as well as information contained in the PAD. The sites evaluated should be operated or funded by the licensee, not by others. Once a consultant is selected and approved, the information should be gathered and analyzed in a timely manner. The study would probably need a summer field season to locate river users for an adequate sample. A consultant with experience in similar projects should be selected, in part to create relevant comparisons to other hydropower projects around the country.

The AMC has some staff expertise in this area because it operates facilities in the White Mountains, in Maine, and elsewhere in its chapters. We could work with the Licensee or contractor to document the known information regarding the river. We will provide volunteers and technical support for the studies when possible as appropriate. We hope to work collaboratively with the Licensee on this study.

(7) Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.

There are several sites along the Connecticut River, private and public, that are used as access points or have camping facilities. However, vast differences exist in the ability or capacity of these sites to handle paddling groups with varying sizes or sanitation needs. Because there is no comprehensive guide or text that provides updated information, field inspection of existing sites should take place. Any needed reconstruction or rehabilitation of existing facilities should be identified. This analysis can be completed during any spring, summer, or fall field season. Such field research needs to be matched with projections of use in the future and with standard requirements for access sites, campsites, portages, sanitation facilities and other amenities. We know of no other means to obtain this information.

2. Controlled Whitewater Flow Study in the Bypass Reach below the Turners Falls Dam.

(1) Describe the goals and objectives of each study proposal and the information to be obtained.

The Turners Falls project contains a 2.7-mile diversion that reduces in-stream flows in the natural riverbed except for minimum flow and during flood events. Natural boatable flows are frequently inaccessible, high, flashy, unpredictable, and are usually available only during periods of seasonal high spillage due to flooding. The Turners Falls Dam and diversion canal impacted the rapids below Turners Falls. The reservoir behind the dam almost certainly destroyed other rapids because it extends all the way north to the Vernon Dam.

Some of the whitewater opportunities eliminated by the project could be restored if the power company provided moderate, stable, and scheduled whitewater flows in the bypass reach that could be accessed from the late spring through early fall months. The current operation of the project largely eliminates valuable seasonal paddling opportunities.

Controlled flow studies have been done on dozens of FERC projects. This whitewater reach is a prime opportunity to restore a whitewater run that could be of enormous recreational and economic value to the community.

The goal of a whitewater flow study is to assess the presence, quality, access needs, flow information needs, and preferred flow ranges for river-based boating resources in a stepwise manner. The information to be obtained can be generally characterized as quantitative and qualitative descriptions of:

Turners Falls bypass reach with low flow, Feb. 1, 2013

- The range of optimal and acceptable flows for whitewater paddling in a whitewater park setting;
- The frequency, timing, duration and predictability of optimal and acceptable paddling flows under current conditions;
- The access needs of whitewater boating use and the current and potential river access options for paddling;
- The flow information needs of whitewater boating and the current and potential flow information distribution system;
- The location, challenge, and other recreational attributes associated with specific rapids and other river features.

Thus, the information to be obtained is a combination of user-generated flow preferences and other engineering information on current and proposed operations (e.g. discharges), geographic information and basic recreational information.

In simpler terms, the Turners Falls Dam would release prescribed flows into the bypass reach for this test, perhaps over two days. For each release, a selected group of paddlers would run the rapid and then answer written questions about their experiences at each flow level. The Turners Falls Dam would release several different flows, measured in cubic feet per second, and the paddlers' experiences would be analyzed to determine the flows that work best at the rapid.

(2) If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.

None of the three requesters is a resource agency.

The Commonwealth of Massachusetts owns and operates several river access areas on the Connecticut River in the vicinity of the Turners Falls Project, and thus has a clearly expressed interest in the public's ability to navigate the commonwealth's rivers. In addition, the Connecticut River and Watershed has been designated America's first National Blueway.

On May 24, 2012, Secretary of the Interior Ken Salazar designated the Connecticut River and Watershed as the nation's first National Blueway. A Memorandum of Understanding signed in August 2012 by the departments of Interior, Agriculture, and the Army has as one objective "providing opportunities for scientific research, environmental education and outdoor recreation and access within the National Blueway to the extent compatible with agency missions." The National Blueway concept takes a watershed viewpoint and addresses the river from its source to the sea. The National Blueways System has as its goal "to advance a whole river and watershed-wide approach to conservation, outdoor recreation, education, and sustainable economic opportunities in the watersheds in which we live, work, and play." The National Blueway designation includes all the tributaries in the watershed and involves several federal and state agencies, including the U.S. Army Corps of Engineers, the Silvio Conte Refuge, U.S. Fish and Wildlife Service, the National Park Service, and the States of Connecticut, Vermont, New Hampshire, and the Commonwealth of Massachusetts, which have prioritized conservation, recreation, and restoration in the 7.2 million-acre Connecticut River Watershed.

The U. S. Fish & Wildlife Service (USF&W), National Marine Fisheries Service (NMFS) and the Massachusetts Department of Fisheries & Wildlife (MA-DF&W) have a clear interest in the passage of anadromous and other migratory fish including shad, blue-back herring, eels and other species through fish ladders at the Spillway, Station # 1 and Cabot. In addition, the Conte Anadromous Fish Laboratory is located within Project boundaries. Although the federal Atlantic Salmon Restoration Program has been recently curtailed, the above agencies continue to study and promote the effective upstream and downstream passage of many endangered or threatened species.

(3) If the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.

The Turners Falls bypass reach offers the public a high-quality whitewater boating resource when flow conditions are suitable. Conducting the necessary studies and implementing measures to ensure public access to outdoor recreation are in the public interest. It is widely accepted that outdoor recreation has significant benefits to participants including health, well being, and quality-of-life. Outdoor recreation also has proven economic benefits for communities located near recreational resources.

Aesthetic resources are also at play in the bypass reach. Dry riverbeds are ugly, and this one is in full view of many people who pass by on nearby Route 2 and who drive across the two Connecticut River bridges that enter the town of Turners Falls.

Turners Falls bypass reach with low flow, Feb. 1, 2013.

Restoration of whitewater recreational opportunities in the Connecticut River has the potential to offer the region economic benefits. FERC has concluded that *"to fully evaluate the project's effect on whitewater recreation opportunities and to balance potential enhancement opportunities with their cost, a controlled-flow whitewater boating study is relevant to Commission's public interest determination."* This is equally true regarding the Turners Falls Project on the Connecticut River.

(4) Describe existing information concerning the subject of the study proposal, and need for additional information.

While many flow studies have been conducted during FERC relicensings on New England's rivers (e.g., Deerfield, Kennebec, Rapid, Green) that have a long history of whitewater paddling use, this section of the Connecticut River is largely unknown to whitewater boaters. Rapids are un-named, the range of difficulty is unknown, and current access opportunities are extremely difficult. The potential high quality of this scenic 2.7-mile long whitewater run should be explored.

Current and historic project operations, however, have resulted in significant information gaps and eliminate most of the low and moderate flows from this reach. The result has been flows too low to paddle, or flashy, spiking high flows that may be too dangerous to attempt. Intermediate paddlers, commercial paddlers, and general river-runners know relatively little about this river reach at low or moderate flows. It should also be determined if there is adequate potential to improve river access in a way that offers a high quality car-top put-in and take-out for use of the entire bypass reach.

One experienced paddler tested low water on the bypass reach in September 2012 to determine if it would be suitable for an office-outing float trip. She entered on river left below the Great Falls Discovery Center, and paddled around the bend. "The entry shallows gave way to a series of 2' high ledges, stacked upon each other," she wrote. "I chose a line more central to river right. I am not sure if there was rebar in them too, I just remember thinking it was too shallow to be in my playboat, and being extra careful not to flip. These would make for some fun rapids I think at higher water, as there was overall several feet of gradient change, and the rock was stacked and defined enough to possibly become something of whitewater significance." At the end of her test run, she concluded: "Regionally, the area lacks Class III rivers. The result is that it is difficult for many New England paddlers to make the transition from Class II to Class IV. With the reduction of the West River releases, and most other regional Class III rivers being spring runoff dependent, many of our regional paddlers will travel to other parts of the country to build their skills and step up to Class IV. Additionally in recent years, with less snow, and rain, dam releases on the Deerfield have come to define the extent of the paddling season. Once these have passed, paddlers find themselves searching for other activities to hold them through till the short season begins again. These include paddlers as far east as Boston, north as New Hampshire & Vermont, south as Connecticut, and Rhode Island, west as New York State. I am not sure if some of these river features might become Class III with more water, but if they could they would be an immense resource to regional clubs and training programs."

The use of a controlled-flow analysis has been described in Doug Whittaker, Bo Shelby, and John Gangemi, *Flows and Recreation: A guide to studies for river professionals* (2005), p. 26-29, available from the National Park Service website at:

http://www.nps.gov/hydro/flowrec.pdf

(5) Explain any nexus between Project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.

The Project controls flows in the Connecticut River by withdrawing more than 13,000 cfs. The operations eliminate most of the paddling days each year, including the virtual elimination of valuable and regionally needed summer paddling opportunities. The Connecticut River can be a high-quality paddling resource, and since paddling is a flow dependent activity, the project directly affects paddling on the Connecticut River. The project nexus is direct.

The results of a controlled flow study would help determine the need for license requirements for scheduled whitewater releases.

(6) Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.

The study we request on the Turners Falls bypass reach of the Connecticut River should follow the standard methodology as described in Whittaker, cited above. This methodology is designed to gather information to assess the presence, quality, and preferred flow ranges for river-based boating resources in a step-wise manner. The process steps are generally 1) desktop analyses, 2) on-land feasibility assessment, 3) on-water single flow assessment, 4) on-water multiple flow assessment. We expect and request the full implementation of this methodology.

Because the quality and flow needs of the resource are unknown, we request an on-water multiple flow assessment be conducted. This study will need to take place on various dates and at variable flow levels throughout a spring and summer. The Appalachian Mountain Club and other boating groups can work with the Licensee to document the known information regarding the river. Along with other paddling groups, we will help provide volunteer paddlers and technical support for the studies as appropriate. We hope to work collaboratively with the FirstLight on this study.

The whitewater boating study methodology we have requested has been used on dozens of other FERC regulated reaches. This study should include an examination of the access issues for the bypass reach and the take-out below.

(7) Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.

Representatives of the AMC and other NGOs with whitewater expertise are willing to work with the Licensee on the whitewater paddling controlled-flow study to keep costs reasonable and the quality of information high.

We will need the integration of information that is already known and then an organized flow study during which several flows are paddled by boaters, with still image and video documentation, surveys of the boaters, a guided conversation among the boaters, and a written report. Given that this is a bypass reach with some minimal access and relatively straightforward hydrology, and given the collaborative approach sought by the paddling community, including in-kind contributions of time and expertise, a consultant should be able to complete this study on behalf of the Licensee for a very reasonable cost.

The Licensee PAD proposes no whitewater feasibility analysis. This no-action step will reveal nothing about the project impacts on whitewater recreation or opportunities for protection, mitigation, or enhancement measures. We currently do not know the relationship between specific low and moderate flows and the paddling experiences they provide. A desktop analysis cannot generate this information. Without this information we cannot fully define the project impacts, nor propose and consider provision of releases that provide targeted recreational experiences.

3: Cultural, Historical, and Educational Analysis and Recommendations.

(1) Describe the goals and objectives of each study proposal and the information to be obtained.

The proper presentation and preservation of historical materials is particularly sensitive at Turners Falls. A major event in colonial America happened here in 1676. The Indian fishing village on the north side of the river was attacked by forces under Capt. William Turner. That battle site now lies mostly flooded under the Turners Falls reservoir. Indian burial grounds dating back thousands of years have been reported on or adjacent to project lands. Yet the Licensee does not have an educational program or interpretative signs that would allow visitors to understand that history.

A study should be done to determine a variety of options for educating the public about this historical site, and to determine what actions should (or should not) be taken to preserve artifacts and provide education.

Some people have suggested that a walkway be constructed on the northern or river right side with interpretative materials. Such a walkway could help solve other major issues with the dam, such as the lack of a portage pathway around the dam, and access to the bypass reach.

This study should also address a second issue. The engineers who built the dams at the Great Falls on the Connecticut River, now Turners Falls, were professionals who did excellent work. Part of that work included documenting their efforts in drawings, photographs (dating from as early as 1865), blueprints, inventories and plans. Those documents are now historical records that should be preserved for the public benefit. The study should discover what records remain and recommend plans for preserving them and making them available to historians and researchers.

We also have an interest in the educational opportunities for the public that should be provided by the project operators on the Connecticut River. Informational signage and kiosks at project facilities can and should promote education about invasive species, water flows, the history of the area, who to call with problems, and what to do to get involved, Existing data should be archived and be publicly accessible. These educational improvements should be coordinated with recreational improvements. These questions should be addressed in this study concerning the “proper presentation” and preservation of history.

(2) If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.

None of the three requesters is a resource agency. The tasks here are properly of concern to the state historical preservation agency and of such nearby institutions as the Great Falls Discovery Center in Turners Falls and the Pocumtuck Valley Memorial Association in Old Deerfield, Mass.

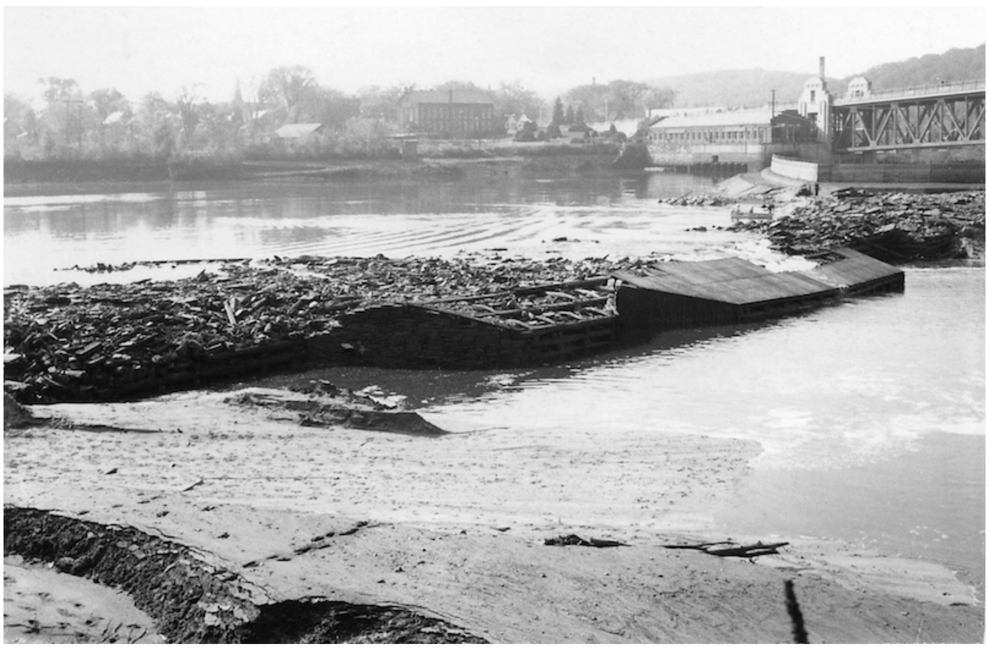
The study and presentation of information about the past involves Indian tribes. They were on one side in the 1676 battle, but more importantly they had lived at the site for centuries. An article titled “Bare Bones” in the *Greenfield Recorder* on Feb. 14, 2013, mentioned a development site near Turners Falls and said, “Sitting on the only lightly developed quadrant of the ancient Indian fishing site known as Peskeomskut (now Turners Falls dam), activists have attempted to derail development there for many years and reasons, including wetland and sacred burial-site issues. The activists claim the site was an important burial ground for local indigenous peoples dating back more than 10,000 years, and they say they have the bones to prove it.” The article by Gary Sanderson reported on an interview with an archeologist, George Nelson, who discovered what was presumably an Indian burial site in a sand bank being used for the reconstruction of Route 2 in 1964, including a full skeleton that he donated to the University of Massachusetts. In private correspondence, Sanderson said, “To be honest, everything within a mile radius of falls would have been loaded with ancient indigenous history/artifacts/burials. When widening Gill Road ca. 1860, they found a spoke burial, 12 bodies, the feet in the center separated by 10-foot circle, many beads, stones, possessions etc.”

In the PAD, the Licensee does not mention the 1676 battle, William Turner, or that the battlefield is submerged under the reservoir. In the PAD, the Licensee states that if any construction takes place the Massachusetts Historical Commission would likely require a Phase 1A study “given the sensitivity of archaeological resources within the given region.” Licensee also mentions that the Abenaki and the Narragansett tribes may be “potentially interested.” Since those tribes have been displaced from this region, perhaps they should be contacted.

(3) If the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.

Historical records and education are valuable public resources. The traditional Native American gathering at the fishing site across the river from Turners Falls is part of the collective heritage of Americans, as is the history of the 1676 battle.

The engineering records related to the construction of dams at Great Falls are also part of our social and industrial history. The first attempt at a Great Falls dam was in 1792, but it washed away. In 1865-66 a timber-crib dam was successfully constructed. It was drowned by a concrete dam in 1909-1912. In 1969-71, the current dam was constructed on the Gill side and the dam on the Turners Falls side was retrofitted with new gates. During that construction, the remains of the original timber-crib dam were removed.



Remnants of the 1865 timber-crib dam were revealed during construction in 1969-71. (Photo courtesy Ed Gregory archive.)

(4) Describe existing information concerning the subject of the study proposal, and need for additional information.

Many history books have dealt with the 1676 fight at Turners Falls and its ramifications during King Phillip’s War. It remains unclear what historical resources remain under water and in the ground. Such sites have a chance of preservation under current laws. The question is: How can the operator of the Turners Falls Dam benefit the public through the presentation of the historical issues at the site?

A study could suggest various opportunities. Some people have suggested an interpretative trail could be cut along the riverbank on the north side with signs indicating the rich history of the area.

As for the engineering history of the site, several books have helped tell that story, but the records held by the Licensee have not been catalogued. Books that relate to this topic include Bill Gove, *Log Drives on the Connecticut River* (Littleton, N.H., Bondcliff Books, 2003), and Ed Gregory, *The Turners Falls Canal; History and Description* (2006).

(5) Explain any nexus between Project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.

The reservoir at Turners Falls covers the site of the battle and probably a lot of artifacts. There may be Indian artifacts or burial grounds on Project lands. The nexus there is direct.

Concerning the colonial and ancient history around Turners Falls, FERC might require an educational component in the license requirements that could assist the public in understanding its history. This might be through direct Licensee action, such as the trail or displays mentioned above, and through support of the preservation of documents by institutions such as the Great Falls Discovery Center in Turners Falls or the Pocumtuck Valley Memorial Association in Old Deerfield.

Presumably the Licensee has in its possession scrapbooks, photographs, construction plans, blueprints, and other historical records related to the construction of the dam, or at least some surviving remnant of such documents. The nexus there is direct. Preservation of such documents should be a license requirement and they should be publicly accessible.

(6) Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.

In this case, tribal values and knowledge would be relevant in the case of Turners Falls.

The study methodology regarding interpreting Native American use of the area should be left to the tribes themselves, some of which are living locally or were long ago removed to Vermont, upstate New York, or Quebec, and to professional historians, anthropologists, and archeologists who are present in numbers at the University of Massachusetts, Amherst College, and the other regional institutions of higher education.

The Pocumtuck Valley Memorial Association, which operates the Memorial Hall Museum and Library located just downstream in Old Deerfield, Mass., has expertise in dealing with Native American artifacts, in creating museum displays, and in maintaining close contact with Native Americans in the region and in Canada. Its library contains thousands of historical records of colonial America. (Deerfield was the site of another major historical battle on Feb. 29, 1704, when French and Indians came down from Canada and attacked Deerfield. They returned to Canada with more than 100 captives who, over time, were generally ransomed back to their families. Some, however, famously choose to live with the Indians. The Indians won that time.)

The generally accepted practices in historical preservation and museum presentation could lead to recommendations for license requirements.

(7) Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.

This area of Massachusetts is rich in academics and museum personnel who could contribute to the Turners Falls effort at a low cost compared to other studies. The people who are knowledgeable about archeology, anthropology, museum presentation, and history in the Turners Falls area are not all local, but some subset of them would be perfect for this study. We are not aware of any less-knowledgeable team that could do an adequate study and make recommendations.

Most of the work in locating the records owned by the Licensee would be internal, with advice and recommendations coming from professional historians after the scope and location of the documents is known. Study of educational opportunities would benefit from consultations with local outdoor educators and schools.

4: Recreation Study at Northfield Mountain.

(1) Describe the goals and objectives of each study proposal and the information to be obtained.

We request a study to recommend improvements and additions that would return the Northfield Mountain Recreation facility to its original intent during its initial licensing and to the level of public benefit required under the previous license. Additions should be recommended as appropriate for a new license. Options might include providing snowmaking for cross-country skiers, or buying additional lands to improve recreation.

There are important issues at Northfield Mountain concerning trails of national significance. The New England Scenic Trail (NET) runs through project lands at Northfield Mountain. The New England National Scenic Trail is a 215-mile trail in Connecticut and Massachusetts that received federal designation in 2009. FirstLight has agreed that a relocation of the NET within project boundaries would provide an enhanced recreational experience and level of safety for the public. This involves moving the trail at a greater distance from the storage reservoir at the mountaintop. Relocating the NET could improve access to popular climbing areas nearby. A recreational study could provide assistance in both cases, possibly by recommending that the Licensee buy nearby land from willing sellers to preserve the climbing areas and provide the best route for the New England Trail.

Major improvements in boating could be required in a new license. FirstLight needs to provide more campsites and access points in the long reach of the Connecticut River that it controls. The Connecticut River Paddlers' Trail recommends one campsite for every five river miles with access in every community along the river. FirstLight's provision of such amenities has not reached that standard.

(2) If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.

None of the three requesters is a resource agency.

The Commonwealth of Massachusetts owns and operates several river access areas on the Connecticut River in the vicinity of the Turners Falls Project, and thus has a clearly expressed interest in the public's ability to recreate on the commonwealth's rivers. In addition to this interest, the Connecticut River and Watershed has been designated America's first National Blueway.

On May 24, 2012, Secretary of the Interior Ken Salazar designated the Connecticut River and Watershed as the nation's first National Blueway. A Memorandum of Understanding signed in August 2012 by the departments of Interior, Agriculture, and the Army has as one objective "providing opportunities for scientific research, environmental education and outdoor recreation and access within the National Blueway to the extent compatible with agency missions." The National Blueway concept takes a watershed viewpoint and addresses the river from its source to the sea. The National Blueways System has as its goal "to advance a whole river and watershed-wide approach to conservation, outdoor recreation, education, and sustainable economic opportunities in the watersheds in which we live, work, and play." The National Blueway designation includes all the tributaries in the watershed and involves several federal and state agencies, including the U.S. Army Corps of Engineers, the Silvio Conte Refuge, U.S. Fish and Wildlife Service, the National Park Service, and the States of Connecticut, Vermont, New Hampshire, and the Commonwealth of Massachusetts, which have prioritized conservation, recreation, and restoration in the 7.2 million-acre Connecticut River Watershed.

(3) If the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.

The Turners Falls Recreation facility offers the public a high-quality resource when fully functional. Conducting the necessary studies and implementing measures to ensure that the facility delivers as promised is in the public access. It is widely accepted that outdoor recreation such as cross-country skiing, hiking, climbing, and boating have significant benefits to participants including health, well being, and quality-of-life. Outdoor recreation also has proven economic benefits for communities located near recreational resources.

(4) Describe existing information concerning the subject of the study proposal, and need for additional information.

The subject of recreation at Northfield Mountain has been addressed in several newspaper articles over the years. The study might examine expenditures by the Licensee over the years in support of the facility, its promotion, and usage.

The study might assess the adequacy of the facility. Launching a canoe on the river at the Northfield Mountain site is unattractive to paddlers, who are displaced to other facilities. Here's a passage that explains why from *The Connecticut River Boating Guide: Source to Sea* (3rd ed., 2007), p. 138, published by the Connecticut River Watershed Council:

> **Mile 124.5**: You have now arrived at the **Riverview Picnic and Recreation Area** at **Northfield Mountain** on the left bank, which has a dock to accommodate the *Quinnetukut II* riverboat, offering river cruises for the general public (phone 800-859-2960). The Northfield Mountain pumped-storage generating plant is sheltered in the mountain behind the site. The main dock area must be kept clear for the *Quinnetukut II*, but boaters and paddlers may use the dock for brief stops to load and unload. The dock is inaccessible directly by car and can only be reached on foot from a parking area 100 yards away. Access is difficult, and the dock is unavailable from mid-April to mid-June. The power company stretches a fish net across the intake of Northfield Mountain during this time to prevent salmon smolt, which are heading downriver, from getting caught in the pumped-storage station. *Caution*: Avoid the discharge area marked by orange floats on the left bank, which can release enough water to swamp a small boat.

Additional information is needed that this study might produce. The study should assess the months of operation of the Riverview facility, which seems to open late and close early in the boating season. Sometimes the power company provides shuttle service for boaters doing day trips on the river, but apparently they charge for that service. The study should assess the appropriateness of such charges, and whether or not anything should be charged by a power company that uses the public's water as its fuel supply.

(5) Explain any nexus between Project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.

The Licensee operates the Northfield Mountain Recreation Area as partial mitigation for its operations at the Northfield Mountain Pumped-Storage Project. There is a direct impact on these resources.

The study should examine the skiing, snowshoeing, hiking, climbing, boating, sightseeing, and educational services provided by the facility with an eye toward how the facility has met previous license requirements and how mitigation should be enhanced for a new license. The study could recommend ways that the facility could be updated and improved as the Licensee seeks a new federal license, and what conditions might be included in that license. The study and the license requirements should address needs for the 30-year proposed life of the license.

(6) Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.

The study might make use of several techniques to determine the effectiveness of the Northfield Mountain recreation facilities. Surveys could determine issues that are current in the skiing, climbing, boating and hiking communities. A survey might also seek to determine what discourages the public from using the facility, or displaces recreation to other areas in the watershed. Such studies have been developed in the administration of parks and recreation areas and can be adapted to this task.

During the relicensing process, there should be plenty of time to collect and analyze data for this task, which would need a full year in order to have access to year-round recreationists.

(7) Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.

The Appalachian Mountain Club has some expertise in this area through its operation of trails and huts in the White Mountains and along the Appalachian Trail in Maine. We are willing to work with the Licensee on the study to keep costs reasonable and the quality of information high. Given such in-kind contributions of time and expertise, a consultant should be able to complete this study on behalf of the Licensee for a very reasonable cost.

The Licensee PAD proposes no recreation analysis of this sort. This no-action step will reveal nothing about the project impacts on recreation or opportunities for mitigation or enhancement measures. Without this information, we cannot fully define the project impacts, nor propose and consider provision of license requirements to improve recreational experiences.

5. Study of the Economic Health of Ownership and Creation of a Decommissioning or Trust Fund.

(1) Describe the goals and objectives of each study proposal and the information to be obtained.

We request a study on the creation of a decommissioning fund or trust fund to protect the public interest. New England's rivers are littered with abandoned dams. Over the centuries, companies have failed, and weather events or human error have crippled dams that were then simply left behind. Energy markets and ownerships have been changing quickly.

A "perfect storm" event, might breach a dam such as Turners Falls. Most of the Connecticut River dams are elderly facilities. The Turners Falls portion of this dam dates from 1909 while the Gill side of the dam dates from 1965.

Distant events, changing regulations, new energy sources, currency devaluations or unfortunate weather events could compromise the health of the current project. If something happened, the public should be insured against the burden of decommissioning costs. A study should recommend the terms of a license requirement for a decommissioning fund.

(2) If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied;

We are unaware of the resource agencies' jurisdiction over decommissioning funds.

(3) If the requester is a not resource agency, explain any relevant public interest considerations in regard to the proposed study.

The economic security of a federally licensed hydropower dam on the longest river in New England is clearly in the public interest. Many hydropower projects support robust recreation economies and they produce a public good by generating renewable forms of electricity.

But the historical record demonstrates—by the thousands of abandoned dams on New England's rivers—that the public should not accept the burden of industrial failure any longer. It has become common to create decommissioning funds at such federally licensed facilities as a way of insuring the public interest against having to pay for removal of a damaged facility or to take over from a failed corporation.

(4) Describe existing information concerning the subject of the study proposal, and the need for additional information.

We are unaware of any published information on the economic viability of the individual dams, which may need to be studied under a non-disclosure agreement, or of the performance of decommissioning funds or other trust funds for this purpose.

(5) Explain any nexus between Project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.

There is a direct connection between Project operations and the economic viability of each individual dam. Study results could lead to a license requirement setting up an escrowed decommissioning or trust fund to protect the public interest.

(6) Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.

The financial viability portion of the study would follow normal procedures in accounting and financial management. The rules of trusts or decommissioning funds are well known.

(7) Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.

The requested study would be relatively inexpensive. Funding the trust would be another matter. We are unaware of alternative means of securing the public from risks that the corporations or the physical assets might fail during the course of the federal license.

Conclusion:

We respectively request studies of multiple-day self-powered trips on the river, a controlled-flow analysis in the bypass reach; a historical, educational, and cultural study; a recreation study at Northfield Mountain; and a decommissioning study that will support dialog and analysis regarding the relicensing of the Turners Falls Dam and the Northfield Mountain Pumped Storage facility.

In addition, we offer our comments on the PADs to better inform this relicensing process. Thank you for considering these comments.

Respectfully submitted this 28th day of February, 2013.

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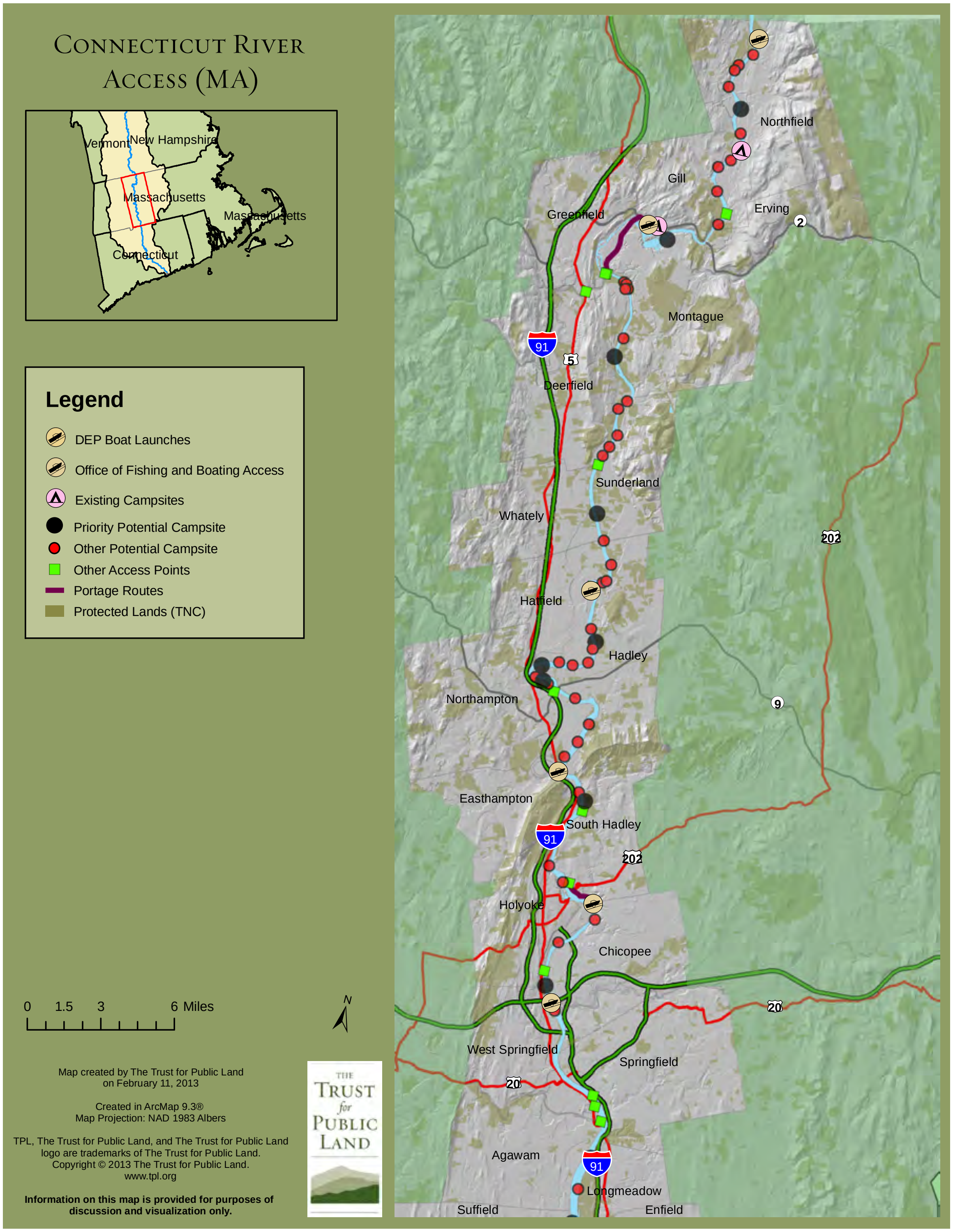
Appendix 1, Paddlers' Trail, MA, Overview, published by the Trust for Public Lands.

See electronic pdf/attachment on last page.

Turners Falls diversion canal.


Connecticut River Access (MA)
Vermont
New Hampshire
Massachusetts
Massachusetts
Connecticut
Legend
DEP Boat Launches
Office of Fishing and Boating Access
Existing Campsites
Priority Potential Campsite
Other Potential Campsite
Other Access Points
Portage Routes
Protected Lands (TNC)
0 1.5 3 6 Miles
N
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Hatfield
Hadley
Northampton
9
Easthampton
South Hadley
91
202
Holyoke
Chicopee
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West Springfield
Springfield
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Agawam
91
Longmeadow
Suffield
Enfield

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

FirstLight Power Resources	Turners Falls Project No. 1889-081 Northfield Mountain Pump Storage Project No. 2485-063

NEW ENGLAND FLOW, AMERICAN WHITEWATER, AND THE APPALACHIAN MOUNTAIN CLUB'S COMMENTS AND STUDY REQUESTS IN RESPONSE TO THE NOTICE OF INTENT TO FILE LICENSE APPLICATION, FILING OF PRE-APPLICATION DOCUMENT (PAD), COMMENCEMENT OF PRE-FILING PROCESS, AND SCOPING: REQUEST FOR COMMENTS ON THE PAD AND SCOPING DOCUMENT, AND INDENTIFICATION OF ISSUES AND ASSOCIATED STUDY REQUESTS REGARDING THE TURNERS FALLS HYDROELECTRIC PROJECT, FERC PROJECT NO.1889-081 AND THE NORTHFIELD MOUNTAIN PUMP STORAGE PROJECT, FERC PROJECT NO. 2485-063.

New England FLOW is a regional non-profit organization whose affiliations have represented whitewater boaters, canoeists, rafters, and other river users on multiple project re-licensings throughout New England for over 25 years. American Whitewater is a national non-profit organization dedicated to protecting and restoring our nation's whitewater resources and enhancing opportunities to enjoy them safely. Since 1876, the Appalachian Mountain Club (AMC) has promoted the protection, enjoyment, and understanding of the mountains, forests, waters, and trails of the Appalachian region, and is the largest conservation and recreation organization in the Northeast with more than 90,000 members. All three groups are steering committee members of the Hydropower Reform Coalition based in Washington, D. C. Our members who are primarily conservation-oriented kayakers, canoeists, and rafters would enjoy this section of the Connecticut River as a weekend trip.

The Turners Falls section of the Connecticut River has the potential ability to offer whitewater paddling opportunities of sufficient quality during irregular spillage events. At moderate spillage flows, the bypass run is used by boaters to surf waves and perform a wide array of acrobatic tricks called "freestyle" paddling. All manufacturers of whitewater kayaks design boats for this purpose.

In addition to kayaking, this reach has potential for rafting, guided kayaking, canoeing, instruction, and general paddling use. Collectively, the recreational use of the resources at this project has the potential to add economic value to the region given its central New England location and its proximity to the University of Massachusetts, Holyoke and Greenfield Community Colleges, and the Northfield-Mt. Hermon School. Millions of people live within a three-hour drive of the Turners Falls facility.

Issue #1: Impacts of the Connecticut River flow diversion on recreational paddling at the Turners Falls bypass reach.

The Turners Falls project's 2.7-mile diversion reduces instream flows substantially, leaving only minimum flows or those flows required for fish passage by the U. S. Fish & Wildlife Service, National Marine Fisheries Service, or the Massachusetts Department of Fish & Wildlife. Natural boatable flows under current operations are high, flashy, unpredictable, and are only available during periods of seasonal spillage to reduce flooding. Some of the whitewater opportunities eliminated by the project could be provided in a moderate, stable, and predictable operational mode and occur during warm weather. The current operation of the project, and lack of access, virtually eliminates valuable summer paddling opportunities.

Lost Rapids Below the Dam Under Turners Falls Bridge

The analysis presented is based on the anecdotal experience provided by local and regional boaters who have used this reach when it becomes available. The recreation-flow relationship needs to be substantiated through both operational analyses and recreational analyses. The correct context to conduct this inquiry is through the use of a "controlled-flow analysis," a stepwise methodology described by Whittaker et al., in "*Flows and Recreation: A guide to studies for river professionals"* (2005), as we formally request below.

In the PAD, the Licensee proposes no flow enhancement to mitigate the project's effects on whitewater recreational use.

In addition to recreation and aesthetics, we recognize that flow-related decisions also affect economic factors related to power generation and other environmental variables, particularly fish passage. We look forward to exploring how all flow-related values relate to one another through participation in this relicensing process.

Issue # 2: Public Access for whitewater boating, rafting, and canoeing is inadequate.

Directly below the Turners Falls Dam at Station #1, there is currently no formal public access or parking owned by the Licensee for whitewater boaters. In order to access the whitewater rapids directly below the Turners Falls Dam, boaters must use the parking available at the Great Falls Discovery Center. Adjacent to the Center is a footpath that boaters can traverse down to the river; however, the Licensee does not own this lot. For access to the whitewater flows below the Cabot Station, parking for boaters is likewise problematic, with limited parking. The takeout for both runs (Station # 1 and Cabot) is at the confluence of the Deerfield River. The access road to this site is not adequate for ordinary 2-wheel drive vehicles and should be upgraded. The steep riverbanks make egress at the end of the run difficult, and although able-bodied kayakers can struggle up the path, the terrain severely limits rafting use, or use by anyone carrying a heavy canoe.

The Licensee identifies in the PAD a shuttle service around the dam for canoeists or boaters, but it provides no value to whitewater enthusiasts who wish to access the rapids immediately below the dam. Boaters are picked up at Barton Cove and shuttled to a put-in off Poplar Street in Montague City, eliminating any potential whitewater run. This portage is unacceptable for flatwater boaters and no use at all to whitewater boaters.

In the PAD, the Licensee proposes no new river access areas.

Issue # 3: Adequacy of camping and sanitary facilities available for multiple-day kayaking or canoe trips (Recreation Use and Needs).

In the PAD, the Licensee cites the Massachusetts SCORP (2006-2011), which indicated a need for "water-based" activities, and one of the goals of the New Hampshire SCORP identified the need for a <u>variety</u> of recreational opportunities. The Vermont SCORP (2005-2009) reveals the need for access to <u>all</u> types of outdoor recreation. While the applicant has itemized and described the different recreational opportunities available throughout the reach from Turners Falls Dam to the Vernon Dam, they have not provided a qualitative analysis of these facilities.

Information provided by canoe clubs and other river recreational interests cite changing demographics and an increase in sea kayaking as reasons for the high interest in flatwater paddling and multiple-day canoe trips.

In the PAD, the Licensee identifies two sites, Barton Cove Campground and Munn's Ferry Campground, as the only two sites with facilities amenable to multi-day trips. However it does not quantify the number of campsites available or the quality of the facilities within each location. Barton Cove Campground does not have a suitable landing site. Nor does the PAD address the adequacy of such facilities for increased use over the next 30 years of a license.

In the PAD, the Licensee proposes no new camping sites or upgrades to existing sites.

Issue #4: Economic impacts.

The diversion of flow around the Turners Falls Dam has significant negative recreational impacts and related socio-economic impacts. By changing the operational scenario of the Turners Falls Project, the potential exists to create new tourism products for a region that is primed to capitalize on it. Retail activity, and food and lodging opportunities will be geared toward non-commercial paddlers, and thousands of people who currently travel to the region each year for rafting, kayaking and other outdoor adventure activities will discover added value to the region.

In making a public interest decision, FERC must weigh the value of water in the river against the value of water in the bypass reach, and then reach a comprehensive plan for the development of the river that strikes the appropriate balance and is best adapted to the river. In many dam relicensing proceedings, the values of flow restoration are largely recreational and ecological, and thus hard to evaluate in dollars. In this case, because of its potential to increase recreation with scheduled flows, we believe FERC should also weigh the predicted economic value associated with the recreational use when looking at various alternatives.

Issue #5: Mitigation for Loss of Whitewater Recreation at Great Falls and Upstream

The Turners Falls Dam sits atop Great Falls and drowns whitewater rapids upstream under a reservoir that extends all the way to the Vernon Dam. Construction of the dam eliminated significant whitewater opportunities both above and below the dam. It would be possible to compensate for this loss through either on-site or off-site mitigation such as at Bellows Falls.

Lost Rapids in the Bypass Reach Below the Dam

In 2012, Secretary of the Interior Ken Salazar designated the Connecticut River and Watershed as the nation's first National Blueway. The National Blueway System (NBS) goals include providing outdoor recreation. NBS takes a watershed and source-to-the sea view of the river in seeking to advance "conservation, outdoor recreation, education, and sustainable economic opportunities" in the watershed. The National Blueway designation includes all the tributaries in the 7.2 million acre Connecticut River watershed and has the support of several federal agencies, including the U.S. Army Corps of Engineers, the Silvio Conte Refuge, U.S. Fish and Wildlife Service, the National Park Service, and the States of Connecticut, Vermont, New Hampshire, and the Commonwealth of Massachusetts, which have prioritized conservation, recreation, and restoration.

Study Requests

We hereby request several studies per 18 CFR 5.9(b).

1. Controlled Whitewater Flow Study in the bypass reach below Turners Falls Dam.

(1) Describe the goals and objectives of each study proposal and the information to be obtained.

The goal of a whitewater flow study is to assess the presence, quality, access needs, flow information needs, and preferred flow ranges for river-based boating resources in a stepwise manner. The information to be obtained can be generally characterized as quantitative and qualitative descriptions of:

- The range of optimal and acceptable flows for whitewater paddling;
- The frequency, timing, duration and predictability of optimal and acceptable paddling flows under current conditions in the bypass reach, and how proposed alternative operations could be used;
- The access needs of whitewater boaters and the current and potential river access option for whitewater and other paddling;
- The flow information needs of whitewater boating and the current and potential flow information distribution system;
- The location, challenge, and other recreational attributes associated with specific rapids and other river features.

Thus, the information to be obtained for the whitewater paddling study is a combination of user-generated flow preferences and other data from test runs, information on current and proposed operations (e.g. discharges), geographic information, and basic recreational information.

(2) If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.

The requester is not a resource agency.

(3) If the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.

The Turners Falls bypass reach offers the public a high-quality whitewater boating resource when flow conditions are suitable. Conducting the necessary studies and implementing measures to ensure public access to outdoor recreation is in the public interest. It is widely accepted that outdoor recreation has significant benefits to participants including health, well being, and quality-of-life. Outdoor recreation also has proven economic benefits for communities located near recreational resources.

Restoration of whitewater recreational opportunities in the Connecticut River has the potential to offer the region economic benefits. FERC has concluded that *"to fully evaluate the project's effect on whitewater recreation opportunities and to balance potential enhancement opportunities with their cost, a controlled-flow whitewater boating study is relevant to Commission's public interest determination."* This is equally true regarding the Turners Falls Project on the Connecticut River.

The Commonwealth of Massachusetts owns and operates several river access areas on the Connecticut River in the vicinity of the Project, and thus has a clearly expressed interest in the public's ability to navigate the state's rivers. In addition to this interest, the Connecticut River and Watershed has been designated at America's first *"Heritage River"* and *"National Blueway."*

(4) Describe existing information concerning the subject of the study proposal, and need for additional information.

While many flow studies as described above have been conducted during FERC relicensings on New England's rivers (e.g., Deerfield, Kennebec, Rapid, Green) that have a long history of whitewater paddling use, this section of the Connecticut River is largely unknown to whitewater boaters. Rapids are un-named, the range of difficulty is unknown, and current access opportunities are difficult. The potential high quality of this scenic 2.7-mile long whitewater run should be explored.

Current and historic project operations, however, have resulted in significant information gaps and virtually eliminate all stable low and moderate flows from this reach. The result has been flows too low to paddle, or flashy, spiking high flows. Intermediate paddlers, commercial paddlers, and general river-runners know relatively little about this river at low or moderate flows. It should also be determined if there is adequate potential to improve river access in a way that offers a high quality car-top put-in and takeout that allows for use of the entire bypass reach.

(5) Explain any nexus between Project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.

The Project controls flows in the Connecticut River by withdrawing more than 13,000 cfs. The operations eliminate 95% of the paddling days on average each year, including the virtual elimination of valuable and regionally needed summer paddling opportunities. The Connecticut

River can be a high-quality paddling resource, and since paddling is a flow dependent activity, the project directly affects paddling on the Connecticut River. The project nexus is direct. The results of a controlled flow study would help determine the need for license requirements for scheduled whitewater releases.

(6) Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.

The study we request on the Turners Falls reach of the Connecticut River should follow the standard methodology as described in Whittaker, referenced above. This methodology is designed to gather information to assess the presence, quality, and preferred flow ranges for river-based boating resources in a step-wise manner. The process steps are generally 1) desktop analyses, 2) on-land feasibility assessment, 3) on-water single flow assessment, and 4) on-water multiple flow assessment. We request the full implementation of this methodology.

Because the quality of the resource and flow needs are not known, we request that an on-water multiple flow assessment be conducted. This study will need to take place on various dates and at variable flow levels throughout a spring and summer. Spring dates are needed to capture moderate and high flows, which may be primarily stochastic, while late spring and summer dates afford the opportunity for scheduled lower flow releases. Higher flow data may be best gathered by an internet-based survey, while lower flow data may be best gathered on-site through controlled study opportunities. We will work with the Licensee to document the known information regarding the river. We will provide volunteers and technical support for the studies as appropriate. We hope to work collaboratively with the Licensee on this study. The whitewater boating study methodology we have requested has been used on dozens of other FERC regulated reaches.

(7) Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.

We are willing to work with the Licensee on the whitewater paddling controlled-flow study to keep costs reasonable and the quality of information high. The information that is already known can jump-start the study process and avoid un-needed effort. What will be subsequently needed is the integration of this information and then an organized flow study during which several flows are paddled by boaters, with still image and video documentation, surveys of the boaters, a guided conversation among the boaters, and subsequently a written report. Given that this is a bypass reach with some access and relatively straightforward hydrology, and given the collaborative approach sought by the paddling community, including in-kind contributions of time and expertise, a consultant should be able to complete this study on behalf of the Licensee for a very reasonable cost.

The Licensee PAD proposes no whitewater feasibility analysis. This no-action step will reveal nothing about the project impacts on whitewater recreation or opportunities for protection, mitigation, or enhancement measures. We currently do not know the relationship between specific low- and moderate-flows and the paddling experiences they provide. A desktop analysis cannot generate this information. Without this information we cannot fully define the project impacts, nor propose and consider provision of releases that provide targeted recreational experiences.

2. Public Access for whitewater boating, rafting, and canoeing is inadequate.

***(1) Describe the goals and objectives of each study proposal and the information to be obtained*.**

The goal of this study is to identify and define adequate access points that provide trails and car-top parking at Station #1 and Cabot Station, and egress at the end of the 2.7-mile run at the confluence of the Deerfield River. The paddling community is interested in access points for the following areas:

- At Turners Falls Dam at Station #1
- At Turners Falls Dam at the Great Falls Discovery Center
- At Cabot Station
- At the confluence of Connecticut and Deerfield Rivers.

(2) If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied;

The requester is not a resource agency.

(3) If the requester is a not resource agency, explain any relevant public interest considerations in regard to the proposed study.

The public has an interest in healthy rivers and streams that support the full suite of beneficial uses and other goals of the Clean Water Act. Access to streams and rivers with adequate base flows and sufficient variability to support high-quality whitewater recreational use will support other businesses within the regional economy.

Several federal agencies may have management goals under the National Blueway System, including the Department of Interior and the National Park Service.

(4) Describe existing information concerning the subject of the study proposal, and the need for additional information.

There is an inconsistent body of knowledge regarding access needs in this reach, and we look forward to learning more. The PAD does not identify access points for any type of whitewater use.

(5) Explain any nexus between Project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements

The project eliminates or does not provide access points for whitewater use. This study is vital to developing a mechanism for defining access points that can best be adapted for whitewater boating and other potential uses.

This study may result in license requirements or other mitigation for the Licensee regarding access to the Connecticut River.

(6) Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.

The flows that paddlers enjoy on virtually all undammed streams are natural components that provide recreation and multiple other functions. Hydropower project operations disrupt or eliminate access that would otherwise naturally provide these recreational values. We request sufficient analysis be conducted to understand the Project topography that would detail which sites would best provide adequate access for multiple uses. Use of Geographic Information System (GIS) may provide a general overview of potential access points within Project bounds and may be helpful.

Given the steep topography leading to the bypass reach, this work should be completed using accepted and certified surveying methods that "ground truth" GIS analysis. Scheduling of this work should be completed during the summer field season when low seasonal flow will allow surveying activities within the bypass reach.

Boater access ramp at the Kennebec River in Maine

(7) Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.

The recommended GIS analysis is a relatively simple desktop analysis using software that is currently available and thus should require little effort or cost. Once potential access points are identified, the cost of a survey is nominal when presented in the context of other studies required by FERC or other stakeholders. No other studies would address the specificity required to identify, layout, and design adequate access for this project.

3: Camping and sanitary facilities available for multiple-day kayaking or canoe trips (Recreation Use and Needs).

(1) Describe the goals and objectives of each study proposal and the information to be obtained.

The goal of this study is to provide a quantitative and qualitative analysis of existing facilities to determine their capacity to manage the increasing number of paddlers who are making multiple-day trips on the Connecticut River. This study should also identify other points on the river that would be suitable for the establishment of additional facilities. And it should assess the adequacy of such facilities for a 30-50 year license period during which river use will increase dramatically.

(2) If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied;

The requester is a not resource agency.

(3) If the requester is a not resource agency, explain any relevant public interest considerations in regard to the proposed study.

The public has an interest in healthy rivers and streams that support the full suite of beneficial uses and other goals of the Clean Water Act. Access to streams and rivers with adequate base flows and sufficient variability will support high-quality recreational use. Information provided by canoe clubs and other river recreational interests cite changing demographics and the rise of sea kayaking as reasons for high interest in flatwater paddling and multiple-day canoe trips.

In the PAD, the Licensee cites the Massachusetts SCORP (2006-2011), which indicated a need for "water-based" activities, and one of the goals of the New Hampshire SCORP identified the need for a variety of recreational opportunities. The Vermont SCORP (2005-2009) reveals the need for access to all types of outdoor recreation.

In addition, the National Blueway System seeks to promote recreational uses wherever possible.

(4) Describe existing information concerning the subject of the study proposal, and the need for additional information.

The Licensee identifies two sites, Barton Cove Campground and Munn's Ferry Campground, as the only two sites with facilities amenable to multi-day trips. One of the better publications available to gather this information is *The Connecticut River Boating Guide: Source to the Sea*, published by the Connecticut River Watershed Council, 3rd Edition, 2007. Those who have through-paddled the Connecticut River say that camping opportunities evaporate once they cross the Massachusetts border. They find islands closed to camping, and frequently end up sleeping on mudflats or illegally camping on isolated privately-owned sites.

(5) Explain any nexus between Project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.

This study will be the defining mechanism for identifying additional sites that can best be adapted for increasing public access and multiple-day paddling trips on the Connecticut River. License requirements may include having the Licensee purchase additional property to provide camping, trail sites, portages or other facilities to assist the public.

(6) Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.

Our interest is in having sufficient information to understand what facilities exist, and what, if any, improvements are necessary to manage an increasing use of multiple-day kayak and canoe trips on the Connecticut River. This analysis should include recommendations for the acquisition and development of additional facilities to meet the interests and needs identified in the multi-state SCORP documents cited by the Licensee in the PAD, and adequate for a 30-50 year license.

(7) Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.

There are several sites along the Connecticut River, private and public, that are used as access points or have camping facilities. However, there are vast differences in the ability or capacity of these sites to handle paddling groups of varying size and numbers or sanitation needs. Because there is no comprehensive guide or text that provides updated information, visual inspection of existing sites should take place. Any needed reconstruction or rehabilitation of existing facilities should be identified. This analysis can be completed during any spring, summer, or fall field season. Such field research needs to be matched with projections of use in the future and with standard requirements for access sites, campsites, portages, and sanitation facilities.

4: Economic impacts.

***(1) Describe the goals and objectives of each study proposal and the information to be obtained*.**

The goal of the recreational economic impact study is to examine the regional economic benefits of various flow alternatives that can be provided by restoring flows to the Turners Falls bypass reach. This study should include a contingent valuation study that compares the economic values of recreation to power generation.

(2) If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.

The requester is not a resource agency.

(3) If the requester is a not resource agency, explain any relevant public interest considerations in regard to the proposed study.

Economic stimulus is clearly in the public interest. Many New England hydropower projects support robust recreation economies. The Deerfield River (FERC No. 2334-0-0) currently injects over $10 million annually into the community of Charlemont, Massachusetts, and is a superb example of supporting multiple businesses throughout the town. Other examples include the Kennebec River and the Penobscot River in Maine, the Black River in New York, and the Gauley River in West Virginia.

(4) Describe existing information concerning the subject of the study proposal, and the need for additional information.

We are unaware of existing information regarding the economic potential of the Turners Falls bypass reach and we look forward to learning more. However, Crane Associates of Burlington, Vermont, published a study in 2005: *"The Economic Impacts of Whitewater Boating on the West River, Jamaica, Vermont."*

(5) Explain any nexus between Project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.

The project has eliminated most paddling opportunities throughout the year. Many of these days could provide kayaking, instructional paddling, canoeing, paddle-boarding, and rafting, all of which have ancillary economic benefits associated with any form of tourism.

Understanding the economic values that could be provided by restoring paddling recreation to the Turners Falls bypass reach will assist FERC and other stakeholder in balancing the trade-offs associated with lost generation. In the case of the Deerfield River, the value of whitewater recreation outweighed the value of power generation by a margin of 24:1.

(6) Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.

Since the present economic values cannot be determined because there is currently minimal recreational activity in the bypass reach, we request the study be compiled using the *"contingent valuation"* method that measures individual's *"willingness to pay."* These values can then be compared to the dollar values of power generation. The economic benefits can be extrapolated to develop an understanding of how those dollars will be multiplied throughout the community as benefits associated with paddling activities. Overall visitor spending will contribute to the economy of the immediate and adjacent region. Such a contingent valuation study would appropriately be done following test runs on the bypass reach for the study described above.

(7) Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.

Primary data should be collected through survey instruments circulated through known paddling clubs throughout New England during the winter months. Individual interviews should be taken on days when the nearby Deerfield River is having releases, and the survey should include kayakers, canoeists, and rafters of varying abilities. Customers of commercial outfitters should also participate in the survey as well as outfitters that provide tubing equipment for those individuals that enjoy just floating down the river. Paddlers who participate in test runs would have a firsthand knowledge of the values.

Contingent valuation studies provide reliable, comparable information that can be used to frame license requirements.

The Licensee has proposed no economic studies in the PAD.

5. Mitigation of Impacts on the Connecticut River and Loss of Whitewater Recreation at and above Turners Falls Dam

(1) Describe the goals and objectives of each study proposal and the information to be obtained.

The goal of this study is to assess the presence, quality, access needs, flow information needs, and preferred flow ranges for regional whitewater boating resources that would mitigate for the loss of whitewater recreation at the Turners Falls Dam.

(2) If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.

The requester is not a resource agency.

(3) If the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.

The Turners Falls Dam removes the public's opportunity to enjoy a whitewater boating resource. Conducting studies and implementing the necessary measures to ensure the public has access to whitewater recreational resources is in the public interest.

Using off-site mitigation has historically been an acceptable practice in FERC licensing. This is evidenced in the Upper Androscoggin Settlement Agreement (FERC No. 11834-000) for the Rapid and Magalloway Rivers in Maine, as well as the Canada Falls Settlement Agreement (FERC No. 2634) for the South Branch of the Penobscot River in Maine.

On May 24, 2012, Secretary of the Interior Ken Salazar designated the Connecticut River and Watershed as the nation's first National Blueway. A Memorandum of Understanding signed in August by the Departments of Interior, Agriculture, and the Army has an objective of "providing opportunities for scientific research, environmental education and outdoor recreation and access within the National Blueway to the extent compatible with agency missions." The National Blueway concept takes a watershed viewpoint and addresses the river from its source to the sea. The National Blueways System has as its goal "to advance a whole river and watershed-wide approach to conservation, outdoor recreation, education, and sustainable economic opportunities in the watersheds in which we live, work, and play." The National Blueway designation includes all the tributaries in the watershed and involves several federal agencies. These agencies include the U.S. Army Corps of Engineers, the Silvio Conte Refuge, the U.S. Fish and Wildlife Service, the National Park Service, and the States of Connecticut, Vermont, New Hampshire, and the Commonwealth of Massachusetts, which have prioritized conservation, recreation, and restoration in the 7.2 million-acre Connecticut River Watershed.

Restoration of recreation opportunities in the watershed of the Connecticut River has the potential to offer the region significant economic benefits.

(4) Describe existing information concerning the subject of the study proposal, and need for additional information.

Current and historic project operations at the Turners Falls Dam provide no consistent or meaningful information for this type of mitigation. It should be determined what flows in the region are best suited for maximum recreational use.

(5) Explain any nexus between Project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.

The flows from Station #1 and Cabot Station at Turners Falls vary between base load and peaking. It becomes very difficult for whitewater boaters to have any consistent flows for whitewater recreation. The Project controls the entire flow in the Connecticut River and the Licensee apparently has limiting factors that generally prevent boatable conditions in the bypass reach and main stem channel except during flood conditions. The result also damages regionally needed summer paddling opportunities in the main stem below the bypass reach.

The dam itself was built on the Great Falls and dewatered the bypass reach, and the reservoir drowned upstream rapids, which would be sufficient cause for off-site mitigation. FERC needs to balance the paddling resources and power generation under the *"Electric Consumers Protection Act" (16 U.S. C. §797,803).* The project nexus is direct.

Study results would and should develop the basis of license terms, including possible off-site mitigation, that could protect the public interest and provide the balance mandated under ECPA.

Lost Rapids Downstream From Station #1 and Cabot Station

(6) Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.

The first step would gather information to assess the presence and quality of options for off-site mitigation. The process steps are generally 1) desktop analyses of candidate rivers, 2) resource agency identification and feasibility assessment, and 3) inter-agency meetings with resource agencies, Licensee, and representatives of the boating community to explore opportunities for mitigation.

We will provide volunteers and technical support for the studies as appropriate. We hope to work collaboratively with the licensee and other agencies on this study.

(7) Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.

We are willing to work with the Licensee on an off-site mitigation study to keep costs reasonable and the quality of information high. Any information that is already known through numerous guidebooks and publications can jump-start the study process and avoid un-needed effort. What will be subsequently needed is the integration of this information and then organized meetings to study alternatives, and subsequently a written report.

Given the collaborative approach sought by the paddling community, including in-kind contributions of time and expertise, the Licensee and agencies should be able to complete these studies for this unique approach to mitigation for a very reasonable cost.

The Licensee PAD proposes no whitewater feasibility analysis.

Conclusion:

We respectively request the hydrological, recreational, economic studies, and off-site mitigation that will support the dialog and analysis regarding the restoration of flows and associated recreational values to the Turners Fall project.

In addition, in these comments we offer our comments on the PAD, to better inform this relicensing process. Thank you for considering these comments.

Respectfully submitted this 28th day of February, 2013

Thomas J. Christopher

Thomas J. Christopher, Secretary/Director
New England Flow
252 Fort Pond Inn Road
Lancaster, MA 01523

Bob Nasdor

Bob Nasdor
Northeast Stewardship Director
American Whitewater
65 Blueberry Hill Lane
Sudbury, MA 01776

_/s/Normal Sims______________________________

Norman Sims
Representing the Appalachian Mountain Club
16 Linden Ave.
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_/s/Kenneth Kimball______________________

Kenneth Kimball
Director of Research
Appalachian Mountain Club
P.O. Box 298
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UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

FirstLight Power Resources	Turners Falls Project No. 1889-081 Northfield Mountain Pump Storage Project No. 2485-063

<u>CERTIFICATE OF SERVICE</u>

Pursuant to Rule 2010 of the Commission's Rules of Practice and Procedure, I hereby certify that I have this day caused the foregoing NEW ENGLAND FLOW, AMERICAN WHITEWATER, AND THE APPALACHIAN MOUNTAIN CLUB'S COMMENTS AND STUDY REQUESTS IN RESPONSE TO THE NOTICE OF INTENT TO FILE LICENSE APPLICATION, FILING OF PRE-APPLICATION DOCUMENT (PAD), COMMENCEMENT OF PRE-FILING PROCESS, AND SCOPING: REQUEST FOR COMMENTS ON THE PAD AND SCOPING DOCUMENT, AND INDENTIFICATION OF ISSUES AND ASSOCIATED STUDY REQUESTS REGARDING THE TURNERS FALLS HYDROELECTRIC PROJECT, FERC PROJECT NO.1889-081 AND THE NORTHFIELD MOUNTAIN PUMP STORAGE PROJECT, FERC PROJECT NO. 2485-063 to be served upon each person designated on the official service list compiled by the Secretary in this proceeding.

Dated this 28th day of February, 2013.

Megan Hooker
American Whitewater
Bend, Oregon

UNIVERSITY OF MASSACHUSETTS
AMHERST

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February 28, 2013

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

Subject: Comments on Scoping Document 1 for the Wilder (FERC No. 1892-026), Bellows Falls (FERC No. 1855-045), Vernon (FERC No. 1904-073), and Turners Falls (FERC No. 1889-081) hydroelectric projects, and the Northfield Mountain Pumped Storage Project (FERC No. 2485-063)

Dear Secretary Bose:

I am writing this letter as the University Director of the Northeast Climate Science Center. This letter is in response to the December 21, 2012 Federal Energy Regulatory Commission (FERC) filing of the Notice of Intent to File License Application, Filing of Pre-Application Document (PAD), Commencement of Pre-Filing Process, and Scoping; Request for Comments on the PAD and Scoping Document, and Identification of Issues and Associated Study Requests for the Wilder, Bellows Falls, Vernon, and Turners Falls hydroelectric projects, and the Northfield Mountain Pumped Storage Project.

The Northeast Climate Science Center (NECSC) is one of eight of the Department of Interior (DOI) funded Climate Science Centers, which are supported by the US Geological Survey's National Climate Change and Wildlife Science Center (NCCWSC). The national mission of the NCCWSC is to provide natural resource managers with the tools and information they need to develop and execute management strategies that address the impacts of climate and other ongoing global changes on fish and wildlife and their habitats. The three primary goals of the NCCWSC are to: 1) Assess and synthesize our state of knowledge about climate change impacts, 2) Work collaboratively with the resource management community to develop adaptation methodologies that minimize the effect of climate change impacts on the Nation's fish, wildlife, and habitats, and 3) Foster research that increases understanding of the interactions between climate and the physical, biological, and chemical forces that influence the structure and functioning of ecosystems and the goods and services they provide.

The Northeast Climate Science Center was established one year ago, and received its initial funding from DOI for a five year period. The NECSC is composed of a consortium of universities comprised of the University of Massachusetts Amherst, College of Menominee Nation, Columbia University, Marine Biological Laboratory, University of Minnesota, University of Missouri-Columbia, and University of Wisconsin-Madison. As one of eight

Climate Science Centers, our study area is the greater northeastern portion of the US. This region is contained within boundaries ranging from Maine southward to Virginia, westward to Missouri, then northward to Wisconsin, and the eastward back to Maine. This area is a region of enormous diversity in geography, climate, biology, and human land use. The NECSC serves 22 states, multiple ecoregions, seven of the 21 regions established for the National Landscape Conservation Cooperative (LCC) Program, and a human population of 131,000,000 (41% of the US population). One of our goals is to understand the impacts of climate change on the resources in this region. In particular, we are very interested in the interface between climate change, infrastructure and natural resource management.

The FERC relicensing of the reservoirs on the Connecticut River is a very important process and I have been following it with great interest. I have been extremely impressed with the level of engagement demonstrated by the natural resource community and the excellent work by the FERC staff. I am writing to add the voice of the NECSC to those who have expressed concerns that in this process, the impacts of climate change on the streamflows in the Connecticut River be explicitly considered in evaluating management alternatives and options.

During the last five years, researchers at the University of Massachusetts Amherst have been studying the range of impacts of climate change on the Connecticut River. We have done this using the hydrologic models of the Connecticut River basin, outputs from highly regarded General Circulation Models (GCMs) and likely emission scenarios provided by the Intergovernmental Panel on Climate Change (IPCC). These results provide a range of future possibilities; however, they consistently indicate the following: 1) An increase in annual temperatures, 2) An increase in total annual precipitation, 3) An increase in high flow events, 4) Significant shifts in the timing of the annual hydrograph, and 5) Greater variability in the low flow regime.

All of these changes can have significant impacts on the flows in the Connecticut River and on how the hydropower facilities on the river and its tributaries should be managed. The relicensing process led by FERC is the one opportunity that exists to investigate how these climate change impacts may influence reservoir operations, and in turn, the management of the aquatic resources in the river.

There is no doubt that climate change is real, that, nationally, we are already seeing the impacts of these changes in our frequency of flood events and droughts and shifts in the hydrograph, and that ignoring these changes in managing our river resources is unwise. The notion that climate "stationarity is dead" is well accepted in the water resources profession and it is important to include this change in any long term planning. With the longevity of FERC licenses, is it especially important that changes in climate be considered in the many studies that are being proposed to supplement this review process and in the final FERC relicensing process.

From our studies we anticipate that in the future, on average, there will be higher streamflows throughout the Connecticut River basin and this will have positive impacts on the quantity of hydropower that can be produced by the systems under study. However, climate change will increase the need to evaluate a wider range of possible operating alternatives and policies to deal with this change over time and to evaluate the impacts of the change, along with reservoir operations, on the aquatic resources in the river.

Although it would be easy to simply use the past as a guide to the future in terms of expected streamflows in the Connecticut River basin, we would strongly urge you against taking this approach. Because there is significant research on the climate impacts on streamflows in the Connecticut River basin, and because they suggest significant changes from the flow regimes of the past, ignoring these changes in the FERC process could lead to erroneous assumptions about future conditions and, in turn, inaccurate results.

We hope that as you review the comments from stakeholders and explore the proposed additional studies, that you will conclude that climate change projections should be a fundamental ingredient in all future work. Relying on the past 50 years for streamflow data in evaluating these facilities will be insufficient without an understanding of the changes in flows that are likely ahead during the next 50 years.

Thank you for considering this request.

Sincerely,

Richard N. Palmer

Richard N. Palmer, Ph.D., PE
Department Head and Professor
Civil and Environmental Engineering

Franklin Conservation District
Hayburne Building - 55 Federal Street
Greenfield, MA 01301
413-772-0384 ext. 110

February 28, 2013

Honorable Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

RE: Northfield Mountain Pumped Storage Project No. 2485-063
Turners Falls Project No. 1889-081
Comments on the Preliminary Application Document, Scoping Document 1, and Study Requests

Dear Secretary Bose,

The Franklin Conservation District (District) was established in the 1940's under Massachusetts General Law, Chapter 21, Sections 18-25 as a quasi-state agency for the purpose of delivering conservation programs at the county level. The purposes of Conservation Districts in Massachusetts are: to focus attention on land, water and related resource problems; to develop programs to solve them; to enlist and coordinate help from all public and private sources that can contribute to accomplishing the District's goals; and to make citizens aware of the interrelationships between human activities and the natural environment.

The Conservation District has been intimately involved with efforts to address erosion on the reach of the Connecticut River from the Turners Falls dam to the Vernon dam, also known as the Turners Falls Pool, since the 1980s. In fact, it was the work of the District in conjunction with the former Franklin County Planning Board that led the Franklin County Commission to form the Connecticut River Streambank Erosion Committee (CRSEC) that has been working with the various utility companies that have owned and operated the Northfield Mountain Pumped Storage Project, with affected landowners and state and federal resource agencies, and with the FERC to address the long-term and ongoing exacerbated erosion of riverbanks in the Pool.

The District appreciates the opportunity to submit comments on the Preliminary Application Document (PAD) and Scoping Document 1, and to submit Study Requests for the projects. The comments on the PAD and Scoping Document 1 are organized by the major sections in each document. We describe some of the Study Requests that we support at the end of this letter. The specific study requests that the District is asking to be undertaken are contained in the Appendix to this letter. Finally, we note an additional issue to draw it to the attention of the FERC.

Comments on Pre-Application Document

Section 3.4.1

It is important to note the omission of the erosion articles in the licenses, Articles 19 of P-1889 and 20 of P-2485. Given the severity of bank erosion and the continuing struggle over license compliance related to these articles, they are critically important current license requirements.

Section 4.2.4

The PAD provides an incomplete and inaccurate portrayal of the conclusions of the 1979 ACOE report regarding the Turners Falls Pool. That report found this was the most hydrodynamically active stretch of the Connecticut River and that water level fluctuations caused by hydropower project operations were the largest contributor, after tractive force, to the exacerbated erosion.

The discussion of the 1991 ACOE follow up study and report omits mention of the fact that it documented a dramatic increase in the extent of eroded riverbank since the 1979 report.

The discussion of the Full River Reconnaissance Studies states that 2008 FRR reports that erosion is decreasing; it should be noted that the report and the methodology employed have been widely criticized and the conclusion vigorously disputed.

Section 4.3.1.4

This section fails to mention that the Licensee is forcing farmers to apply to the Licensee for a permit to withdraw irrigation water from the Connecticut River, saying it is a requirement of their FERC license. That is an arguable contention. This issue merits attention and resolution.

Comments on Scoping Document 1

The District offered detailed comments on the Scoping Document at the January 31, 2013 Joint Evening Scoping meeting in Turners Falls. Rather than repeat them here, the District notes and incorporates by reference the issues cited in that testimony and offers one additional comment.

Section 3.0

The District urges consideration of an alternative to the applicant's proposed action, specifically taking Northfield Mountain Pumped Storage Project off-stream, entirely or at least partially. This would be accomplished by creating and using a lower reservoir other than the Connecticut River.

Study Requests

The District supports many of the study requests of which it is aware and is making three, which are included in full in Appendix 1. In general terms they are:

- Study shoreline erosion caused by Northfield Mountain Pumped Storage (NMPS) operations
- Study the impacts of NMPS and Turners Falls dam on sedimentation in Connecticut River
- Study the feasibility of converting NMPS to a closed-loop or partially closed-loop system

Additional Issue

Administrative support for Connecticut River Streambank Erosion Committee (CRSEC)

Given the amount of time and resources necessary for the CRSEC to keep regional, state, and federal governmental entities, non-governmental organizations, and citizens adequately informed of and involved with addressing the erosion issue, it is reasonable that the licensee, benefitting economically from its use of a valuable public resource, provide annual funding to help support the administrative functions of the CRSEC, e.g. organizing and staffing meetings, etc.

Thank you for the opportunity to comment on these documents and important issues.

Sincerely,

Carolyn Shores Ness

Franklin Conservation District

Vice Chair

Appendix 1
Franklin Conservation District's Study Requests

Study Request 1 - Study of Shoreline Erosion Caused by Northfield Mountain Pumped Storage (NMPS) Operations

Development of the current configuration of the Northfield Mountain Pumped Storage project included raising the dam height at Turners Falls by 5.9 feet in 1970 in preparation for NMPS operations. Operations began in 1972; since then all project operations have operated under this raised dam environment. The additional 5.9 foot in elevation changed the elevation of the Turners Falls impoundment, which extends some 20 miles upstream. The increase in river elevation also resulted in motorized boat traffic becoming more popular and makes the use of larger boats more possible. The presence of motorized recreational boats increases wake energy that can accelerate bank erosion rates.

The operation of NMPS causes alterations to the river as a direct feature of plant functionality. The alterations include: 1) daily fluctuating pond levels which at times in some places can exceed six feet (the license allows fluctuations up to 9 feet measured at an undisclosed location near and upstream of the Turners Falls dam), 2) altered flow and velocity profiles of river and 3) changes to the downstream hydrograph. Elevation data for the river in Appendix E of the PAD indicate that stage changes of 2 to 3 feet during the summer of 2012 were not uncommon.

Raising the level of the river can saturate bank soils. These same soils can quickly become dewatered when the river is lowered by the NMPS pumping cycle. Repeated saturation and dewatering of banks can lead to bank instability which in turn can lead to bank failure and eroded material entering the river. See Field (2007)[1] for an extended discussion on bank erosion and failure mechanics. Elevated levels of turbidity and suspended solids in the water column can diminish rearing and migratory habitat for fish. When too much fine grain material is deposited on channel bed substrates, particularly those substrates used for spawning, spawning success of resident and migratory fish is compromised, potentially reducing recruitment and carrying capacity.

Goals and Objectives
The goals of this study request would be to determine the environmental effects of the presence and operation of the licensed facilities on river bank stability, shoreline habitat, agricultural farmland, wetland resources, bed substrate, and water quality in the Turners Falls impoundment. We recognize that data from other studies will be made available and we think that the data from these other studies could be used to help meet the objectives of this study request.
Objectives of the study include the following:

1. Calculate the total volume of eroded material, calculate resulting nutrient loading of eroded material, and document and describe the three dimensional changes to the bank, including lateral bank recession, changes to bank slope, and the presence and subsequent

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[1] Field Geology Services. (2007). *Fluvial geomorphology study of the Turners Falls Pool on the Connecticut River between Turners Falls, MA and Vernon, VT.* Prepared for Northfield Mountain Pumped Storage Project. Farmington, ME: Field Geology Services.

inundation of pre-project beaches and shoreline since the Turners Falls Dam was raised and the Northfield Mountain Pumped Storage facility came on-line.
2. Document and describe the changes to banks upstream and downstream of riverbank restoration projects, including bank recession.
3. Identify the changes that have occurred to bed substrate as a result of fine grain material being eroded from the banks and being deposited on the channel bed.

Relevant Resource Management Goals and Public Interest Considerations
Among our management goals is to ensure high quality habitat for migratory diadromous fish. Shortnose sturgeon, American shad and American eel all require suitable spawning, rearing, migratory and foraging habitat. Eroding banks and subsequent increases in turbidity and deposition of fine grained material onto bed substrates in the Turners Falls impoundment, the bypass reach and downstream of the Turners Falls project reduces the quality of habitat for these species. Elevated levels of suspended sediment are associated with a diminution in water quality which also affects the quality of habitat encountered by trust resource species.

In addition to habitat effects, soil erosion contributes to nutrient loading. In 2001, the U.S. EPA approved New York and Connecticut's Long Island Sound (LIS) dissolved oxygen TMDL. As a result, the New England Interstate Water Pollution Control Commission (NEIWPCC) established the Connecticut River Workgroup and the Connecticut River Nitrogen Project. This project is a cooperative effort involving staff from NEIWPCC, the states of Connecticut, Massachusetts, New Hampshire, and Vermont, and EPA's Region 1 and Long Island Sound (LIS) offices. All are working together to develop scientifically-defensible nitrogen load allocations, as well as an implementation strategy, for the Connecticut River Basin in Massachusetts, New Hampshire, and Vermont that are consistent with TMDL allocations established for LIS. Since its inception, the Connecticut River Workgroup has participated in a number of projects to better understand nitrogen loading, transport, and reductions in erosion.

Public Interest Considerations if Requester is not a Resource Agency.
The Franklin Conservation District (District) was established in the 1940's under Massachusetts General Law, Chapter 21, Sections 18-25 as a quasi-state agency for the purpose of delivering conservation programs at the county level. The purposes of Conservation Districts in Massachusetts are: to focus attention on land, water and related resource problems; to develop programs to solve them; to enlist and coordinate help from all public and private sources that can contribute to accomplishing the District's goals; and to make citizens aware of the interrelationships between human activities and the natural environment.

Existing Information and Need for Additional Information
The PAD makes reference to several studies in section 4.2.4 including the Erosion Control Plan (Simons & Associates, 1999), previous Full River Reconnaissance studies (1998, 2001 – maps but no report generated, 2004, and 2008), Field Geology Services' 2007 fluvial geomorphic investigation of the Turners Fall impoundment, and 2012 investigations by Simons & Associates. Field Geology Services' 2007 investigation provided several good recommendations for future work in section 9.3 of its report which, if implemented, could provide for: a) an improved understanding of the causes of erosion; b) more accurate monitoring of erosion; and c) more successful bank stabilization efforts. This document is a good point of reference. The Simons &

Associates' (2012) documents are qualitative and based on several unstated assumptions that may not be valid. Full River Reconnaissance efforts have been undertaken using varying methodologies, making for difficult comparisons from one report to the other.

We believe that these existing studies do have data that can be useful if certain new analyses are undertaken. These analyses of existing data would help fill in our gaps of understanding of bank erosion in the Turners Fall impoundment. We are also asking for some additional field collected data. With the existing information, it should be possible to better display what changes have occurred to streambanks over time. Current Geographic Information System (GIS) software allows for various types of data to be assembled into a map and into a database such that change over time analysis can be conducted fairly easily. The change over time analysis is a critical analysis that is needed, and was already started under Field (2007).

Photos that have been taken at or near the same location but at different times exist. For example, the last three Full River Reconnaissance efforts have included continuous videotaping of the river banks with locational information. With these data, "snapshots" of the bank at various locations could be extracted and compared over time. Field (2007) photo locations could be re-shot as well. This existing information should be presented such that it is easy to discern where the photo was taken and what changes have occurred over time. A comparison of the bank every 100 ft could be compared over the years.

Historic aerial photography for the Turners Fall impoundment should be gathered and analyzed. Examples of good photographic datasets include the Field 2007 appendices and 1929 aerials. The location of the shoreline over time should be noted such that it is easy to discern where bank retreat has been most severe and where the river has been relatively stable since the earliest aerial photograph was taken.

Very little turbidity data for the Turners Falls impoundment, the bypass reach or stretches of the Connecticut River downstream of the Turners Fall project exist. Thus far, implementation of the *Northfield Mountain Pumped Storage Project Sediment Management Plan* (revised February 15, 2012) has yielded few results, and many technological difficulties (see *2012 Sediment Management Plan – 2012 Summary of Annual Monitoring* dated November 30, 2012). Suspended sediment monitoring equipment is installed at the Route 10 Bridge upstream of the project and inside the powerhouse, theoretically taking readings representative of pumping and discharging through the turbines. An analysis of how turbidity might change relative to rapidly changing impoundment levels would be very useful information.

Nexus to Project Operations and Effects

The construction of the NMPS project was contingent upon the Turners Falls project raising the dam crest elevation by 5.9 feet. The NMPS project operations rely on the Turners Falls impoundment as the source of water to be pumped up and then discharged back into the river through turbines. The importance of this river reach to the NMPS operation is made clear by FirstLight's reference to this portion of the river as the "lower reservoir." Daily pumping and discharging changes the ponded elevation of the Connecticut River which in turn leads to bank material that repeatedly becomes saturated and then dewatered. Weakened bank material can then become eroded and the fine grain material from the banks can enter the water column and be transported in suspension in the river and eventually settle onto bed material. The raising of the Turners Falls impoundment also made recreational boating more popular, including the introduction of large, high-horsepower powerboats that were not previously present. Because of the fluctuating water levels, boat wakes impact the shoreline to a much greater extent than would occur if levels were more constant, thus exacerbating both the effects of the wakes and the fluctuating levels. For these reasons, erosion caused or contributed by NMPS project operation can negatively affect spawning, rearing and migratory habitat for trust species and the endangered shortnose sturgeon. The requested study will help inform the Commission when contemplating mitigation measures and or operational modifications.

Proposed Methodology

1. This study should determine the net soil loss in cubic yards between 1970 and the present; a density estimate of the eroded material should also be provided. Provide an analysis of where the greatest loss has occurred, location of proximity to the tailrace, soil type, riparian land use, and vegetative cover in that area. Calculate nutrient loadings (nitrogen and phosphorus compounds) to the river system based on soil loss.
2. Obtain copies of the original survey plans for the project, and complete a new survey using the same landmarks used previously. The Field (2007) report states on page 11 that the original survey plans of the river are still retained by Ainsworth and Associates, Inc. of Greenfield MA. Use pre-operation aerial photos and current aerial photos to complete a 10-foot topographic map of the section of river between Turners Falls Dam and Vernon Dam and the 200-foot buffer regulated under the Massachusetts Rivers Protection Act. The Field (2007) report on page 11 states that Eastern Topographics, Inc. determined that sufficient information is known about the 1961 aerial photos (e.g., height of airplane) to create a 10-foot topographic map of that time period, and that 1961 aerial photos could be accurately overlayed with recent aerial photos. Field (2007) states that this analysis would enable a more reliable determination of small-scale shifts in channel position and changes in bank height that may have resulted from the erosion of a low bench that previously existed along portions of the river. Among other things, create a single map showing areas of erosion and deposition, and also overlay the Field report's hydraulic modeling analysis of the river channel.
3. With respect to the January 22, 2013 submittal from FirstLight to FERC regarding its long term monitoring transects in the Turners Fall impoundment, we ask that any data errors (as discussed in Field, 2007) and problems that have occurred over the years at each site be mentioned. We also ask that an analysis for each cross section extending to the top of the bank and including a portion of the floodplain be provided.
4. Take the information presented in Figure 4.2.3-1 "Soils in the vicinity of Turners Falls and Northfield Mountain projects" in the PAD and convert from 63 categories to just a few that are defined in a key that will allow readers to understand which soils are easily erodible, which aren't, and where there is bedrock along the banks.
5. Complete detailed surficial mapping (topographic map or LIDAR) to identify the various geomorphic surfaces, height of benches/terraces above the river level, and types of sediments underlaying the surfaces. This will allow one to determine how erosion varies with geomorphic conditions. One could then normalize the amount of erosion to a specific type of bank material/geomorphic surface/terrace.

6. Another information request covers the range of daily water level fluctuations. In this study request, we ask for an analysis on the degree to which boat wakes increase that fluctuation range. The task would be to observe boat wakes under a range of boat sizes and flow rates on the river. We recommend implementation of the 2007 Field report recommendation that states, “A more thorough study of boat waves is merited to better document how many boats use the Turners Falls Pool, how fast they travel, the type and size of waves they produce, and their impact on shoreline erosion.”

A component of this study request is not necessarily for new data, but for existing data to be presented in a more clear, coherent and comprehensive manner. All existing photographs of banks that have been collected either by FirstLight, on behalf of FirstLight or on behalf of the FRCOG Streambank Erosion Committee should be georeferenced in such a way that it is easy to discern where the photograph was taken and the date should be easily discernible as well. These photos should be presented in a manner that makes it easy to visually see how a particular section of bank has changed over time. Providing geographic context for photographic data of river banks and making these photos comparable over time should be standard practice. The 2007 Field report contains the following recommendation on page 47: “An attempt should be made to overlay the 1961 aerial photographs with a current flight and to create a topographic map from the 1961 flight. The feasibility of this effort has been confirmed by Eastern Topographics, Inc. This effort will identify the previous extent of the low bench and identify areas of the most significant bank recession the past 45 years.” Given that this statement was written in 2007, we request that that the analysis is extended to current conditions.

Given the complexity of this study request and the expertise necessary to implement it, we request that we and the mandatory conditioning agencies be involved with the selection of the hired consultant.

Level of Effort and Cost

The level of effort to compile existing information and to make the data available in a map and searching for existing bed substrate material data should not take more than a few days. The level of effort for the bed sampling work will vary based upon how much existing historic information exists. Much of the effort of this study request is essentially office work that compiles and better presents existing data. While an estimate on the amount of field time required is difficult to make, we estimate that up to two weeks of field work could be required and that some of the data collection could be done while other field studies are occurring.

Study Request 2 – Study the Impact of Operations of the Northfield Mountain Pumped Storage Project and Turners Falls Dam on Sedimentation and Sediment Transport in the Connecticut River

Goals and Objectives
The goal of this study request is to provide hydraulic and sediment transport modeling of both the intake and discharge conditions (current and proposed) at the Northfield Mountain Pumped Storage Project. The results of the study should provide information sufficient to enable MA DEP staff and stakeholders to understand current and proposed effects on water level fluctuations and relate to potential increase in sedimentation to the Connecticut River. MA DEP staff and stakeholders should be able to identify techniques that could be used to mitigate the effects of project operations or other mitigation techniques that could be developed to reduce riverbank erosion within the impoundment. In addition, an assessment of means to minimize the sediment load passing through the Turners Falls Canal during and after maintenance drawdowns should be conducted.

The specific objectives of this study are as follows:

- Assess hydraulic and sediment dynamics in the Connecticut River from Vernon Dam to Turners Falls Dam, the upper reservoir at Northfield Mountain, and downstream of the Turners Falls Dam.
- Identify management measures to minimize erosion and sedimentation.
- Determine areas of sediment deposition and beach formation in the Project Area and 1 km downstream of Cabot Station and describe habitat features of these areas, recreational uses and effects on invasive species, if any. Habitat areas include but are not limited to coves (e.g. Barton Cove), back channels, islands, wetland habitats, shorelines, shoals, deep water areas and channels.
- Identify management measures to mitigate for substrate (habitat) impacts and recreational impacts in sediment-starved areas below the dam and sediment accumulation areas upstream of the dam.

Relevant Resource Management Goals and Public Interest Considerations
The resource management goal is to ensure that the Connecticut River, which is designated as a Class B river for its entire length in Massachusetts, meets its designated uses of habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation. Class B waters must also have consistently good aesthetic value and meet minimum criteria for numerous water quality indicators to achieve compliance with the standards set forth in the regulations. The other resource management goal is to protect prime farmland soils, which are eroding, and riparian habitat. Eco-based tourism is important to the economy of Franklin County so maintaining the water quality of the river and protecting scenic landscapes along the river from erosion are important.

Public Interest Considerations if Requester is not a Resource Agency.
The Franklin Conservation District (District) was established in the 1940's under Massachusetts General Law, Chapter 21, Sections 18-25 as a quasi-state agency for the purpose of delivering conservation programs at the county level. The purposes of Conservation Districts in Massachusetts are: to focus attention on land, water and related resource problems; to develop

programs to solve them; to enlist and coordinate help from all public and private sources that can contribute to accomplishing the District's goals; and to make citizens aware of the interrelationships between human activities and the natural environment.

Existing Information and Need for Additional Information
The PAD provides a summary of the work that has been done to characterize streambank conditions of the Turners Falls Impoundment, to understand the causes of erosion, and to identify the most appropriate approaches for bank stabilization. There has been no work undertaken to gather and assess the data that this study request would provide. Implementation of the *Northfield Mountain Pumped Storage Project Sediment Management Plan* (revised February 15, 2012) was begun in 2011 and is scheduled to end in 2014. This is a limited study related to sediment problems in the upper reservoir, not the entire river.

Nexus to Project Operations and Effects
The Turners Falls and Northfield Mountain Pumped Storage projects operate in a peaking mode, with allowable impoundment fluctuations of up to 9 feet, with the intent to continue as such. It is proposed to evaluate increasing the volume of flow from the Northfield Mountain Pumped Storage Project through increased use of the upper reservoir, which is expected to result in additional water level fluctuations. Upstream hydroelectric facilities also operate in a peaking mode of operation. Periodically, the upper reservoir at Northfield Mountain and the power canal at the Turners Falls dam need to be dewatered for maintenance purposes. Historically, both procedures have resulted in the discharge of large quantities of sediment. Sediment from shoreline erosion and riverbank failure is one of the major contributors that negatively affect water quality and habitat by increasing the turbidity and sedimentation, smothering aquatic habitat. Repetitive water level fluctuations and flow alterations caused by hydroelectric peaking operations are known to be a major contributor to shoreline erosion.

The Proposed Massachusetts Year 2012 Integrated List of Waters shows two river segments, from the VT/NH state line to the Turners Falls dam (MA34-01 & MA34-02) impaired and considered a “Water Requiring a TMDL” due to “Other flow regime alterations”, “Alteration in stream-side or littoral vegetative covers” and “PCB in Fish Tissue”. In addition, the segment below the Turners Falls dam to the confluence with the Deerfield River (MA34-03) is impaired by these causes as well as total suspended solids.

Proposed Methodology
We concur with the proposed methodology developed by the MA Department of Environmental Protection, which is consistent with accepted practices:

<u>Assess hydraulic and sediment dynamics</u>

- FirstLight to continue implementing the Northfield Mountain Pumped Storage Project Sedimentation Management Plan over the full range of river flows and pumping/generating cycles. An unfulfilled task in the Plan is to develop a correlation over the full range of flow conditions between the overall suspended sediment transport through the entire cross section of the river compared to the continuous sampling at the single fixed location. Environmental Protection Agency approval of a Quality Assurance Project Plan is required for valid data acquisition.

- Provide data on the daily water level fluctuation changes from the past five years from stations listed in the PAD, and estimate fluctuations within Turners Pool assuming proposed operations and hydraulic conditions.
- Identify the most appropriate techniques for bank stabilization given the existing and proposed hydraulic conditions.

Determine areas of sediment deposition in the Project Area

- Field (2007) conducted a bathymetric study as part of his report. Use previous bathymetric data, if available (Field 2007 recommends putting additional effort into finding a bathymetric survey from 1913 that was partially shown in Reid 1990), and current bathymetric information to look at areas of sediment accumulation. Determine areas of sediment deposition in the Project Area and 1 km downstream of Cabot Station and describe habitat features of these areas. Habitat areas include but are not limited to coves (e.g., Barton Cove), back channels, islands, wetland habitats, shorelines, shoals, deep water areas and channels.
- Identify recreational uses and impacts in areas known to be impacted by accumulated sediment, such as Barton Cove.
- Identify invasive species (plant or animal) present in the reaches and determine if erosion and sedimentation in any way contributes to the establishment and/or proliferation of these species.
    - Investigate the formation of beaches using remote sensing, LIDAR at low pool levels or some other mapping technique to understand the processes of beach deposition the distribution of beaches in the pool, the impact of beach deposition on habitat and species, and how can this be related to operation of NMPS.
    - Evaluate management strategies to address the release of accumulated sediment through Northfield Mountain Project works during upper reservoir drawdown or dewatering activities. FirstLight should specifically evaluate the feasibility of the installation of a physical barrier across the bottom of the intake channel designed to prevent the migration of sediment during future drawdowns of the upper reservoir
  - Evaluate management strategies to minimize flow fluctuations within Turners Pool including coordination with upstream users.
  - Evaluate management strategies to minimize sediment released through spillway gates and the log sluice located near the bottom of the forebay adjacent to the Cabot Powerhouse during canal dewatering activities.
  - Identify a prioritized list of locations for bank stabilization projects in the Project Area
  - Develop a map of land owned by FirstLight within 200 feet of the Connecticut River with an overlay of land use and vegetation cover. Provide land use options aimed at reducing bank erosion.

Management measures to change sediment flow below and above the dam.

- Any historic information of existing bed substrate material in the Turners Falls impoundment, bypass reach or downstream of the project should be collected and assembled. To the extent possible, the location of each sample should be made available on a map. The request for new data would stem from being able to make any valid

comparison to changes in bed substrate at a given location, assuming the historic data exist.
- Identify measures that could be taken to mitigate impacts to recreational use, habitat, or invasive species from sedimentation.
- Identify measures that could be taken to change or mitigate sediment starved reaches below the Turners Falls dam.

Level of Effort and Cost
Many erosion studies have already been conducted and the cost of expanding the scope of some should be reasonable. A Full River Reconnaissance under the *Erosion Control Plan for the Turners Falls Pool of the Connecticut River* (Simons & Associates, Inc. dated June 15, 1999) is scheduled for 2013 and could accomplish many of the objectives listed above.

Study Request 3 - Study the Feasibility of Converting the Northfield Mountain Pumped Storage (NMPS) Facility to a Closed-loop or Partially Closed-loop System

Building and operating the Northfield Mountain Pumped Storage project required the Turners Falls Dam be raised 5.9 feet. The Turners Falls impoundment of the Connecticut River acts as the lower reservoir and is subject to large sub-daily fluctuations in water level. The collateral environmental consequences of using the Connecticut River during the pumping and generation cycles for the last 40 years are not fully understood, but have likely contributed to extensive erosion of streambanks, downstream sedimentation, entrainment of large numbers of resident and migratory fishes, and destruction of important spawning and nursery habitat, both within the Turners Falls Pool and downstream. Intrinsic consequences include radical fluctuations in the hydrograph at a sub-daily level, which also negatively impact recreation, habitat, and likely disrupt key life history stages of resident and migratory fishes, benthic invertebrates, and macrophytes. The vast majority of proposed new pumped storage projects currently being considered by FERC are closed-loop because of a growing consensus that open-cycle pumped storage causes unacceptable environmental damage.

Resource agencies have identified restoration of a more natural hydrograph to the Connecticut River as a key management goal, and view the current relicensing process for five projects on the Connecticut River mainstem as an opportunity to achieve this. Converting to closed-loop or partial closed-loop would allow the restoration of ecological flows to the Connecticut River, and provide much greater flexibility in operational guidance for both NMPS and the other hydropower stations on the Connecticut River. It will also eliminate or partially eliminate many of the environmental concerns expressed by Federal and state agencies and other stakeholders, which are outlined in the numerous study requests and comment letters that FERC will receive on the NMPS project and the other four hydropower projects.

Goals and Objectives

The goal of this study request is to provide resource managers, stakeholders, and the licensee with an analysis of possible options for converting the plant to a close-loop or partially closed-loop system.

The objectives of this study request would be to determine:

- Candidate locations for placement of a lower reservoir
- Costs and logistics of construction and modification of the current facility to convert to a closed-loop or partially closed-loop system
- Projected savings associated with eliminating need for ongoing mitigation measures, both for stabilizing river banks as well as likely modification to operations that the facility that will be required to implement in order to protect habitat and native fauna.
- Other ancillary costs or savings, such as eliminating requested studies, operational changes, or mitigation measures

Relevant Resource Management Goals and Public Interest Considerations

The resource management goal is to ensure high quality habitat for migratory diadromous fish. Shortnose sturgeon, American shad, blueback herring, and American eel all require suitable spawning, rearing, migratory and foraging habitat. Eroding banks and subsequent increases in turbidity and deposition of fine grained material onto bed substrates in the Turners Falls impoundment, the bypass reach and downstream of the Turners Falls project reduces the quality of habitat for these species. Elevated levels of suspended sediment are associated with a diminution in water quality that also affects the quality of habitat encountered by endangered species. Entrainment into the facility could be lethal to any of these fish. Juvenile and larval stages of resident and migratory species, including rare, threatened, and endangered species of vertebrates and invertebrates are particularly vulnerable to entrainment. This damage is aggravated by the repeated cycling of the facility—unlike standard hydro, where organisms are likely only exposed to passage events a single time and may bypass the system safely, NMPS continuously recycles river water, and therefore increases the risk of exposure to entrainment and death.

Public Interest Considerations if Requester is not a Resource Agency

The Franklin Conservation District (District) was established in the 1940's under Massachusetts General Law, Chapter 21, Sections 18-25 as a quasi-state agency for the purpose of delivering conservation programs at the county level. The purposes of Conservation Districts in Massachusetts are: to focus attention on land, water and related resource problems; to develop programs to solve them; to enlist and coordinate help from all public and private sources that can contribute to accomplishing the District's goals; and to make citizens aware of the interrelationships between human activities and the natural environment.

Existing Information and Need for Additional Information

Some data on environmental effects of NMPS and facilities that use fresh or salt water for generation and/or cooling are widely available and consistently point to these types of facilities as damaging to native and migratory fauna. Once plentiful populations of blueback herring have been entirely eliminated from this portion of the Connecticut River. Populations of American eel are in steep decline throughout this reach, and American shad that initially used fish passage facilities downstream of NMPS have experienced dramatic reductions above Turners Falls Dam.

Section 4.4.6 of the PAD (page 4-146) discusses entrainment at Northfield Mountain of migratory fish species. Previous studies estimated 28.6% of Atlantic salmon entrained, which was reduced to 6.7% after the installation of a guide net only during upstream passage season. LMS Engineers estimated in 1993 that the facility impacted 0 to 12.4% of adult American shad passing the water intake. No studies have looked at impacts to resident fish or other migratory fish or other times of the year, but several study request address this information gap.

Other facilities in the region (Brayton Point Power Station, a coal plant in Mt. Hope Bay) have been required by EPA to switch from open- to closed cycle at very significant cost because of the extensive damage done to fragile habitats by open-cycle pumping.

Streambank erosion has been a major concern since NMPS began operation in 1972. Section 4.2.4 of the PAD summarizes the extensive work that has been done to study and mitigate erosion along the river banks. Significant loss of agricultural land has resulted from unnatural river fluctuations and increased boat wakes from a raised impoundment, and in some cases poor mitigation efforts like helicopter removal of trees along the banks. Since 1996, the licensee has reportedly spent $750,000 - $1,000,000 annually on erosion control measures. In some cases, these projects will need to be re-done in the future. Converting the plant to closed-loop operation could provide significant cost savings over the life of the upcoming license, eliminating erosion control projects, proposed studies related to use of the Connecticut River as a lower reservoir, and any mitigation or operational changes that may be contemplated as a result of relicensing.

Nexus to Project Operations and Effects
In conjunction with other study requests, parties to the relicensing process will be reviewing data and considering operation and facility conditions that will best achieve the balance between natural resource protection, property and infrastructure protection, and power generation. Making the plant closed-loop or partially closed-loop is one important consideration to the scenario and would eliminate any operation changes that might result from concerns about fishery resources, water quality effects, and farmland losses.

Proposed Methodology

- Collate existing geological and hydrologic information of areas surrounding Northfield Mountain, including preliminary design plans for suitable facilities able to accommodate the existing and proposed discharge. These plans should include any and all possible locations, including modifications to infrastructure near the current outfall, and any other locations that could accommodate the necessary volume of water.
- Provide an engineering analysis of structural modifications necessary to accommodate a full or partial lower reservoir in an alternate nearby location.
- Provide information on whether and how a smaller lower reservoir, with ties to the Connecticut River, would act as a buffer to river level fluctuations and change the hydrologic pattern of flow on the Connecticut River in the Turners Falls pool (fluctuations), the water quality effects, and decrease the possibility of entrainment.
- Provide an analysis on water losses from evaporation and leakage and how much make-up water would be needed during normal operations by season or month.
- Identify and make available any similar studies conducted during the planning phase of the existing facility in the 1960’s or any other time.
- Provide a cost estimate of each option considered and evaluated.
- Provide an itemized cost estimate of how taking the project off-stream would affect other costs, such as eliminating the erosion control program, any ancillary changes to generation at Turners Falls Dam and NMPS, and fish protection measures.

These methods are consistent with accepted practice for weighing costs and benefits of environmental impacts.

Level of Effort and Cost
The level of effort to compile existing information and to make the data available in a map should be low. Development of contingency scenarios would be low. The majority of the effort of this study request is essentially office work, with some engineering and design work required to scope likely costs of various scenarios.

United States Department of the Interior

NATIONAL PARK SERVICE
NORTHEAST REGION
15 State Street
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IN REPLY REFER TO:

February 28, 2013 Filed Electronically

Kimberly Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

Comments and Study Requests in Response to the Notice of Intent to File License Application, Filing of Pre-Application Document (PAD), Commencement of Pre-Filing Process and Scoping and Request for Comments on the PAD and Scoping Document. Turners Falls Hydroelectric Project (FERC 1889-081) and Northfield Mountain Pumped Storage Project (FERC 2485-063), FirstLight Power Resources.

Dear Secretary Bose:

General Comments

The National Park Service files these comments in order to facilitate the relicensing process for both applicants and offers this agency's technical expertise on public recreational access, land conservation and preservation and our understanding of the values placed by the general public on river related resources. Together, the five projects currently up for relicensing directly influence almost 170 miles of New England's longest river and represent five of the nine Connecticut River mainstem dams. The other four dams – the Holyoke Dam (FERC 2004) and the three dams associated with the 15 Mile Falls Hydroelectric Project (FERC 2077) were relicensed relatively recently and Federal Energy Regulatory Commission (FERC) included in each licensing order for those projects a host of comprehensive environmental measures to benefit the public and the shared natural resources associated with the Connecticut River. The FERC has clearly and appropriately recognized the importance of taking a comprehensive look at the current group of Connecticut River relicensings as evidenced by its decision to hold joint site visits, joint Scoping meetings and a Cumulative Effects Meeting as part of the Scoping process; only the third time FERC has done so in a relicensing proceeding.

The U.S. Department of the Interior (DOI) has also recently recognized the importance of the Connecticut River by designating it as the nation's first National Blueway on May 24, 2012. Secretary Salazar noted that "The Connecticut River Watershed is a model for how communities can integrate their land and water stewardship efforts with an emphasis on 'source-to-sea' watershed conservation [as we] seek to fulfill President Obama's vision for healthy and accessible rivers that are the lifeblood of our communities and power our economies." Among the stated goals are to advance a whole river and [utilize] a water-based approach to conservation, outdoor recreation, education and sustainable economic opportunities in the watersheds in which we live, work and play."

The National Blueways System is part of the America's Great Outdoors Initiative which seeks to establish community-driven conservation and recreation for the 21st century. Both the DOI and the Department of Agriculture identified the Connecticut River as an important priority under America's Great Outdoors. The Connecticut River and its 7.2 million-acre watershed includes National Forests, National Historic Sites, National Wildlife Refuges, National Scenic Byways, Partnership Wild and Scenic Rivers, National Recreation Trails, National Natural Landmarks, Important Bird Areas, and segments of the New England National Scenic Trail; the Appalachian National Scenic Trail; the East Coast Greenway Trail; the Northern Forest Canoe Trail; Revolutionary Route National Historic Trail, a Ramsar wetland site, and an American Heritage River, and approximately two million acres of public and private conservation land.

The relicensing of the five projects in the subject proceedings offer a once in a generational opportunity to move forward in achieving the goals of the National Blueways System and the Administration's America's Great Outdoors initiative. Together, the projects currently undergoing relicensing impound over 90 miles of formerly free-flowing river and affect river resources from roughly 45 miles above the Wilder Dam downriver almost all the way to the upper reaches of the Holyoke Dam impoundment. The river offers myriad paddling opportunities for canoeing, kayaking and rowing, including multiple-day trips. It flows through many population centers, both urban and rural and is easily accessible to millions of people. However, serious obstacles to multi-day paddling trips: Several of the dams offer either no portage, as at Turners Falls and long and dangerous portages around other dams such as at Bellows Falls. Public access points and campsites (both river and shore access) are limited and inadequate to accommodate a reasonable amount of public recreational use.

Land Protection

Although the PAD identifies licensee owned lands within the project boundary, it does not so identify licensee owned lands adjacent to the project boundary. In some cases, these adjacent lands could be appropriate for providing additional recreational access to the river, new trails or connections to existing trails. Permanent protection of these lands would also confer aesthetic benefits to those using the river by providing views from the river of undeveloped lands. Regarding lands within the project boundary, those not integral to project operations should be permanently preserved and in many cases consist of prime agricultural lands. Even those lands currently under Agricultural Preservation Restrictions are only temporarily protected. Permanent protection ensures the long term viability of these important resources. Numerous non-governmental organizations as well as the Commonwealth of Massachusetts through its State Comprehensive Outdoor Recreation Plan (SCORP) have identified valuable and important land protection locations and opportunities along the Connecticut River. This information should be identified and used collectively to determine appropriate opportunities for land protection in the context of these relicensing proceedings.

Comments and Issues Specific to Individual Projects

Identification of issues is set out below followed by specific study requests and justifications.

Obstacles to Multi-Day Paddling

The licensee's PAD cited the current Massachusetts SCORP (2006-2011), which identified the need for "water-based" recreational activities. Multiple-day paddling trips clearly meet such needs, but are severely limited by the operations of the Turners Falls hydropower dam. Although campsites and boat ramps do exist, the dam and existing portage discourages paddlers seeking to navigate the length of the Connecticut River. Just as fish are challenged by multiple obstacles to their passage, paddlers are similarly discouraged and either abandon their efforts to migrate downriver or more likely do not even consider such a through trip. The licensee's PAD does not propose and measures to mitigate limits to or enhance the opportunities for multiple-day paddling trips.

Turners Falls

Impacts to Recreational Paddling at the Turners Falls Bypass Reach

Current access to the bypass reach is extremely challenging and dangerous. Fences have been installed; however, intrepid kayakers can access river left, but river right, which is more desirable is fenced off, has steep access with no stairs and little parking. The take out at the Deerfield River confluence is also steep, frequently muddy, and regularly unusable. Aesthetic issues are also present and scheduled spring, summer and/or fall flows (for paddling or otherwise), would offer the public an important opportunity to observe the natural river in its pre-dam condition. Current project operations preclude potentially valuable (to the public and commercially for the local community) seasonal paddling opportunities during irregular spillage events. The licensee's PAD does not offer any flow proposals mitigate ongoing project impacts to whitewater recreational use. At moderate and higher spillage flows, boaters who manage to access the bypassed reach surf waves and paddle the 2.7-mile whitewater section which provides numerous Class II and Class III features. The bypassed reach also offers potential for rafting, guided kayaking, canoeing, instruction, and general paddling use which in turn, has the potential to add economic value to the region if the releases were scheduled and predictable. With proximity to the University of Massachusetts, Holyoke and Greenfield Community Colleges, and the Northfield-Mt. Hermon School as well as the millions of people living within a three-hour drive of Turners Falls, there is potential for economic benefits to the surrounding community.

The NPS recognizes that scheduled or regular flows into the bypassed reach impact power generation, fish passage, and other environmental variables and should be examined in the broader context.

The NPS recommends a controlled-flow study of whitewater in the Turners Falls bypass reach. The Turners Falls bypass section of the Connecticut River has the potential to offer quality whitewater paddling opportunities.

Impacts of Water Level Fluctuations on Recreational Access and Opportunities

Numerous citizens and representatives of various agencies and organizations made repeated comments at the Scoping meetings relative to adverse impacts associated with water level fluctuations in the Turners Falls impoundment caused primarily from water withdrawals and returns to Northfield Mountain. Power boaters and paddlers alike reported being unable to access or exit from the river due to water level drops and numerous reports of fish strandings were identified. These were identified every location from small informal access points to Barton Cove, where certain conditions literally prevent the use of the facility. Given the applicant's proposal to utilize additional capacity at Northfield Mountain, these situations will only be exacerbated. Bank erosion was also identified as a significant problem due to constant water level fluctuations and numerous efforts are ongoing to alleviate problem locations. These impacts cause damage to archaeological resources and result in the loss of arable lands.

In order to assess ongoing impacts from current operations and potential additional impacts from proposed operational changes, the applicant should conduct a thorough evaluation of the impacts of water level fluctuations on all recreational access points, both existing and new access locations identified through the studies to be conducted in association with the current proceeding.

Preservation of Cultural, Historical, and Educational Resources

The Turners Falls impoundment covers the scene of a significant event in American history: In May 1676, colonial forces under the command of Capt. William Turner attacked an Indian village across the river from the current town of Turners Falls. Many of the inhabitants were slaughtered, especially women and children. Some of the men escaped. They returned with friends and pursued the retreating English forces, killing Capt. Turner. However, no educational or interpretative signs exist to allow visitors to understand that event. Historical artifacts may still exist at the site, much of which has been submerged beneath the Turners Falls impoundment. Educational opportunities should be coordinated with recreational improvements. A possible option identified during the Scoping meetings is to construct a walkway on the north or river right side at Turners Falls which would include interpretative signage. The walkway would also address the lack of a portage pathway and the difficulty of accessing the bypass on river right.

A study should be undertaken to determine a variety of options for educating the public about the site, and to determine what actions should (or should not) be taken to preserve artifacts.

Records associated with the construction of the Turners Falls dam and the Northfield Mountain Pumped Storage facility (engineering studies, drawings, and photographs taken during construction) are of historical importance and should be preserved. The current relicensing offers an opportunity to collect, catalogue and preserve important historical records held by the licensee related to the design and construction of the hydropower facilities.

A study should determine what historical records remain, make suggestions for their safe storage, and suggest improvements at the projects to highlight the historical significance of the facilities.

Northfield Mountain

Recreational Opportunities at Northfield Mountain

Cross Country Skiing

The original licensee of the Northfield Mountain Pumped Storage project created a locally and regionally significant four season recreational area. It is a locally and regionally valuable cross-country skiing facility during winter months with sufficient snow, and numerous activities such as hiking and birding occur during spring, summer and fall. However, staff cutbacks have significantly limited recreation use. River based facilities shut down too early in the fall and there are no opportunities for night or twilight skiing, nor is there any snowmaking capability, which would be highly beneficial to local ski teams as well as the general public.

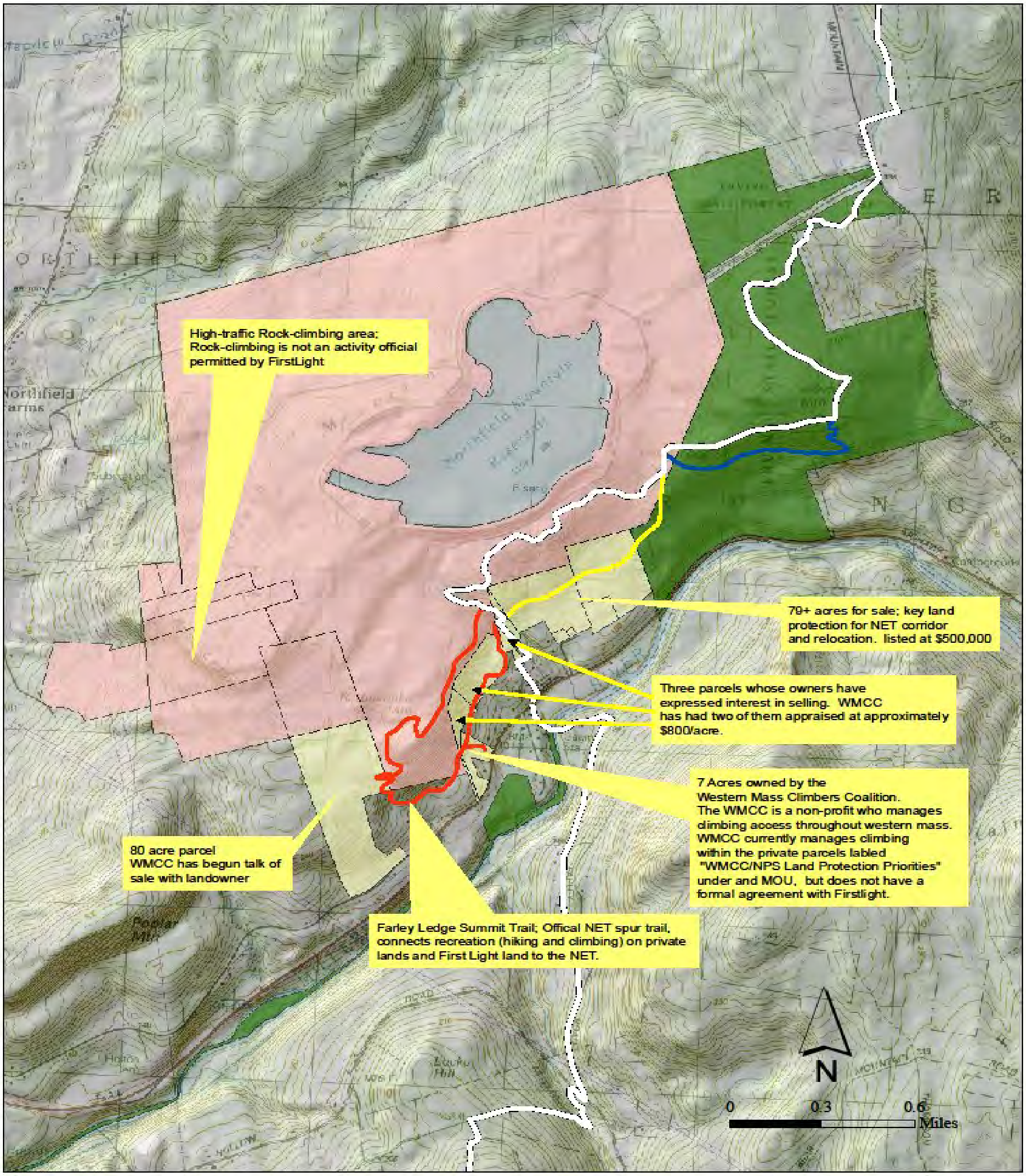
During the Scoping meetings, a parent and manager of the Amherst High School Nordic Ski Team stated that "Northfield Mt. is a treasure. There are beautiful hiking, snowshoeing and cross-country trails and the grooming of the ski trails is excellent. [However,] the mountain needs lights for night skiing and the ability to make snow. Currently, the mountain is closed on Monday and Tuesdays and closes at 4:30 PM. Our team skis after school, arrives at Northfield around 3 PM and can only ski for an hour and half although there is adequate light to ski for longer. Often the mountain is closed when there is snow on upper trails, but not lower trails. Also, Northfield should be available to host high school Nordic ski meets. Currently they are unwilling to do this. Northfield Mt. would be an ideal place to make snow. There is no trouble accessing water and the lower trails are in the shade and would hold snow for a long period of time. A five kilometer loop of man-made snow would be ideal. This would allow for skiing throughout the season and would make Northfield Mt. a truly valuable resource for outdoor recreation in Massachusetts."

The NPS requests that a study be undertaken identify and recommend improvements and additions that would return Northfield Mountain to its full recreational potential and perhaps provide greater amenities for the future license. One option might be to provide snowmaking for early cross-country skiers before any big winter storms can cover the trails.

Hiking Trails

The Northfield Mountain project area encompasses trails of national significance. The 215-mile long New England Scenic Trail (NET) runs through 39 communities in Massachusetts and Connecticut and received federal designation in 2009. The licensee has acknowledged that a partial relocation of the NET within project boundaries would provide an enhanced recreational experience and improved level of safety for the public. In addition, regionally significant climbing areas nearby would also become more accessible after the relocation of the NET. The Western Massachusetts Climbers Coalition (WMCC) has identified high value climbing locations, several parcels adjacent to the project boundary that are or might be for sale (through fee or easement) and a proposed route to relocate the existing trail. Taken together, these options could enhance the NET for hikers and improve climbing and access opportunities. The map prepared by the WMCC is reproduced below.

An appropriate Study could provide assistance relative to both improved cross country skiing and climbing opportunities, identifying options relative to the licensee buying or so assisting in the acquisition of nearby land and/or easements from willing sellers to preserve the climbing areas and provide the best route for the New England Trail.



Legend

Trails	Property
New England National Scenic Trail (NET)	Firstlight Power Resources
Proposed NET Relocation	Erving State Forest
Farley Ledge Summit Trail	NPS/WMCC Land Protection Priorities
Hermit Mountain Trail	

Study Requests Pursuant to 18 CFR 5.9(b).

These studies should include an analysis of why members of the public do not use certain resources associated with the Connecticut River in the project vicinity. As heard repeatedly during the scoping meetings, there is a lack of adequate recreational facilities on the Connecticut River in the project areas. These likely results in the cumulative displacement of use to other facilities in the watershed, possibly causing overcrowding at those resources. Although FERC's Form 80 is done every 6 years by the licensee, there is no requirement to do any evaluation other than user identification through on site surveys; therefore, considerable use is missed depending upon numerous factors such as survey dates, weather and conditions. There is also no requirement to survey or reach out to known user groups.

The standard recreational use studies identify current users captured during the study period on specific days; they do not attempt to identify users and more important, user groups/organizations that regularly (or for events) utilize project resources and adjacent lands. In order to develop a complete picture of user needs and goals, the applicant needs to identify local, state and regional user groups (through their mailing/membership lists/web sites info) and reach out to those people through mails and/or online surveys to identify user preferences and concerns. An on-site survey also does not address why certain users do not utilize and area, which may be due to overcrowding or lack of desired facilities. Among the user groups that could be so utilized are the Connecticut River Watershed Council, the Appalachian Mountain Club (AMC), American Rivers, American Whitewater, WMCC and New England FLOW, to name just a few, along with the commercial outfitters and facilities on the river. Any organization that attended the scoping meetings or which provides comments or study requests should be so utilized for this purpose.

Conducting the necessary studies and implementing the measures needed to ensure the public has access to quality outdoor recreational resources are in the public interest. It is widely accepted that outdoor recreation offers significant benefits to the public. Outdoor recreation also has proven economic benefits for communities located near recreational resources.

1. Study of Project Facilities to Support Multiple-day Self-Powered Boating Trips on the Connecticut River.

The NPS requests a study of the quantity, quality, and adequacy of land-based facilities operated by the licensees and associated with self-powered boating on the Connecticut River. This study should examine put-in and take-out facilities especially for canoes, kayaks, rowing shells and other self-powered watercraft; portage routes; campsites; parking and road access; seasons of operation of the facilities to match with actual river use; maintenance; water supplies and other amenities at campsites; and trash and sanitary facilities. The study should include a projection of usage during the proposed 30-year life of the licenses, and the opportunities for the project owners to buy land and/or interests therein from willing sellers in order to increase recreational benefits.

The study should examine the facilities that are necessary specifically for canoe, kayak and rowing shell access to the river. Information from the state SCORP study and from other river recreational interests suggests that interest in quiet water paddling is rising along with the sales of sea kayaks, rowing shells and canoes. Most of the existing facilities were designed for day use by motorboats with hard-surfaced ramps which may not be particularly suited to canoeists, especially those using wood-and-canvas or fiberglass canoes.

Paddlers attempting source to sea trips report challenging portages and limited opportunities for camping. Once in Massachusetts, campsites become scarce. Most islands are posted as off-limits and paddlers often camp on mudflats or portions of private lands. At the Turners Falls Scoping meetings, a landowner reported finding canoeists on his property in the morning and was kind enough to shuttle them below the Turners Falls dam. Although the licensee maintains two campsites, at Barton Cove and Munn's Ferry, both charge $22 per night for a tent site and require reservations and deposits. Munn's Ferry; however, lacks potable water and competition for campsites is common. The study should evaluate methods to minimize and/or remedy such situations. From the Turners Falls dam upriver to the Vernon Dam and downriver to the Holyoke dam, there are limited sites for overnight water access camping. According to the Connecticut River Paddler's Trail organization, the ideal frequency of canoe campsites on flatwater stretches is one every five river miles, along with canoe and kayak access in each town. Campsite amenities provided by the licensee should be well signed for visibility form the river and standardized to include adequate canoe landing sites, toilets, potable water, trash disposal, picnic tables, and tent platforms or three-sided shelters.

The Turners Falls Dam has no existing portage pathway. Paddlers arriving at Barton Cove *during working hours* can call for a truck to pick them up, assuming they have a phone and the correct number. Most paddlers report that the licensee is prompt and courteous in providing a shuttle service that drops users off at the mouth of the Deerfield River. That location; however, is often unusable due to water levels and/or muddy conditions and should be improved. Still, a trail is needed in the new license. Two opportunities exist for a portage trail: one on river right which could incorporate educational and interpretive displays and one on river left along the power canal that now serves as a bike trail. Appropriate locations for a take-out and put-in are also critical for safety reasons.

The study should include both water and land-based trails. The Connecticut River Paddler's Trail and the Connecticut River Birding Trail cross project boundaries and their collective interests should be included to ensure a watershed viewpoint, especially as it involves trail networks and associated facilities. Project lands at all the facilities, as well as adjacent lands should be studied for recreational and conservation improvement opportunities. In some cases, certain project lands could be added to existing public facilities (provided adequate resources are available to ensure appropriate long-term management) or placed under permanent conservation restrictions in order to improve conservation and recreation. The study should evaluate the adequacy and maintenance of existing trail systems for the term of the new license to be issued, and determine opportunities for additional hiking trails on project lands, and for linking those trails to existing trails. Such trails in the watershed could cross project boundaries, and adding to them could involve requiring the licensee to purchase additional land or interests therein.

For example, although the NET is referenced, there is no analysis of existing use, trends or user groups. The information developed by the AMC and WMCC should be presented to the applicant along with an offer to work collaboratively with them to achieve the WMCC's goals regarding moving the trail and land acquisition. Given the scope of these projects, it is not unreasonable to request that the applicant assist in the purchase of fee and/or easements of the identified priority parcels, as well as assist in funding/undertaking trail development.

Project operations have created serious aesthetic issues along the route of the Connecticut River. The dry bypass reach at Turners Falls is an aesthetic sore spot on the river. Even worse, the dams have substituted their industrial appearance for the naturally scenic rapids and falls that graced the Connecticut River. The public has an interest in the scenic values of this major public resource.

Significant additional information relative to the use of the Connecticut River in the project areas exists, yet has not been included or evaluated in the PAD. There is inconsistent knowledge regarding multiple-day trips on the Connecticut River. Although the PAD lists facilities which are not owned or operated by the licensee, such as commercial operations, there is a lack of consistency about those facilities in terms of their seasons of use and what amenities they provide for public recreational use.

Several publications are widely used by paddlers and recreationalists. The primary source of information is *The Connecticut River Boating Guide: Source to Sea* (3rd ed.) published by the Connecticut River Watershed Council (2007). Recreational maps and guides to the river have been published for some reaches by KM Digital Productions in South Hadley, Mass., and are available from the Connecticut River Watershed Council. These foldout river maps cover the reaches from Vernon, Vt., to Turners Falls, Mass. (2008). Three other similar maps cover segments from Turners Falls (2007) down to Hartford, Conn. (2010), which is about the extent of the tidal zone. Most of those maps are in need of updates. In 1991, New England Cartographics in Amherst, Mass., published the *Connecticut River Guide in Massachusetts* by Doug Greenfield and Christopher J. Ryan. The Connecticut River Birding Trail organization located in White River Junction, Vt., has published maps detailing the upper valley section, the northern section, and the southern section of the river.

The Connecticut River Paddler's Trail prepared *The Connecticut River Paddler's Trail MA-CT Expansion Feasibility Study* in 2013. In that document, Noah Pollock of the Vermont River Conservancy examined the Massachusetts and Connecticut reaches of the river. The *Connecticut River Paddler's Trail MA-CT Expansion Feasibility Study* contained a map of the river in Massachusetts created by the Trust for Public Lands with dots indicating recommended locations for additional campsites.

The study identified above will provide the defining mechanism for identifying sites that can be improved as well as additional sites that should be developed in order to ensure increased public opportunities and desire by currently discouraged users to participate in multi-day and local paddling trips on the river. The study will serve to identify potential properties whose acquisitions or fee or interests therein may provide appropriate opportunities for additional recreational facilities. The study should also serve to identify indirect effects of the hydro facilities that may be discouraging public use or displacing water-based recreation to other parts of the watershed. Cumulative effects would also be evaluated given the number of dams on the river and the fragmenting effect they have on recreational use and experiences.

Studies to evaluate the adequacy of public resources and recreational uses and needs are standard throughout the hydro relicensing process. Methodologies can be selected from among the recognized and accepted standards of the resource and public planning fields. Surveys of people who do NOT use the river or are displaced can employ randomized samples from several databases associated with various local, regional and national user groups. Sufficient information is available from the guidebooks and maps of the river that identify access points and campsites, from the map done by the Paddler's Trail for Massachusetts, as well as information contained in the PAD. Once a consultant is selected and approved, the information should be gathered and analyzed in a timely manner. The study would require spring, summer and fall seasons in order to locate river users and develop a statistically adequate sample. A consultant with experience in similar projects should be selected, in part to create relevant comparisons to other hydropower projects around the country.

Because there is no comprehensive text or guide that provides current information regarding carrying capacity of river-based recreational facilities associated with both individuals and groups of paddlers, the above described study will serve to bridge this information gap as well as to identify needed reconstruction or expansion of existing facilities or the development of new facilities. Any field research would need to be correlated with future use projections and standard requirements for water based access, campsites, sanitary and picnicking facilities and portages.

2. Controlled Whitewater Flow Study in the Bypass Reach Below the Turners Falls Dam.

The Turners Falls project contains a 2.7-mile diversion that reduces in-stream flows except for minimum flow and during flood events. Natural boatable flows are frequently inaccessible, high, flashy, unpredictable, and are usually available only during periods of seasonal high spillage due to flooding. The Turners Falls Dam and diversion canal impacted the rapids below Turners Falls. The reservoir behind the dam rendered other rapids inaccessible as it extends all the way north to the Vernon Dam. Whitewater opportunities eliminated by the project could be partially restored if the licensee provided moderate, stable, and scheduled whitewater flows in the bypass reach that could be used from the late spring through early fall. The current operation of the project largely eliminates valuable seasonal paddling opportunities.

Controlled flow studies are routinely ordered to be conducted on FERC projects. This whitewater reach is a prime opportunity to restore a whitewater run that could be of enormous recreational and economic value to the community.

The goal of a whitewater flow study is to assess the presence, quality, access needs, flow information needs, and preferred flow ranges for river-based boating resources in a stepwise manner. The information to be obtained can be generally characterized as quantitative and qualitative descriptions of the following:

1. The range of optimal and acceptable flows for whitewater paddling in a whitewater park setting.

2. The frequency, timing, duration and predictability of optimal and acceptable paddling flows under current conditions.
3. The access needs of whitewater boating use and the current and potential river access options for paddling.
4. The flow information needs of whitewater boating and the current and potential flow information distribution system.
5. The location, challenge, and other recreational attributes associated with specific rapids and other river features.

The information gathered is a combination of user-generated flow preferences and other engineering information on current and proposed operations (e.g. discharges), geographic information and basic recreational information. Essentially, the Turners Falls Dam would release prescribed flows into the bypass reach for this test, perhaps over two days. For each release, a selected group of paddlers would run the rapid and then answer written questions about their experiences at each flow level. The Turners Falls Dam would release several different flows, measured in cubic feet per second, and the paddlers' experiences would be analyzed to determine the flows that work best at the rapid.

The Turners Falls bypass reach would likely offer the public a high-quality whitewater boating resource when flow conditions are suitable. Conducting the necessary studies and implementing measures to ensure public access to outdoor recreation are in the public interest. In addition, the dry riverbed is not generally considered to be aesthetically pleasing and is in full view of many people who pass by on nearby Route 2 and who drive across the two Connecticut River bridges entering the town of Turners Falls.

Restoration of whitewater recreational opportunities in the Connecticut River has the potential to offer the region economic benefits. FERC has concluded that "to fully evaluate the project's effect on whitewater recreation opportunities and to balance potential enhancement opportunities with their cost, a controlled-flow whitewater boating study is relevant to Commission's public interest determination." This is equally true regarding the Turners Falls Project on the Connecticut River.

Numerous whitewater flow studies have been conducted during FERC relicensings on New England's rivers (including the nearby Deerfield River) that have a long history of whitewater paddling use. However, the bypassed reach below the Turners Falls dam is largely unknown to whitewater boaters. Rapids are un-named, the range of difficulty is unknown, and current access opportunities are extremely difficult. The potential high quality of this scenic 2.7-mile long whitewater run should be evaluated.

Current and historic project operations leave significant information gaps and eliminate most of the low and moderate flows from this reach, resulting in flows too low to paddle, too flashy, or consisting of spiking high flows that may be too dangerous to attempt. Intermediate paddlers, commercial paddlers, and general river-runners know relatively little about this river reach at low or moderate flows. It should also be determined if there is adequate potential to improve river access in a way that offers a high quality car-top put-in and take-out for use of the entire bypass reach. The use of a controlled-flow analysis has been described in Doug Whittaker, Bo Shelby, and John Gangemi, Flows and Recreation: A guide to studies for river professionals (2005), p. 26-29, is available from the National Park Service website at: www.nps.gov/hydro/flowrec.pdf .

The Project controls flows in the Connecticut River by withdrawing more than 13,000 cfs. The operations eliminate most of the paddling days each year, including the virtual elimination of valuable and regionally needed summer paddling opportunities. This bypassed reach could be a high-quality paddling resource, and since paddling is a flow dependent activity, the project directly affects paddling on the Connecticut River, thereby providing a direct nexus. The results of a controlled flow study would help determine the need for license requirements for scheduled whitewater releases.

The study request in the Turners Falls bypass reach of the Connecticut River should follow the standard methodology as described in Whittaker, referenced above. This methodology is designed to gather information to assess the presence, quality, and preferred flow ranges for river-based boating resources in a step-wise manner. The process steps are generally 1) desktop analyses, 2) on-land feasibility assessment, 3) on-water single flow assessment, 4) on-water multiple flow assessment. We expect and request the full implementation of this methodology.

Because the quality and flow needs of the resource are unknown, we request an on-water multiple flow assessment be conducted. This study will need to take place on various dates and at variable flow levels throughout a spring and summer. Boating groups (such as American Whitewater, NEFLOW and the AMC) can work with the licensee to document the known information regarding the river and would help provide volunteer paddlers and technical support for the studies as appropriate. The whitewater boating study methodology identified above has been used on dozens of other FERC regulated reaches. This study should include an examination of the access issues for the bypass reach and the take-out below. The whitewater boating community would work with the applicant to keep costs reasonable and the quality of information high.

The study will require integration of known information followed by an organized flow study during which several flows are paddled by boaters, with still image and video documentation, surveys of the boaters, a guided conversation among the boaters, and a written report. Given that this is a bypass reach with some minimal access and relatively straightforward hydrology, and given the collaborative approach sought by the paddling community, including in-kind contributions of time and expertise, a consultant should be able to complete this study on behalf of the licensee for a very reasonable cost.

The PAD proposes no whitewater feasibility analysis. This no-action step will reveal nothing about the project impacts on whitewater recreation or opportunities for protection, mitigation, or enhancement measures. There is currently no information relative to the relationship between specific low and moderate flows and the paddling experiences they might provide. A desktop analysis cannot generate this information. Without this information, the FERC cannot fully evaluate or define the project impacts, nor propose and consider provision of releases that provide targeted recreational experiences.

3: Study to Assess Preservation of Cultural, Historical, and Educational Resources

The Indian fishing village that was attacked by forces under Capt. William Turner in 1676 now lies mostly flooded under the Turners Falls reservoir. Indian burial grounds dating back thousands of years have been reported on or adjacent to project lands. Yet the licensee does not have educational and interpretative signs to offer visitors and opportunity to understand this event and its context in American Colonial history. A study should be undertaken to determine a variety of options for educating the public about this historical site, and to determine what actions should (or should not) be taken to preserve artifacts and provide education.

Suggestions at the Scoping meetings included constructing a walkway on the northern or river right side complete with interpretative materials. This walkway would also serve to address the lack of a portage pathway around the dam, as well as access to the bypass reach.

This study should also address the need to document, catalogue, preserve and where appropriate, display the work of the engineers who built the dams at the Great Falls on the Connecticut River, now Turners Falls. Historic resources including drawings, photographs, blueprints, inventories and plans should be considered historical resources worthy of preservation for the public benefit. The study should discover what records remain and recommend plans for preserving them and making them available to historians and researchers. The engineering records related to the construction of dams at Great Falls are a valuable element of our social and industrial history.

The study is primarily the purview of the Massachusetts Historical Commission, but would greatly benefit Indian tribes, the Great Falls Discovery Center in Turners Falls as well as local and regional historically focused entities. The traditional Native American gatherings at a fishing site at Turners Falls are part of the collective heritage of Americans. The study would also include a focus on information about Indian tribes. They had lived at the Turners Falls site for centuries. An article in the Greenfield Recorder on Feb. 14, 2013, mentioned a development site near Turners Falls: “Sitting on the only lightly developed quadrant of the ancient Indian fishing site known as Peskeomskut [now Turners Falls dam], activists have attempted to derail development there for many years and reasons, including wetland and sacred burial-site issues. The activists claim the site was an important burial ground for local indigenous peoples dating back more than 10,000 years, and they say they have the bones to prove it.” The article by Gary Sanderson reported on an interview with an archeologist, George Nelson, who, in 1964 discovered what was presumably an Indian burial site in a gravel bank along Route 2. Sanderson also noted that it is likely that “everything within a mile radius of falls would have been loaded with ancient indigenous history/artifacts/burials. When widening Gill Road ca. 1860, they found a spoke burial, 12 bodies, the feet in the center separated by 10-foot circle, many beads, stones, possessions etc.”

Although numerous history books have dealt with the 1676 fight at Turners Falls and its ramifications during King Phillip’s War, it is undetermined what historical resources remain under water and in the ground. Such sites can be protected and preserved under current laws, but the licensee, and FERC, through its study authority, can provide additional public benefits through a more comprehensive presentation of the historical resources at the site. A number of outcomes for public recreation might be available; among them is an interpretative trail along the riverbank on the north side with signs indicating the rich history of the area. Numerous books have told the engineering story, but the records held by the licensee have not been catalogued. Books that relate to this topic include Bill Gove, Log Drives on the Connecticut River (Littleton, N.H., Bondcliff Books, 2003), and Ed Gregory, The Turners Falls Canal; History and Description (2006).

The reservoir at Turners Falls covers the site of the battle and likely numerous artifacts. There may be Indian artifacts or burial grounds on Project lands, therefore providing a direct nexus.

FERC could also require an educational component in the license requirements that could assist the public in understanding the colonial and ancient history associated with Turners Falls. This might be through direct licensee action, such as the trail or displays mentioned above, and through support of the preservation of documents by institutions such as the Great Falls Discovery Center in Turners Falls or the Pocumtuck Valley Memorial Association in Old Deerfield.

The study methodology regarding interpreting Native American use of the area is properly left to the tribes themselves, some of whom are living locally or were long ago removed to Quebec and to professional historians, anthropologists, and archeologists who are present in numbers at the University of Massachusetts, Amherst College, and the other regional institutions of higher education.

The Pocumtuck Valley Memorial Association, which operates the Memorial Hall Museum and Library located just downstream in Old Deerfield, Mass., has expertise in dealing with Native American artifacts, in creating museum displays, and in maintaining close contact with Native Americans in the region and in Canada. Its library contains thousands of historical records of colonial America. Generally accepted historical preservation and museum presentation practices could lead to recommendations for license requirements.

4: Recreation Study at Northfield Mountain

The study would evaluate existing conditions and recommend improvements and additions at the Northfield Mountain Recreation facility the level of public benefit required under the previous license. Additions should be recommended as appropriate for a new license. Options might include providing snowmaking for cross-country skiers, or buying additional lands or interests therein to improve recreation.

As discussed above, FirstLight has agreed that a relocation of the NET within project boundaries would provide an enhanced recreational experience and improved level of safety for the public. This would involve relocating the trail a greater distance away from the storage reservoir at the mountaintop. This relocation would also improve access to popular climbing areas nearby. A recreational study could provide assistance in both cases, possibly by recommending that the licensee acquire or assist in the acquisition of nearby land or interests therein from willing sellers to preserve the climbing areas and provide the best route for the New England Trail. The map prepared by the WMCC and included above illustrates several well thought out and evaluated options.

The subject of adequate recreation at Northfield Mountain and changes to the facility's management and operations has been addressed in several newspaper articles over the years. The study should evaluate expenditures by the licensee over the term of the current license in support of the facility, its promotion, and usage and extrapolate in current dollars, what would be necessary to bring the facility up the quality and level of use that applicable FERC laws and regulation prescribe.

The study should also assess the adequacy of the facility for paddlers. Launching a canoe on the river at the Northfield Mountain site not a desired option for paddlers, who are displaced to other facilities. According to *The Connecticut River Boating Guide: Source to Sea* (3rd ed., 2007), p. 138, published by the Connecticut River Watershed Council:

> **Mile 124.5**: You have now arrived at the **Riverview Picnic and Recreation Area** at **Northfield Mountain** on the left bank, which has a dock to accommodate the *Quinnetukut II* riverboat, offering river cruises for the general public (phone 800-859-2960). The Northfield Mountain pumped-storage generating plant is sheltered in the mountain behind the site. The main dock area must be kept clear for the *Quinnetukut II*, but boaters and paddlers may use the dock for brief stops to load and unload. The dock is inaccessible directly by car and can only be reached on foot from a parking area 100 yards away. Access is difficult, and the dock is unavailable from mid-April to mid-June. The power company stretches a fish net across the intake of Northfield Mountain during this time to prevent salmon smolt, which are heading downriver, from getting caught in the pumped-storage station. *Caution*: Avoid the discharge area marked by orange floats on the left bank, which can release enough water to swamp a small boat.

Additional information is needed to determine if changes to the existing facility or its operations could improve the desirability and options for paddlers. The study should assess the months of operation of the Riverview facility, which seems to open late and close early in the boating season. Although the licensee provides shuttle service for boaters doing day trips on the river, there is a fee charged for that service. The study should assess the appropriateness of such a fee on a public resource.

The study should examine the skiing, snowshoeing, hiking, birding, climbing, boating, sightseeing, and educational services provided by the facility with a focus on how the facility has met previous license requirements and how mitigation should be enhanced for a new license. The study could recommend ways that the facility could be updated and improved as the licensee seeks a new federal license, and what conditions might be included in that license. The study and the license requirements should address needs for the entire term of the new license.

The licensee operates the Northfield Mountain Recreation Area as partial mitigation for its operations at the Northfield Mountain Pumped-Storage Project, therefore providing a direct nexus for the impacts on these resources.

The study can utilize several techniques to determine the effectiveness of the Northfield Mountain recreation facilities. User preference surveys and reaching out to various user groups (see page seven, above) could determine issues that are current in the skiing, climbing, boating and hiking communities. The study would also serve to determine what discourages the public from using the facility, or displaces recreation to other areas in the watershed. Such studies have been developed in the administration of parks and recreation areas and can be adapted to this task. The timeframe for the study would need to encompass at least a full year in order to have access to recreationists during the four seasons. It might also be necessary to extend the study beyond a single year to include additional field season if needed due to conditions such as the lack of snow or extreme low water in one of the survey seasons.

The PAD proposes no recreational analysis for this high value recreational resource. Such a no-action type alternative does not provide the FERC with an adequate factual basis upon which to fully evaluate project impacts or to propose and consider license requirements to improve recreational experiences.

5. Creation of a Decommissioning Fund.

The NPS believes a study of the financial production of each individual facility that is being relicensed is appropriate. The analysis and/or NEPA document to be prepared should evaluate creating an escrowed decommissioning or trust fund for the dam and pumped storage project. Given that both parent companies of the licensees are foreign owned, deregulation, future ownership changes and the potential financial impacts of climate change can affect the financial health of the current and potential future owners. The licensees, not the public, should not be burdened with potential costs associated with decommissioning. FERC license conditions often address additional mitigation such as trust funds, dam decommissioning funds, and public committees to oversee license implementation. To that end, the NPS requests a study of both the fiscal health of each FirstLight facility on the river and recommendations for the creation of a decommissioning fund or trust fund to protect the public interest.

New England’s rivers are littered with abandoned dams. Over the centuries, companies have failed, and weather events or human error have crippled dams that were then simply left behind. Although the owners of these facilities are presently in good financial health and can meet the requirements over the life of a new license, times and circumstances can change. Unforeseen events might cause either business or physical failure. A number of extraordinary storm events (such as Hurricane Irene and several extreme drought, rain and snow events) have occurred in New England in recent years, thereby increasing the need to fully evaluate a potential dam failure and the associated costs. International business remains risky and both TransCanada and FirstLight are foreign owned. Changing foreign regulations, currency devaluations or circumstances completely out of FERC’s purview could compromise the health of the licensee. The economic security of a federally licensed hydropower dam on the longest river in New England is clearly in the public interest. Many hydropower projects support robust recreation economies and produce a public good by generating renewable forms of electricity. The historical record demonstrates—by the thousands of abandoned dams on New England’s rivers—that the public should not accept the burden of industrial failure, especially associated with dams. It has become common to create decommissioning funds at such federally licensed facilities as a way of insuring the public interest against having to pay for removal of a damaged facility or to take over from a failed corporation. Therefore, the American public should be insured against the burden of decommissioning costs. A study could examine the health of the facilities and their owner and recommend the terms of a license requirement for decommissioning.

There is a direct nexus between Project operations and the economic viability of each individual dam. Study results could lead to a license requirement setting up an escrowed decommissioning or trust fund to protect the public interest. The financial viability portion of the study would follow normal procedures in accounting and financial management. The study itself would be relatively inexpensive; however, adequately funding the trust would more challenging. The NPS is unaware of alternative means of securing the public from risks that the corporations or the physical assets might fail during the course of the federal license.

Conclusion

The National Park Service appreciates the opportunity to comment on the PAD and to present study requests we believe to be in the public interest. NPS Hydro Program staff will remain available throughout the course of these proceedings to assist the applicant, other resource agencies and non-governmental organization in the development, conduct and evaluations of the studies requested.

Questions or comments on this submittal should be addressed to Kevin Mendik at kevin_mendik@nps.gov or by phone at 617-223-5299.

Respectfully submitted,

Kevin R. Mendik
NPS Hydro Program Manager
Northeast Region

The Nolumbeka Project, Inc.
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February 28, 2013

Ken Hogan, Project Supervisor
Federal Energy Regulatory Commission
Office of Energy Projects
Division of Hydropower Licensing
Washington, DC 20426

RE: Wilder Dam Project No. 1892-026
Bellows Falls Project No. 1855-045
Vernon Project No. 1904-073
Turners Falls Project No. 1889-081
Northfield Mountain Pump Storage Project No. 2485-063

Dear Mr. Hogan,

The Nolumbeka Project Inc., wishes to establish a line of communication between your office and our organization as you move forward in re-licensing the five hydroelectric projects along the middle Connecticut River in the states of Vermont, New Hampshire, and Massachusetts.

The Nolumbeka Project is a Massachusetts based 501 (c) (3) non-profit corporation whose preservation mission includes the promotion of a deeper, broader, and more accurate depiction of the history and culture of the Native Americans of New England. Our organization holds the deed in preservation of a forty-one (41) acre ancient Indian village and sacred site called Wissatinnewag on the Connecticut River just down stream of the Turners Falls Dam. This twelve thousand year old village is part of a much larger complex that make up what archaeological studies have revealed to be one of the most significant and culturally diversified Native American gathering places on the banks of the Connecticut River. We are currently partners with U.S. Fish and Wildlife Service with their twenty-two (22) acres in our preservation efforts for a combined sixty-three (63) acre historically important piece of property that abuts the Connecticut River on the west bank, running north to south from the confluence of the Falls River, just below the Great Falls (Turners Falls) and down stream a distance. The village itself was a larger complex that runs further south down stream to what is now referred to as Rock Dam. The Wissatinnewag Village site is located on the border of Gill and Greenfield Massachusetts, across the river from the village of Turners Falls, in the Town of Montague.

The history of this area and our site is much too complex to go into detail in this letter, but if given the opportunity to provide information to your office and the public, I am certain that it will become clear just how important this stretch of river was in the history of the indigenous people going back over twelve thousand years. Our website does offer more detailed information. Go to www.nolumbekaproject.org

The story that lies here in this land and on this river has never been fully and accurately told for many reasons, mostly political and cultural. The last time the hydro projects were up for licensing and re-licensing there existed all across the country, and most especially here in the Northeast, an indifferent attitude toward old Indian sites and burial places. That attitude proved to be devastating to the Native American cultural resources here on the river and elsewhere. However in 2011, members of our organization had the opportunity to monitor the work on an electrical power grid infrastructure upgrade in the town of Leverett, Massachusetts. The challenge on that project was to bring heavy equipment on to the site without damaging the ceremonial stone structures identified there. The level of cooperation and respect we experienced on that project to preserve the ceremonial stone landscape in the project area proved to us there has been a change of attitude from the utilities about historic cultural preservation, and we look forward to this new level of dialogue and respect.

In relation to conducting field studies, it should be known that archaeological training processes used by most universities and public organizations are woefully lacking on the subtle cultural understanding of the lifestyles and social practices of the indigenous peoples of the Northeast. Our organization feels it is of paramount importance that this work be done and supervised by people with the proper training and understanding of how to read the land and to recognize the lifestyle and sacred practices and spaces of the indigenous peoples that existed on this stretch of river. The data from this study needs to be digitized into a format that will make it accessible for use by the appropriate researchers and Tribal Historic Preservation Offices (THPO’s). The Nolumbeka Project, as the first indigenous people’s cultural preservation organization in the region has taken on this challenge and seeks a role as a lead organization for future researchers, historians and government agencies.

The impact the past and current hydro projects have had on the very ancient relationship that played out with the water’s edge, the land, fish, animal and human interactions on the Wissatinnewag site as well as other places on the river, has been forever changed, and with it a chance to see and better understand what was here, when, and why the indigenous people from many different tribal cultures journeyed here by the thousands each spring, and stayed throughout the summer to fish and grow crops.

A cultural gathering place that was a melting pot of intertribal activities encompassing social, spiritual and technological exchanges, and a connecting point, “the hub of the wheel”, that brought together tribes from a radius of a thousand miles was established here. There is much we can learn about what that looked like on a seasonal and more importantly on a daily basis, but most of the archaeological studies and dig information for the Riverside Archaeological District and other places on the river and elsewhere in our area, have been inaccessible for decades, and in most cases have been classified as highly restricted. Our organization has been repeatedly denied access to that information. That old system of restricting access to classified research data to protect archaeological resources, has had the opposite effect, and has failed to communicate to the public and the resource managers, the story of the Indian People and the land in a way that could have protected many of the unique and irreplaceable cultural assets we witnessed destroyed on the Wissatinnewag property that is now in our stewardship. This has also been true for many other sites on the river and elsewhere.

It is our sincere hope that the time has arrived for organizations like ours to experience a more balanced, and equity driven working relationship with the FERC, the utilities, the public, the Massachusetts Historic Commission and other governmental agencies.

We are seeking to bring into balance the historical and cultural gaps and losses of natural habitat and cultural resources that were experienced on this stretch of river during the time of past re-licensing issuances. To do this, we will lay out our request for five project studies for consideration at this time that we feel will contribute to the usefulness of the yet untapped historical project resources under consideration.

Study request 1

We are requesting a comprehensive investigation and mapping of the many ancient traversing trail systems and fishing stations as well as village locus and other special places that still exist all along the river’s edge and up on the land of the Wissatinnewag village, as well as south down river to and beyond the area now known as Rock Dam. The northern section of this area is currently listed in the National Register of Historic Places as part of The Riverside Archaeological District. Our goal is to identify and recognize the hidden historical and cultural value in this land that will foster a stronger awareness and level of protection from the many poor development choices we experienced in the past and see on the horizon.

Part two of request 1

We are requesting to do additional comprehensive investigations, documents searches and other research and field studies and inventory and formal archaeological digs, to address the project areas north up to and around the Wilder and Vernon Falls (dam) on the New Hampshire, Vermont, and Massachusetts sides of the river. Any time there are obstructions on the river, like a falls, we understand that a fishing site and a village would have been a part of the landscape. This is where fish are held and create fishing opportunities. These areas hold a wealth of archaeological information that needs to be taken into account when projects are undertaken on the river’s edge, or on infrastructure upgrades that are made inland of the project area and might cause the loss of those cultural assets. The Nolumbeka Project, Inc. sees the access to background literature reviews of previous cultural resources and archaeological study reports, and the development of archaeological sensitivity models and focused field reconnaissance studies, which include access to the existing archaeological study data in the files of the Vermont, New Hampshire, and the Massachusetts, State, corporate and other NGO archives, as an important component for use in our historical archive research library. This would add a centralized and accessible body of knowledge for use in determining the cultural assets at risk in the project scope area.

Because of the current disconnect to the past cultural data, and lax attitude of past project's responsibility to that data, we see a need to organize that data in a central location and make it digitally available. At this point in the conversation, without knowing all the parties who would need or want to be involved, it would be nearly impossible to do a cost projection for this request.

Study request 2

We request that a comprehensive field survey of wildlife and botanical species/habitat to identify, catalogue, digitize, and show the association and use of the many indigenous plant species, both protected, and unprotected, that played a part in the cultural lifestyles of the people who used them. This information would prove to be useful for endangered species protection and life ways studies of the ancient river tribes. The cost of this process would be determined by the number of sites that give indication of Native land use in the projects areas, and that has yet to be fully determined.

Study request 3

We request a project be undertaken to stabilize the exposed sand bank and protect from erosion damages other disturbed areas on the Wissatinnewag property damaged during mining and contracting work or the result of storm damage experienced prior to the acquisition of the land by The Nolumbeka Project. The goal would be to return the site to a green-fields condition for use as a cultural educational resource. This should include planting of indigenous grasses and plants known to have existed here prior to the land being disturbed. In addition, this would allow an experienced team of botanists, historians and archaeologists to do the basic research to develop a more complete cultural profile on the Wissatinnewag site and other important sites on the river in the resource areas under the license obligations from the utilities. The cost for this process would be impacted by the results of the second study request, which we do not have at this time.

Study request 4

We request a project be undertaken to identify and implement the formation of a National Historic Park around the Great Falls fight site in the Gill and Turners Falls area. A Historic Educational Park and self guided hiking trails, would allow the story of the May 19, 1676 attack on the refugee camp at the Wissatinnewag and the Peskeompskut village sites to be told from the indigenous point of view, and would help to educate and celebrate the importance of the relationship The Great Falls played in the lives of the indigenous people, who for over 200 generations, considered it to be a village of peace and place of cultural and technical exchange and celebration. This educational experience fits right into the Town of Montague's efforts to establish the River Culture and history of the Great Falls as a destination for historical tourism. The Town of Northfield is also talking about historic tourism as part of their new Master Plan. As part of this process we would like to also request a central housing facility in the Gill or Turners Falls area for our historic archives and study programs. Researchers, educators, and THPO's across the northeast and beyond could use this office. It could also be a central location for preservation efforts here in Western Massachusetts. A study needs to be done first to arrive at the cost of this project. An office location for the Nolumbeka Project might be incorporated into a River Culture complex with the Town of Montague and other NGO's, to offset the expense of the project.

Study request 5

In the early sixties a construction company mined the northern portion of the Wissatinnewag Village area we are responsible for preserving. During that time period sand and gravel from the Wissatinnewag Village site was taken for the building of Route 2 in Greenfield across the street and Route 10 in the Northfield area. During this phase of history on the site, part of the village was destroyed and untold numbers of unmarked burials were displaced. Sadly, human remains mixed in the sand and gravel often became part of the road base for the Route 2 and Route 10 road construction projects at that time. The construction company used the mined out portion of the village to deposit and bury construction debris. Old tires, discarded construction materials and steel barrels were buried there. That portion of the village leaches into Falls Brook, which goes into the Falls River and within a few hundred feet into the Connecticut River. We would like to clean up the pollution going into Falls Brook and restore the area to a clean and healthy ecosystem. Addressing this challenge would make the area safer and more useful in our educational and preservation programs on the site. The cost of this effort could only be determined by testing for the extent of the contamination on the site impacted, and that has yet to be done

From the Board of The Nolumbeka Project and myself, we would like to thank you for the opportunity to be a part of this process, and we look forward to a rewarding and productive exchange and working relationship on this re-licensing project.

Sincerely,

Joseph Graveline, President
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Franklin Regional
Council of Governments

March 1, 2013

Honorable Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

Re: Northfield Mountain Pumped Storage Project No. 2485-063
Turners Falls Project No. 1889-081
Comments on the Preliminary Application Document, Scoping Document 1, and Study Requests

Dear Secretary Bose:

The Franklin Regional Council of Governments (FRCOG) is the regional planning agency for Franklin County, Massachusetts. Two committees of the FRCOG, the Connecticut River Streambank Erosion Committee (CRSEC) and the Franklin Regional Planning Board (FRPB), have worked closely with the owner/operator of the Northfield Mountain and Turners Falls Projects for almost 20 years to develop and implement bank stabilization projects that address problems of significant streambank erosion occurring in the Turners Falls Pool on the Connecticut River (the Pool). This cooperative effort set aside differences over erosion causes and focused instead on working together to identify and achieve solutions that protect prime farmland, structures, and other natural resources.

Since the new licenses for these projects will be valid for 30 to 50 years, stakeholders have a "once in a lifetime" opportunity to participate in the process to identify, evaluate and mitigate the environmental impacts of these projects. We believe that it is vital for the residents and municipalities of Franklin County to be actively represented and engaged in the relicensing effort to ensure that the health and vitality of the river is sustained; to protect the region's treasured prime farmland, riparian and aquatic habitat for rare and endangered species; and to make sure that recreational areas and facilities are maintained. We hope that FERC will hold the owner of the hydroelectric projects to high standards and expectations.

We have been and continue to be concerned with the frequent and significant water level fluctuations associated with the operation of the Northfield Mountain Pumped Storage and Turners Falls projects, which result in streambank erosion and impacts to water quality, threatened and endangered species, fisheries, wetlands, and riparian and littoral habitat. In particular, we believe that the Northfield

Mountain Pumped Storage project and its operational use of the Connecticut River have been a long-term “experiment” that has resulted in significant adverse environmental impacts. We now have an opportunity to seriously consider the benefits of taking the river “off-line” and creating a closed-loop lower reservoir that would address most of the environmental impacts and specific resource concerns raised by Federal and state agencies and stakeholders.

Our regional economy benefits from the number and variety of recreational resources associated with the projects. We appreciate the applicant’s efforts to maintain and enhance the projects’ recreational opportunities over the years. We encourage the applicant to continue their stewardship and consider working with the local towns and regional groups to expand and enhance the recreational opportunities, which in turn will help to strengthen and grow the Franklin County economy. Tourism is important to the economy of Franklin County, which is one of the poorest counties in the state.

Representatives of the FRCOG attended the public scoping meetings held by FERC on January 30th and 31st in Turners Falls, Massachusetts. We understand from these meetings that it is FERC’s intention to collectively review and consider the cumulative impacts of the five hydroelectric projects on the Connecticut River up for relicensing. The FRCOG strongly endorses this holistic and cumulative approach because we believe the river and these projects should be evaluated as a single, hydrologically-interconnected system. We recommend that the Vermont Yankee Atomic Power Station and water withdrawals also be evaluated in this review. It is imperative that FERC and the mandatory conditioning agencies have the information they need to better understand the individual and cumulative environmental impacts of all these projects and to balance power generation with environmental protection of the river.

The FRCOG believes that the magnitude of river alteration caused by these five projects and the complexity of issues involved, and the controversy of the best approaches to maintain power generation while not decimating aquatic communities and other natural resources, fully warrants an Environmental Impact Statement (EIS) under NEPA. We endorse FERC’s approach to developing a single EIS for the five Connecticut River hydroelectric facilities to evaluate their individual and cumulative impacts on the river ecosystem. Now is the best opportunity in the near and long term to look at all these facilities holistically. We are committed to working with FERC and other stakeholders to implementing an Integrated Licensing Process for these projects that will positively affect the Connecticut River and its resources for present and future generations.

We recently received notification that FirstLight filed a Hydraulic Modeling Assessment of the Turners Falls Impoundment, Turners Falls Hydroelectric Project (No. 1889) and Northfield Mountain Pumped Storage Project (No. 2485) with FERC. FirstLight states in the report that “[t]he findings contained herein demonstrate that the TF Impoundment does not backwater to the base of the Vernon Dam and that the upstream influence of the TF Project is located approximately 9,000 feet downstream of Vernon

Dam, or just below Stebbins Island. The findings also show that hydraulic control of the river shifts from the TF Dam to the Gorge at a flow of approximately 30,000 cfs. Accordingly, FL intends to propose a geographic scope for its relicensing studies limited to the zone of impact of the TF Project. In addition FL will propose modifying both the width and upstream geographic extent of the Project Boundary as part of its relicensing proposal." Since the report was made available on February 22, 2013, we did not have adequate time to review the report and provide our comments as part of this letter. We respectfully request that we be given at least 90 days to provide FERC with our comments.

We appreciate the opportunity to submit our comments on the Preliminary Application Document (PAD), Scoping Document 1, and Study Requests for the projects. For ease of reference, our comments on the PAD and Scoping Document 1 are organized by the major sections in each document. The Study Requests that we are submitting to FERC are detailed in the Appendix to this letter.

Preliminary Application Document (PAD)

The purpose of the Preliminary Application Document (PAD) is to provide information on the existing environment, existing data, and studies relevant to the existing environment, and any known or potential effects of the Turners Falls Project and the Northfield Mountain Project on natural, recreational, cultural, aesthetic and socio-economic resources. The information in the PAD also helps stakeholders identify scoping issues and study needs for the FERC's National Environmental Policy Act (NEPA) document.

Section 3.4 Other Turners Falls Project and Northfield Mountain Project Information

3.4.1 Current License Requirements

We are concerned that the list of "key license requirements" for the two projects did not include Article 19 for the Turners Falls Dam (P-1889) and Article 20 for the Northfield Mountain Pumped Storage Project (P-2485). Given the amount of money the applicant has spent to address the severe and ongoing erosion in the Turners Falls Pool, we believe that the section on "key license requirements" should include Articles 19 and 20. Article 19 states, "[i]n the construction, maintenance, or operation of the project, the Licensee shall be responsible for, and shall take reasonable measures to prevent, soil erosion on lands adjacent to streams or other waters, stream sedimentation, and any form of water or air pollution. The Commission, upon request or upon its own motion, may order the Licensee to take such measures as the Commission finds to be necessary for these purposes, after notice and opportunity for hearing." Article 20 contains similar language, "[t]he Licensee shall be responsible for and shall minimize soil erosion and siltation on lands adjacent to the stream resulting from construction and operation of the project. The Commission upon request, or upon its own motion, may order the Licensee to construct and maintain such preventive works to accomplish this purpose and to revegetate exposed soil surface as the Commission may find to necessary after notice and opportunity for hearing."

The PAD does reference the 1999 Erosion Control Plan (ECP), which was developed by Simons & Associates (S&A) for the previous Licensee to address riverbank erosion in the Turners Falls impoundment. The ECP was developed in response to concerns over riverbank erosion and pursuant to Articles 19 and 20 of the FERC licenses for the Turners Falls Dam and Northfield Mountain Pumped Storage projects. The ECP was approved by FERC and includes a list of 20 riverbank segments where erosion was most severe. These sites were identified as priority sites to be considered for stabilization. Management measures for erosion control in the ECP included: restoration of eroded riverbank segments, preventative maintenance to minimize or prevent future erosion, and maintenance and monitoring of the restored sites. The ECP has been and is currently being implemented in cooperation with the Connecticut River Streambank Erosion Committee (CRSEC), of which the Licensee is a member. This ad hoc committee provides an established forum for the Licensee to coordinate with resource agencies and local landowners on erosion control projects and issues. One provision in the ECP requires the Licensee to periodically repeat the classification and prioritization process at 3- to 5-year intervals (Full River Reconnaissances) during the remaining term of the current FERC license.

3.4.3 <u>Proposed Modifications</u>

The applicant listed the following proposed project modifications in the PAD:

- Upgrading Station No. 1 with new or rehabilitated turbines.
- Closing Station No. 1 and adding a turbine generator at Cabot of similar hydraulic capacity to that at Station No. 1.
- Utilizing the full hydraulic capacity of the Cabot turbines including currently unused capacity.
- Utilizing more storage in the Northfield Mountain Project's upper reservoir.
- Increasing the unit and station capacity at the Northfield Mountain Project.

We are concerned that no specific information about these proposed modifications was included in the PAD. We request that FERC require the applicant to provide information to the public on the need and justification for these proposed modifications as soon as possible. Also, we request that any studies undertaken by the applicant to evaluate environmental impacts of the projects include the environmental impacts of the above proposed modifications to the project facilities and operations. We urge that these analyses be done early in the relicensing process so they can be fully understood and evaluated by all interested parties.

Section 4 Description of Existing Environment and Resource Impacts

4.2.4 <u>Reservoir Shoreline and Streambanks</u>

Although, as the applicant states, numerous studies have been conducted since 1979 to study erosion of streambanks along the Connecticut River, we caution that there has been a considerable amount of controversy over the findings and conclusions of several of the reports listed in this section. We are concerned that the summary of the 1979 U.S. Army Corps of Engineers' (USACE) study provided in the PAD doesn't reference specific findings related to the Turners Falls Pool but instead includes general summary statements that are not informative or specific to this reach of the river. For example, we have excerpted general and specific findings in the 1979 USACE study, which are informative and specific to the Turners Falls Pool and should have been included in the PAD. These findings are listed below and include:

- *In the Executive Summary – "Note that forces exerted on the bank of a channel by the flowing water can be increased as much as 60 percent by such factors as flood stage variations, pool fluctuations, boat and wind waves, etc. Evaluation of forces causing bank erosion verifies the relative importance of causative factors. In descending order of importance they are: shear stress (velocity), pool fluctuations, boat waves, gravitational forces, seepage forces, natural stage variations, wind waves, ice, flood variations, and freeze-thaw."*
- *On page 21 of the report it states that the "Turners Falls Dam was raised by 5.5 feet in 1971 as a part of the Northfield Mountain Project. Prior to that time it operated similarly to the three upstream dams. Conditions have dramatically changed since completion of this project. Soils that were rarely wet are subject to frequent inundation. Pool fluctuations and variations in discharges and velocities have increased. In fact, the entire hydraulics of the system has changed."*
- *On page 51 – "Sediment and cross-sectional data are the two most important data gaps preventing a quantitative analysis of the Connecticut River."*
- *On pages 118-120 – "The impacts of hydropower development on bank stability in Turners Falls Pool have been and continue to be more severe than for the other pools. The increase in pool level, the larger pool fluctuations and flow reversals caused by the present hydropower operation all contribute to the documented bank instabilities in this part of the study reach. In analyzing the causes of bank erosion in Turners Falls Pool it is suggested that the erosion analysis presented in Table 2 and subsequent tables should be utilized. From this analysis coupled with consideration of adverse hydraulic conditions related to power generation it is concluded that:*

    1. *The maximum tractive forces that can be exerted on the banks of the river will occur during periods of moderate and major floods. Hence, power generation has not altered this condition.*
    2. *The flow reversals, turbulence and changes in river stage caused by present power generation methods have increased the tractive force sufficiently to induce bank erosion in those locations where the bank alignment and bank material causes the rate to be vulnerable to these forces.*
    3. *The increase in pool fluctuations on bank stability in Turners Falls Pool is a very significant factor. Pool fluctuations on the order of 5 feet are at least twice as destructive*

to banks or pool fluctuations of about 1-3 feet as experienced in the other hydropower pools.

4. *To stabilize the eroding banks in Turners Falls Pool will require special attention.*

In summary, if upper bank erosion is to be controlled it will be necessary to implement some measure of upper bank protection capable of withstanding the forces to which it will be subjected; also the means to provide lower bank protection to prevent failure of upper bank protection must be considered, and the cost of such bank stabilization treatments is large. Conversely, if upper bank protection is not provided where such erosion is in progress, erosion will continue until a stable terrace or bench is formed. It is estimated that upper bank erosion will slow down and in many cases stabilize within a 5-10 year period unless conditions for further upper bank erosion are set up by lower bank erosion. Furthermore, in the Turners Falls Pool upper bank erosion may extend landward on the order of 20-25 feet at vulnerable sites before some semblance of upper bank stability is achieved."

Our concerns with the methodology and findings and conclusions of the 2008 Full River Reconnaissance are well documented in our correspondence to FirstLight and FERC, yet have not been included in the PAD. We reiterate our concerns here that accurate data and a reproducible methodology are needed for documenting the type and stage of erosion in the pool and evaluating whether the pace of erosion control work is keeping up with the rate of erosion. We request that the relicensing record reflect our continuing objections to the findings of the 2008 FRR, and specifically, our objections to including statements in the PAD that reference the 2008 FRR, and all of the text on page 4-12 of the section *4.2.4.2 Shoreline and Streambank Characterization.*

4.2.4.3 Geomorphic Studies

We are pleased to see a reference to the 2007 Fluvial Geomorphology Study of the Turners Falls Pool on the Connecticut River between Turners Falls, MA and Vernon, VT prepared for FirstLight by Field Geology Services. We endorsed FirstLight's decision to undertake this study and enthusiastically supported its findings and encouraged FirstLight to implement the study's recommendations. We are disappointed to find the PAD does not accurately present the important findings and recommendations of this study that are specific to the Turners Falls Pool. Instead, the PAD includes a brief, generalized discussion of erosion.

In particular, the Executive Summary of the Field study is compelling and should have been included in the PAD. Dr. John Field also offered detailed recommendations for future work in the Turners Falls pool, which, if implemented, could provide for: a) an improved understanding of the causes of erosion; b) more accurate monitoring of erosion; and c) more successful bank stabilization efforts. Following are excerpts from the Executive Summary of the report that could have been used to inform the readers of the PAD:

"Four types of bank erosion are present in the Turners Falls Pool and occur together through time at any given location. Undercutting and notching at the base of the banks results in topples and slides as the stability of the upper bank is compromised. The slide and topple blocks are disassociated into flows and deliver loose sediment to the base of the bank. This loose sediment can be carried away from the bank by water currents generated by flood flows, boat waves, pool fluctuations, groundwater seeps, and overland flow. Where sediment is moved directly offshore, beaches can form that may promote the stabilization of the bank if the accumulated sediment is not removed or beach face inundated by flood flows. The monitoring of several cross sections since 1990 shows that bank recession rates are on the order of 1.0 ft/yr, but as much as 9.0 ft of erosion has occurred in a single year (i.e., Kendall Site). The average erosion rate of 1.0 ft/yr is corroborated by the measurement of bank recession adjacent to fixed bank points along sections of river armored with rock.

The raising of the Turners Falls Dam in 1970 destabilized previously stable portions of the bank by increasing the pore pressure in bank sediments higher up the bank. An increase in pool fluctuations with the opening of the Northfield Mountain Pumped Storage Project in 1972 and an increase in boat waves accompanying greater recreational use of the Turners Falls Pool could have played a role in the increase in erosion documented by mapping in 1978 and 1990. The lack of a riparian buffer in a few localities makes the banks more susceptible to erosion due to a lack of roots to bind the soil together and an increase in runoff over the bank that can cause gullying. An increase in overall bank stability between 1990 and 2001, as documented by erosion maps, may be related to the development of beaches observed throughout much of the Turners Falls Pool.

Comparisons of erosion maps from different years must account for variations in mapping season, mapping methods, and mapping personnel. Comparisons of two different erosion maps completed in 1990 reveal several discrepancies in the location and amount of erosion. The minor increases in erosion between 2001 and 2004 are less than the discrepancies between the 1990 maps. Consequently, policy decisions based on the erosion mapping data should be carefully reviewed, because apparent differences in erosion from year to year may simply be an artifact of the mapping process. Currently 20 percent of the bank length has been protected with rock armor. As bank stabilization efforts proceed, new approaches should be considered, because the continued reliance on armoring at the base of the bank with rock, in both riprap and bioengineering projects, could lead to increased erosion elsewhere. While the development of beaches is an indication of increasing bank stability, erosion is likely to persist as natural flood flows rework beach deposits and inundate the beach face.

However, promoting the development and preservation of beaches through the addition of large woody debris could improve bank stability by buttressing the banks against erosion and by further *trapping fine sediment on the beaches. Given the complexity of issues surrounding erosion in the Turners Falls Pool the results of this study should be considered preliminary in nature. Many areas of additional study are necessary including surveys of erosion using a systematic and explicit method for mapping the types of erosion present in order to eliminate artifacts in the mapping process. Experimentation with large woody debris placements on beach faces should also begin to determine their value in improving bank stability. Only with a thorough understanding of the character and causes of erosion can effective and sustainable bank stabilization efforts be implemented throughout the Turners Falls Pool."*

The final report listed in section 4.2.4.3 is the 2012 Riverbank Erosion Comparison along the Connecticut River prepared for FirstLight by Simons & Associates (S&A). We strenuously object to the findings and conclusions stated in this report and repeated in the PAD. Unlike the USACE reports and the Field Geology Services report, the S&A report does not include a documented methodology, the analysis lacks a robust data set, and the analysis itself is qualitative and subjective.

We specifically object to the conclusion that the Turners Falls Impoundment is in better condition than all other reaches of the river studied. This conclusion is drawn solely from an analysis of a few erosion sites in the Holyoke, Turners Falls, Vernon and Bellows Falls impoundments, documented photographically in 1998 and again in 2008, the results of the 2008 FRR, and the findings of a fluvial geomorphic study that focused on the free-flowing reach of the Connecticut River farther upstream of these four impoundments (Field Geology Services, 2005). The S&A report notes that erosion was continuing in all but one of the 23 sites evaluated in the Holyoke, Vernon, and Bellow Falls impoundments. In contrast, the report claims that in the Turners Falls impoundment, most of the eroded sites were either stabilized, in the process of stabilization through erosion control measures, or experiencing some degree of natural stabilization. We note that this conclusion is based on the results of the 2008 Full River Reconnaissance, which we dispute. The 2012 S&A report goes on to state that the segment of the river with the greatest extent of eroding riverbanks is the free-flowing reach of the Connecticut River farther upstream of these four impoundments. However, we are not convinced that such a direct comparison can be made based on the paucity of data in the S&A report and dissimilar methodologies used between the S&A report and the 2005 Field Geology Services report.

4.3.1.4 <u>Water Withdrawals</u>

We are concerned that this section did not include information about FirstLight's requirement that irrigation withdrawals obtain a permit from FirstLight. We request information about the fee structure, permit language and time-frame, need for requiring the permits, and the legal authority under which FirstLight is requiring these permits. The PAD states that for the Four Star Farms' withdrawal, "[c]ompared to the Connecticut River flow at this location, this withdrawal volume is negligible. We would anticipate that this is the case for the remaining four irrigation withdrawals in this reach of the river. Uninterrupted access to irrigation water is critical to the economic viability of these farms. The need for and legality of the permits required by FirstLight is not clear. Further, the climate of uncertainty created by the need for the farmers to obtain a permit from a private corporation to use a public resource, when this permit can be at any time and for any reason revoked, is a burden that interferes with the economic viability of these farms.

Section 5 Preliminary Issues and Studies List

5.1 Issues Pertaining to the Identified Resources

We would like to add the following issues:

5.1.2 Water Resources - Effects on water quantity, particularly the availability of water to the downstream reach of the river, below the Turners Falls dam, known as the bypass channel.

5.1.3 Water Quality – Effects of the projects' operations on the levels of turbidity, total suspended solids, and nutrients in the water. Effect of project operations on water quality, which results in the river being listed as impaired by the MA DEP (Category 5 – Waters Requiring a TMDL). The entire length of the river within the projects' boundary is listed for the following impairments.

- Segment MA34-01 (3.5 miles) for "other flow regime alternations" and "alteration in stream-side or littoral vegetative covers"
- Segment MA34-02 (10.9 miles) for "alteration in stream-side or littoral vegetative covers"
- Segment MA34-03 (3 miles) for total suspended solids, "low flow alterations" and "other flow regime alternations"
- Segment 34-04 (34.4 miles) for *E.coli* bacteria
- Barton Cove is listed as impaired for non-native aquatic plants (Eurasian water milfoil).

5.2 Potential Studies or Information Gathering

5.2.1 Geology and Soils. In the PAD, the applicant states that information from previous studies will be used to assess the effects of the project operations on streambank erosion. At the Scoping Meeting, the applicant updated the list of proposed studies for this resource category to include the following:

- 2013 Full River Reconnaissance (FRR) study and development of a QAPP for the Turners Falls Impoundment.
- Hydrologic, Hydraulic and Geomorphic Analysis of Erosion in Turners Falls Impoundment.
- Analysis of Erosion in Vicinity of Route 10 Bridge Spanning the Connecticut River (completed 2012).

- Riverbank Erosion Comparison along the Connecticut River (completed 2012).

First, for the reasons articulated above and in previous correspondence with FERC, we are concerned with the applicant's plan to use information from the earlier Full River Reconnaissance (FRR) studies (2001, 2004 and 2008) and the Riverbank Erosion Comparison along the Connecticut River (2012) report. We are currently working with the applicant to develop a suitable Quality Assurance Project Plan (QAPP) and appropriate methodology for the 2013 FRR. At this point, an outline for the proposed Hydrologic, Hydraulic and Geomorphic Analysis of Erosion in the Turners Falls Impoundment has not been shared with us so we aren't able to provide specific comments other than our hope that the findings and recommendations for further study found in the 2007 Field Geology Services report are reflected in the proposed study.

5.2.3 Water Quality. Add the following to the *Study Objectives* section:

- Collect data on the levels of turbidity, total suspended solids, and nutrients in the water.
- Collect data on the effect of project operations that result in the river being listed as impaired by the MA DEP (Category 5 – Waters Requiring a TMDL) for the following impairments:
  - "other flow regime alternations"
  - "alteration in stream-side or littoral vegetative covers"
  - total suspended solids
  - "low flow alterations"
  - *E.coli* bacteria
  - non-native aquatic plants (Eurasian water milfoil).

Scoping Document 1

We have several comments to offer on the Scoping Document 1 issued on December 2012 by FERC. Our comments are arranged by the sections in the document.

3.5 Alternatives to the Proposed Action

On page 8 of the Scoping Document, the text reads that "[i]n accordance with NEPA, the environmental analysis will consider the following alternatives, at a minimum: (1) the no-action alternative, (2) the applicant's proposed action, and (3) alternatives to the proposed action." We strongly urge the FERC staff to consider a closed-loop alternative for the lower reservoir serving the pumped storage project and request that the applicant complete a feasibility study of this alternative to the proposed action.

4.0 Scope of Cumulative Effects and Site-Specific Resource Issues

We concur with the list of resources listed in Scoping Document 1 that could be cumulatively affected by the proposed operation and maintenance of the five hydroelectric projects on the Connecticut River. The Connecticut River is a public resource that is used as fuel for these hydroelectric projects, which not only generate electricity for public use (at a cost) but generate profits for the projects' owners. This is the public's first opportunity to evaluate environmental data and operational information and to suggest modifications to the way the projects operate, both individually and collectively, to avoid or mitigate the environmental impacts. We respectfully request that all project resource issues be analyzed for both cumulative and individual project effects. The geographical scope of the cumulative impacts analysis should include the main stem of the Connecticut River from the Wilder Project downstream to the Holyoke Dam.

4.3 FirstLight's Turners Falls and Northfield Mountain Pumped Storage Project Resource Issues

Our comments on this section are the same as the comments we provided on the PAD, above, for Section 5 Preliminary Issues and Studies List, 5.1 Issues Pertaining to the Identified Resources. Rather than repeating our comments here, we request that our comments on the PAD be noted as comments on Section 4.3.1 Geology and Soil Resources and 4.3.2 Water Resources of the Scoping Document 1.

6.0 Request for Information and Studies

We are aware of at least 18 Study Requests that have been drafted by Federal and state resource agencies, with the assistance of various NGOs and other stakeholders for the Turners Falls and Northfield Mountain Pumped Storage projects. The sheer number of requests indicates how little we know about the environmental impacts these projects have had and will have in the future. Further, we believe that the wide range and severity of the environmental impacts provides additional support for a closed-loop alternative to using the Connecticut River as the lower reservoir for the Northfield Mountain project. We support these Study Requests and encourage FERC to require the applicant to undertake these studies. FRCOG staff reviewed and provided comments during the drafting of these study requests. FRCOG endorses and submits the following study requests as its own in support of the resource agencies and a complete relicensing process.

1. Study of shoreline erosion caused by Northfield Mountain Pump Storage (NMPS) operations.
2. Study of feasibility for converting Northfield Mountain Pump Storage (NMPS) station to a closed-loop or partially closed-loop system.
3. Study of Northfield Mountain/Turners Falls Operations Impact on Sedimentation and Sediment Transport.
4. Water Quality Study.

5. Impacts of Water Level Fluctuations on Aquatic Vegetation Including Invasive Species and their Associated Habitats in the Project Impoundment.
6. Model River Flows and Water Levels Upstream and Downstream from the Turners Falls Project Dam Generating Stations and Integration of Project Modeling with Upstream and Downstream Project Operations.
7. Develop A Comprehensive And Predictive Model Of The Electrical Generation System Consisting Of Five Generation Projects Along The Connecticut River To Study The Impact and Feasibility Of Various Changes In Operations On Environmental Resources

Detailed discussion of these Study Requests is included as an appendix to this letter. It should be noted that no fishery study requests are included. While FRCOG supports those requests as relevant and important to understanding the impact of the hydroelectric projects on the Connecticut River, fisheries are outside of its purview. We encourage FERC to accept the study recommendations of the Federal and state fishery agencies.

We appreciate the opportunity to provide comments on the PAD, Scoping Document 1 and the Study Requests. We look forward to continuing our active engagement in the relicensing of the Connecticut River hydroelectric projects.

Sincerely,

Bill Perlman, Vice-Chair
FRCOG Executive Committee

Jerry Lund, Chair
Franklin Regional Planning Board Executive Committee

Tom Miner, Chair
Connecticut River Streambank Erosion Committee

cc: Franklin County Legislative Delegation
US Fish & Wildlife Service
Massachusetts Department of Environmental Protection
Massachusetts Department of Conservation and Recreation
Congressman James McGovern
Town of Gill, MA
Town of Northfield, MA
Town of Montague, MA
Franklin Conservation District
Connecticut River Watershed Council
Nathan L'Etoile, Four Star Farms
John Howard, FirstLight Power

Attachment: Appendix 1 – Franklin Regional Council of Governments' Study Requests

Appendix 1
Franklin Regional Council of Governments' Study Requests

Study Request 1 - Study of Shoreline Erosion Caused by Northfield Mountain Pumped Storage (NMPS) Operations

Development of the current configuration of the Northfield Mountain Pumped Storage project included raising the dam height at Turners Falls by 5.9 feet in 1970 in preparation for NMPS operations. Operations began in 1972; since then all project operations have operated under this raised dam environment. The additional 5.9 foot in elevation changed the elevation of the Turners Falls impoundment, which extends some 20 miles upstream. The increase in river elevation also resulted in motorized boat traffic becoming more popular and makes the use of larger boats more possible. The presence of motorized recreational boats increases wake energy that can accelerate bank erosion rates.

The operation of NMPS causes alterations to the river as a direct feature of plant functionality. The alterations include: 1) daily fluctuating pond levels which at times in some places can exceed six feet (the license allows fluctuations up to 9 feet measured at an undisclosed location near and upstream of the Turners Falls dam); 2) altered flow and velocity profiles of river; 3) reversal of river flow direction; and 4) changes to the downstream hydrograph. Elevation data for the river in Appendix E of the PAD indicate that stage changes of 2 to 3 feet during the summer of 2012 were not uncommon.

Raising the level of the river can saturate bank soils. These same soils can quickly become dewatered when the river is lowered by the NMPS pumping cycle. Repeated saturation and dewatering of banks can lead to bank instability which in turn can lead to bank failure and eroded material entering the river. See Field (2007)[1] for an extended discussion on bank erosion and failure mechanics. Elevated levels of turbidity and suspended solids in the water column can diminish spawning, rearing and migratory habitat for fish. When too much fine grain material is deposited on channel bed substrates, particularly those substrates used for spawning, spawning success of resident and migratory fish is compromised, potentially reducing recruitment and carrying capacity.

Goals and Objectives

The goals of this study request would be to determine the environmental effects of the presence and operation of the licensed facilities on river bank stability, shoreline habitat, agricultural farmland, wetland resources, bed substrate, and water quality in the Turners Falls impoundment. We recognize that data from other studies will be made available and we think that the data from these other studies could be used to help meet the objectives of this study request.

Objectives of the study include the following:

1. Calculate the total volume of eroded material, calculate resulting nutrient loading of eroded material, and document and describe the three dimensional changes to the bank, including lateral bank recession, changes to bank slope, and the presence and subsequent inundation of pre-

[1] Field Geology Services. (2007). *Fluvial geomorphology study of the Turners Falls Pool on the Connecticut River between Turners Falls, MA and Vernon, VT*. Prepared for Northfield Mountain Pumped Storage Project. Farmington, ME: Field Geology Services.

project beaches and shoreline since the Turners Falls Dam was raised and the Northfield Mountain Pumped Storage facility came on-line.
2. Document and describe the changes to banks upstream and downstream of riverbank restoration projects, including bank recession.
3. Identify the changes that have occurred to bed substrate as a result of fine grain material being eroded from the banks and being deposited on the channel bed.

Relevant Resource Management Goals and Public Interest Considerations

Our management goal is to ensure high quality habitat for migratory diadromous fish. Shortnose sturgeon, American shad and American eel all require suitable spawning, rearing, migratory and foraging habitat. Eroding banks and subsequent increases in turbidity and deposition of fine grained material onto bed substrates in the Turners Falls impoundment, the bypass reach and downstream of the Turners Falls project reduces the quality of habitat for these species. Elevated levels of suspended sediment are associated with a diminution in water quality which also affects the quality of habitat for native, rare and endangered fish and other aquatic and riparian species.

In addition to habitat effects, soil erosion contributes to nutrient loading. In 2001, the U.S. EPA approved New York and Connecticut's Long Island Sound (LIS) dissolved oxygen TMDL. As a result, the New England Interstate Water Pollution Control Commission (NEIWPCC) established the Connecticut River Workgroup and the Connecticut River Nitrogen Project. This project is a cooperative effort involving staff from NEIWPCC, the states of Connecticut, Massachusetts, New Hampshire, and Vermont, and EPA's Region 1 and Long Island Sound (LIS) offices. All are working together to develop scientifically-defensible nitrogen load allocations, as well as an implementation strategy, for the Connecticut River Basin in Massachusetts, New Hampshire, and Vermont that are consistent with TMDL allocations established for LIS. Since its inception, the Connecticut River Workgroup has participated in a number of projects to better understand nitrogen loading, transport, and reductions in erosion.

Public Interest Considerations if Requester is not a Resource Agency.

The Franklin Regional Council of Governments (FRCOG) is a regional organization that offers diverse programming, products and services, both on the municipal and regional level, to our 26 member towns. The FRCOG is also the Regional Planning Agency for Franklin County, Massachusetts, which is the most rural county in the state. The FRCOG serves the town governments, municipal boards and committees, businesses, and our citizens. In the early 1990's, the FERC recognized the creation of an ad hoc committee, the Connecticut River Streambank Erosion Committee, convened by the FRCOG and FRPB to bring together the NMPS operator, state and municipal entities, landowners, and NGOs to carry out bioengineering projects to stabilize and repair areas of bank erosion. We advocate on behalf of our communities and the county at the federal, state and regional levels. We work together to advocate for legislative action, social policy, and governmental programming that recognize the unique character and conditions of our rural area.

Existing Information and Need for Additional Information

The PAD makes reference to several studies in section 4.2.4 including the Erosion Control Plan (Simons & Associates, 1999), previous Full River Reconnaissance studies (1998, 2001 – maps but no report generated, 2004, and 2008), Field Geology Services' 2007 fluvial geomorphic investigation of the Turners Fall impoundment, and 2012 investigations by Simons & Associates.

Field Geology Services' 2007 investigation provided several good recommendations for future work in section 9.3 of its report which, if implemented, could provide for: a) an improved understanding of the causes of erosion; b) more accurate monitoring of erosion; and c) more successful bank stabilization efforts. This document is a good point of reference. The Simons & Associates' (2012) documents are qualitative and based on several unstated assumptions that may not be valid. Full River Reconnaissance efforts have been undertaken using varying methodologies, making for difficult comparisons from one report to the other.

We believe that these existing studies do have data that can be useful if certain new analyses are undertaken. These analyses of existing data would help fill in our gaps of understanding of bank erosion in the Turners Fall impoundment. We are also asking for the collection of additional field data. With the existing and additional information, it should be possible to better display what changes have occurred to streambanks over time. Current Geographic Information System (GIS) software allows for various types of data to be assembled into a map and into a database such that change over time analysis can be conducted fairly easily. The change over time analysis is a critical analysis that is needed, and was already started under Field (2007).

Photos that have been taken at or near the same location but at different times exist. For example, the last three Full River Reconnaissance efforts have included continuous videotaping of the river banks with locational information. With these data, "snapshots" of the bank at various locations could be extracted and compared over time. Field (2007) photo locations could be re-shot as well. This existing information should be presented such that it is easy to discern where the photo was taken and what changes have occurred over time. A comparison of the bank every 100 ft could be compared over the years.

Historic aerial photography for the Turners Fall impoundment should be gathered and analyzed. Examples of good photographic datasets include the Field 2007 appendices and 1929 aerials. The location of the shoreline over time should be noted such that it is easy to discern where bank retreat has been most severe and where the river has been relatively stable since the earliest aerial photograph was taken.

Very little turbidity data for the Turners Falls impoundment, the bypass reach or stretches of the Connecticut River downstream of the Turners Fall project exist. Thus far, implementation of the *Northfield Mountain Pumped Storage Project Sediment Management Plan* (revised February 15, 2012) has yielded few results, and many technological difficulties (see *2012 Sediment Management Plan – 2012 Summary of Annual Monitoring* dated November 30, 2012). Suspended sediment monitoring equipment is installed at the Route 10 Bridge upstream of the project and inside the powerhouse, theoretically taking readings representative of pumping and discharging through the turbines. An analysis of how turbidity might change relative to rapidly changing impoundment levels would be very useful information.

Nexus to Project Operations and Effects

The construction of the NMPS project was contingent upon the Turners Falls project raising the dam crest elevation by 5.9 feet. The NMPS project operations rely on the Turners Falls impoundment as the source of water to be pumped up and then discharged back into the river through turbines. The importance of this river reach to the NMPS operation is made clear by FirstLight's reference to this portion of the river as the "lower reservoir." Daily pumping and discharging changes the ponded elevation of the Connecticut River which in turn leads to bank material that repeatedly becomes saturated and then dewatered. Weakened bank material can then become eroded and the fine grain material from the banks can enter the water column and be transported in suspension in the river and eventually settle onto bed material. The raising of the Turners Falls impoundment also made recreational boating more popular, including the introduction of large, high-horsepower powerboats that were not previously present. Because of the fluctuating water levels, boat wakes impact the shoreline to a much greater extent than would occur if levels were more constant, thus exacerbating both the effects of the wakes and the fluctuating levels. For these reasons, erosion caused or contributed by NMPS project operation can negatively affect spawning, rearing and migratory habitat for rare and endangered species, including the endangered shortnose sturgeon. The requested study will help inform the mandatory conditioning agencies and stakeholders when contemplating mitigation measures and or operational modifications.

Proposed Methodology

1. This study should determine the net soil loss in cubic yards between 1970 and the present; a density estimate of the eroded material should also be provided. Provide an analysis of where the greatest loss has occurred, location of proximity to the tailrace, soil type, riparian land use, and vegetative cover in that area. Calculate nutrient loadings (nitrogen and phosphorus compounds) to the river system based on soil loss.
2. Obtain copies of the original survey plans for the project, and complete a new survey using the same landmarks used previously. The Field (2007) report states on page 11 that the original survey plans of the river are still retained by Ainsworth and Associates, Inc. of Greenfield MA. Use pre-operation aerial photos and current aerial photos to complete a 10-foot topographic map of the section of river between Turners Falls Dam and Vernon Dam and the 200-foot buffer regulated under the Massachusetts Rivers Protection Act. The Field (2007) report on page 11 states that Eastern Topographics, Inc. determined that sufficient information is known about the 1961 aerial photos (e.g., height of airplane) to create a 10-foot topographic map of that time period, and that 1961 aerial photos could be accurately overlaid with recent aerial photos. Field (2007) states that this analysis would enable a more reliable determination of small-scale shifts in channel position and changes in bank height that may have resulted from the erosion of a low bench that previously existed along portions of the river. Among other things, create a single map showing areas of erosion and deposition, and also overlay the Field report's hydraulic modeling analysis of the river channel.
3. With respect to the January 22, 2013 submittal from FirstLight to FERC regarding its long term monitoring transects in the Turners Fall impoundment, we ask that any data errors (as discussed

in Field, 2007) and problems that have occurred over the years at each site be mentioned. We also ask that an analysis for each cross section extending to the top of the bank and including a portion of the floodplain be provided.

4. Take the information presented in Figure 4.2.3-1 "Soils in the vicinity of Turners Falls and Northfield Mountain projects" in the PAD and convert from 63 categories to just a few that are defined in a key that will allow readers to understand which soils are easily erodible, which aren't, and where there is bedrock along the banks.
5. Complete detailed surficial mapping (topographic map or LIDAR) to identify the various geomorphic surfaces, height of benches/terraces above the river level, and types of sediments underlying the surfaces. This will allow one to determine how erosion varies with geomorphic conditions. One could then normalize the amount of erosion to a specific type of bank material/geomorphic surface/terrace.
6. Another information request covers the range of daily water level fluctuations. In this study request, we ask for an analysis on the degree to which boat wakes increase that fluctuation range. The task would be to observe boat wakes under a range of boat sizes and flow rates on the river. We recommend implementation of the 2007 Field report recommendation that states, "A more thorough study of boat waves is merited to better document how many boats use the Turners Falls Pool, how fast they travel, the type and size of waves they produce, and their impact on shoreline erosion."

A component of this study request is not necessarily for new data, but for existing data to be presented in a more clear, coherent and comprehensive manner. All existing photographs of banks that have been collected either by FirstLight, on behalf of FirstLight or on behalf of the FRCOG Connecticut River Streambank Erosion Committee should be geo-referenced in such a way that it is easy to discern where the photograph was taken and the date should be easily discernible as well. These photos should be presented in a manner that makes it easy to visualize how a particular section of bank has changed over time. Providing geographic context for photographic data of river banks and making these photos comparable over time should be standard practice. The 2007 Field report contains the following recommendation on page 47: "An attempt should be made to overlay the 1961 aerial photographs with a current flight and to create a topographic map from the 1961 flight. The feasibility of this effort has been confirmed by Eastern Topographics, Inc. This effort will identify the previous extent of the low bench and identify areas of the most significant bank recession the past 45 years." Given that this statement was written in 2007, we request that that the analysis is extended to current conditions.

Given the complexity of this study request and the expertise necessary to implement it, we request that we and the mandatory conditioning agencies be involved with the selection of the hired consultant.

Level of Effort and Cost

The level of effort to compile existing information and to make the data available in a map and searching for existing bed substrate material data should not take more than a few days. The level of effort for the bed sampling work will vary based upon how much existing historic information exists. Much of the effort of this study request is essentially office work that compiles and better presents existing data. While an estimate on the amount of field time required, including a current flight for aerial photography (LIDAR) or a topographic map survey, is difficult to make, we estimate that up to two weeks of field work could be required and that some of the data collection could be done while other field studies are occurring.

Study Request 2 – Study the Impact of Operations of the Northfield Mountain Pumped Storage Project and Turners Falls Dam on Sedimentation and Sediment Transport in the Connecticut River

Goals and Objectives

The goal of this study request is to provide hydraulic and sediment transport modeling of both the intake and discharge conditions (current and proposed) at the Northfield Mountain Pumped Storage Project. The results of the study should provide information sufficient to enable mandatory conditioning agencies and stakeholders to understand current and proposed effects on water level fluctuations and relate them to potential increase in sedimentation to the Connecticut River. Mandatory conditioning agencies and stakeholders should be able to identify techniques that could be used to mitigate the effects of project operations or other mitigation techniques that could be developed to reduce riverbank erosion within the impoundment. In addition, an assessment of means to minimize the sediment load passing through the Turners Falls Canal during and after maintenance drawdowns should be conducted.

The specific objectives of this study are as follows:

1. Assess hydraulic and sediment dynamics in the Connecticut River from Vernon Dam to Turners Falls Dam, the upper reservoir at Northfield Mountain, and downstream of the Turners Falls Dam.
2. Identify management measures to minimize erosion and sedimentation.
3. Determine areas of sediment deposition and beach formation in the Project Area and 1 km downstream of Cabot Station and describe habitat features of these areas, recreational uses and effects on invasive species, if any. Habitat areas include but are not limited to coves (e.g. Barton Cove), back channels, islands, wetland habitats, shorelines, shoals, deep water areas and channels.
4. Identify management measures to mitigate for substrate (habitat) impacts and recreational impacts in sediment-starved areas below the dam and sediment accumulation areas upstream of the dam.

Relevant Resource Management Goals and Public Interest Considerations

The resource management goal is to ensure that the Connecticut River, which is designated as a Class B river for its entire length in Massachusetts, meets its designated uses of habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation. Class B waters must also have consistently good aesthetic value and meet minimum criteria for numerous water quality indicators to achieve compliance with the standards set forth in the regulations. The other resource management goal is to protect prime farmland soils, which are eroding, and riparian habitat. Eco-based tourism and agricultural operations are important to the economy of Franklin County so maintaining the water quality of the river and protecting scenic landscapes and productive farmland along the river from erosion are important.

Public Interest Considerations if Requester is not a Resource Agency

The Franklin Regional Council of Governments (FRCOG) is a regional organization that offers diverse programming, products and services, both on the municipal and regional level, to our 26 member towns. The FRCOG is also the Regional Planning Agency for Franklin County, Massachusetts, which is the most rural county in the state. The FRCOG serves the town governments, municipal boards and committees, businesses, and our citizens. In the early 1990's, the FERC recognized the creation of an ad hoc committee, the Connecticut River Streambank Erosion Committee, convened by the FRCOG and FRPB to bring together the NMPS operator, state and municipal entities, landowners, and NGOs to carry out bioengineering projects to stabilize and repair areas of bank erosion. We advocate on behalf of our communities and the county at the federal, state and regional levels. We work together to advocate for legislative action, social policy, and governmental programming that recognize the unique character and conditions of our rural area.

Existing Information and Need for Additional Information

The PAD provides a summary of the work that has been done to characterize streambank conditions of the Turners Falls Impoundment, to understand the causes of erosion, and to identify the most appropriate approaches for bank stabilization. There has been no work undertaken to gather and assess the data that this study request would provide. Implementation of the *Northfield Mountain Pumped Storage Project Sediment Management Plan* (revised February 15, 2012) was begun in 2011 and is scheduled to end in 2014. This is a limited study related to sediment problems in the upper reservoir, not the entire river.

Nexus to Project Operations and Effects

The Turners Falls and Northfield Mountain Pumped Storage projects operate in a peaking mode, with allowable impoundment fluctuations of up to 9 feet, with the intent to continue these fluctuations. It is proposed to evaluate increasing the volume of flow from the Northfield Mountain Pumped Storage Project through increased use of the upper reservoir, which is expected to result in additional water level fluctuations. Upstream hydroelectric facilities also operate in a peaking mode of operation. Periodically, the upper reservoir at Northfield Mountain and the power canal at the Turners Falls dam need to be dewatered for maintenance purposes. Historically, both procedures have resulted in the discharge of large quantities of sediment. Sediment from shoreline erosion and riverbank failure is one of the major contributors that negatively affect water quality and habitat by increasing the turbidity and sedimentation, and smothering aquatic habitat. Repetitive water level fluctuations and flow alterations caused by hydroelectric peaking operations are known to be a major contributor to shoreline erosion.

The Proposed Massachusetts Year 2012 Integrated List of Waters shows two river segments, from the VT/NH state line to the Turners Falls dam (MA34-01 & MA34-02) impaired and considered a "Water Requiring a TMDL" due to "Other flow regime alterations", "Alteration in stream-side or littoral vegetative covers" and "PCB in Fish Tissue". In addition, the segment below the Turners Falls dam to the confluence with the Deerfield River (MA34-03) is impaired by these causes as well as total suspended solids.

Proposed Methodology

We concur with the proposed methodology developed by the MA Department of Environmental Protection, which is consistent with accepted practices:

Assess hydraulic and sediment dynamics

1. FirstLight should continue implementing the Northfield Mountain Pumped Storage Project Sedimentation Management Plan over the full range of river flows and pumping/generating cycles. An unfulfilled task in the Plan is to develop a correlation over the full range of flow conditions between the overall suspended sediment transport through the entire cross section of the river compared to the continuous sampling at the single fixed location. Environmental Protection Agency approval of a Quality Assurance Project Plan is required for valid data acquisition.
2. Provide data on the daily water level fluctuation changes for the past five years from stations listed in the PAD, and estimate fluctuations within Turners Pool assuming proposed operations and hydraulic conditions.
3. Identify the most appropriate techniques for bank stabilization given the existing and proposed hydraulic conditions.

Determine areas of sediment deposition in the Project Area

1. Field (2007) conducted a bathymetric study as part of his report. Use previous bathymetric data, if available (Field 2007 recommends putting additional effort into finding a bathymetric survey from 1913 that was partially shown in Reid 1990), and current bathymetric information to look at areas of sediment accumulation. Determine areas of sediment deposition in the Project Area and 1 km downstream of Cabot Station and describe habitat features of these areas. Habitat areas include but are not limited to coves (e.g., Barton Cove), back channels, islands, wetland habitats, shorelines, shoals, deep water areas and channels.
2. Identify recreational uses and impacts in areas known to be impacted by accumulated sediment, such as Barton Cove.
3. Identify invasive species (plant or animal) present in the reaches and determine if erosion and sedimentation in any way contributes to the establishment and/or proliferation of these species.
    a. Investigate the formation of beaches using remote sensing, LIDAR at low pool levels or some other mapping technique to understand the processes of beach deposition the distribution of beaches in the pool, the impact of beach deposition on habitat and species, and how can this be related to the operation of NMPS.
    b. Evaluate management strategies to address the release of accumulated sediment through the Northfield Mountain Pumped Storage Project works during upper reservoir drawdown or dewatering activities. FirstLight should specifically evaluate the feasibility of the installation of a physical barrier across the bottom of the intake channel of the upper reservoir that is designed to prevent the migration of sediment during future drawdowns of the upper reservoir
4. Evaluate management strategies to minimize flow fluctuations within Turners Pool including coordination with upstream users.

5. Evaluate management strategies to minimize sediment released through spillway gates and the log sluice located near the bottom of the forebay adjacent to the Cabot Powerhouse during canal dewatering activities.
6. Identify a prioritized list of locations for bank stabilization projects in the Project Area.
7. Develop a map of land owned by FirstLight within 200 feet of the Connecticut River with an overlay of land use and vegetation cover. Provide land use options aimed at reducing bank erosion.

<u>Management measures to change sediment flow below and above the dam.</u>

1. Any historic information of existing bed substrate material in the Turners Falls impoundment, bypass reach or downstream of the project should be collected and assembled. To the extent possible, the location of each sample should be made available on a map. The request for new data would stem from being able to make any valid comparison to changes in bed substrate at a given location, assuming that historic data exists.
2. Identify measures that could be taken to mitigate impacts to recreational use, habitat, or invasive species from sedimentation.
3. Identify measures that could be taken to change or mitigate sediment starved reaches below the Turners Falls dam.

Level of Effort and Cost

Many erosion studies have already been conducted and the cost of expanding the scope of some should be reasonable. A Full River Reconnaissance under the *Erosion Control Plan for the Turners Falls Pool of the Connecticut River* (Simons & Associates, Inc. dated June 15, 1999) is scheduled for 2013 and could accomplish many of the objectives listed above.

Study Request 3 - Study the Feasibility of Converting the Northfield Mountain Pumped Storage (NMPS) Facility to a Closed-loop or Partially Closed-loop System

Building and operating the Northfield Mountain Pumped Storage project required the Turners Falls Dam be raised 5.9 feet. The Turners Falls impoundment of the Connecticut River acts as the lower reservoir and is subject to large sub-daily fluctuations in water level. The collateral environmental consequences of using the Connecticut River during the pumping and generation cycles for the last 40 years are not fully understood, but have likely contributed to extensive erosion of streambanks, downstream sedimentation, entrainment of large numbers of resident and migratory fishes, and destruction of important spawning and nursery habitat, both within the Turners Falls Pool and downstream. Intrinsic consequences include radical fluctuations in the hydrograph at a sub-daily level, which also negatively impact recreation, habitat, and likely disrupts key life history stages of resident and migratory fishes, benthic invertebrates, and macrophytes. The vast majority of proposed new pumped storage projects currently being considered by FERC are closed-loop because of a growing consensus that open-cycle pumped storage causes unacceptable environmental damage.

Resource agencies have identified restoration of a more natural hydrograph to the Connecticut River as a key management goal, and view the current relicensing process for five projects on the Connecticut River mainstem as an opportunity to achieve this. Converting to closed-loop or partial closed-loop would allow the restoration of ecological flows to the Connecticut River, and provide much greater flexibility in operational guidance for both NMPS and the other hydropower stations on the Connecticut River. It will also eliminate or partially eliminate many of the environmental concerns expressed by Federal and state agencies and other stakeholders, which are outlined in the numerous study requests and comment letters that FERC will receive on the NMPS project and the other four hydropower projects.

Goals and Objectives

The goal of this study request is to provide resource managers, stakeholders, and the licensee with an analysis of possible options for converting the plant to a close-loop or partially closed-loop system.

The objectives of this study request would be to determine:

1. Candidate locations for placement of a lower reservoir.
2. Costs and logistics of construction and modification of the current facility to convert to a closed-loop or partially closed-loop system.
3. Projected savings associated with eliminating need for ongoing mitigation measures, both for stabilizing river banks as well as likely modification to operations that the facility that will be required to implement in order to protect habitat and native fauna.
4. Other ancillary costs or savings, such as eliminating requested studies, operational changes, or mitigation measures.

Relevant Resource Management Goals and Public Interest Considerations

The resource management goal is to ensure high quality habitat for migratory diadromous fish. Shortnose sturgeon, American shad, blueback herring, and American eel all require suitable spawning, rearing, migratory and foraging habitat. Eroding banks and subsequent increases in turbidity and deposition of fine grained material onto bed substrates in the Turners Falls impoundment, the bypass reach and downstream of the Turners Falls project reduces the quality of habitat for these species. Elevated levels of suspended sediment are associated with a diminution in water quality that also affects the quality of habitat encountered by endangered species. Entrainment into the facility could be lethal to any of these fish. Juvenile and larval stages of resident and migratory species, including rare, threatened, and endangered species of vertebrates and invertebrates are particularly vulnerable to entrainment. This damage is aggravated by the repeated cycling of the facility—unlike standard hydro, where organisms are likely only exposed to passage events a single time and may bypass the system safely, NMPS continuously recycles river water, and therefore increases the risk of exposure to entrainment and death.

Public Interest Considerations if Requester is not a Resource Agency

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Existing Information and Need for Additional Information

Data on environmental effects of NMPS and facilities that use fresh or salt water for generation and/or cooling are widely available and consistently indicated that these types of hydroelectric facilities damage native and migratory fauna. Once plentiful populations of blueback herring have been entirely eliminated from this portion of the Connecticut River. Populations of American eel are in steep decline throughout this reach, and American shad that initially used fish passage facilities downstream of NMPS have experienced dramatic reductions above Turners Falls Dam.

Section 4.4.6 of the PAD (page 4-146) discusses entrainment at Northfield Mountain of migratory fish species. Previous studies estimated 28.6% of Atlantic salmon entrained, which was reduced to 6.7% after the installation of a guide net only during upstream passage season. LMS Engineers estimated in 1993 that the facility impacted 0 to 12.4% of adult American shad passing the water intake. No studies have looked at impacts to resident fish or other migratory fish or other times of the year, but several study requests address this information gap.

Other facilities in the region (Brayton Point Power Station, a coal plant in Mt. Hope Bay) have been required by EPA to switch from open- to closed cycle at very significant cost because of the extensive damage done to fragile habitats by open-cycle pumping.

Streambank erosion has been a major concern since NMPS began operation in 1972. Section 4.2.4 of the PAD summarizes the extensive work that has been done to study and mitigate erosion along the river banks. Significant loss of agricultural land has resulted from unnatural river fluctuations and increased boat wakes from a raised impoundment, and in some cases poor mitigation efforts like helicopter removal of trees along the banks. Since 1996, the licensee has reportedly spent $750,000 - $1,000,000 annually on erosion control measures. In some cases, these projects will need to be re-done in the future. Converting the plant to closed-loop operation could provide significant cost savings over the life of the upcoming license, eliminating erosion control projects, proposed studies related to use of the Connecticut River as a lower reservoir, and any mitigation or operational changes to protect fisheries and other natural resources that may be contemplated as a result of relicensing.

Nexus to Project Operations and Effects

In conjunction with other study requests, parties to the relicensing process will be reviewing data and considering operation and facility conditions that will best achieve the balance between natural resource protection, property and infrastructure protection, and power generation. Making the plant closed-loop or partially closed-loop is one important consideration to the scenario and would eliminate any operation changes that might result from concerns about fishery resources, water quality effects, and farmland losses.

Proposed Methodology

1. Collate existing geological and hydrologic information for areas surrounding Northfield Mountain, including preliminary design plans for suitable facilities able to accommodate the existing and proposed discharge. These plans should include any and all possible locations, including modifications to infrastructure near the current outfall, and any other locations that could accommodate the necessary volume of water.
2. Provide an engineering analysis of structural modifications necessary to accommodate a full or partial lower reservoir in an alternate nearby location.
3. Provide information on whether and how a smaller lower reservoir, with ties to the Connecticut River, would act as a buffer to river level fluctuations and change the hydrologic pattern of flow on the Connecticut River in the Turners Falls pool (fluctuations), the water quality effects, and decrease the possibility of entrainment.
4. Provide an analysis on water losses from evaporation and leakage and how much make-up water would be needed during normal operations by season or month.
5. Identify and make available any similar studies conducted during the planning phase of the existing facility in the 1960’s or any other time.
6. Provide a cost estimate of each option considered and evaluated.
7. Provide an itemized cost estimate of how taking the river off-line (not using it as the lower reservoir) would affect other costs, such as eliminating the erosion control program, any ancillary changes to generation at Turners Falls Dam and NMPS, and fish protection measures.
8. Provide a summary of available information on the costs of converting existing open-loop pumped storage systems to a closed-loop system and a description of the environmental benefits of other closed-loop pumped storage facilities.

These methods are consistent with accepted practice for weighing costs and benefits of environmental impacts.

Level of Effort and Cost

The level of effort to compile existing information and to make the data available in a map should be low. Development of contingency scenarios would be low. The majority of the effort of this study request is essentially office work, with some engineering and design work required to scope likely costs of various scenarios.

Study Request 4 - Water Quality Monitoring in the Turners Falls Impoundment and Downstream of the Turners Falls Project

Goals and Objectives

Determine the current water quality of the Connecticut River within the Turners Falls impoundment. The results of the study should provide information sufficient to enable mandatory conditioning agency staff to understand water quality conditions at the project. The study plan for the water quality monitoring should be developed in consultation with the U.S. Fish and Wildlife Service (USFWS) and the Massachusetts Department of Environmental Protection (MA DEP).

The specific objectives of this study are as follows:

1. Characterize water quality in the Turners Falls impoundment, bypass reach, canal and below the confluence of the bypass reach and canal discharge.
2. Evaluate the potential effects of project operation on water quality parameters such as temperature, dissolved oxygen, total suspended sediment and turbidity in conjunction with various other water uses.
3. Determine the level of contamination in sediment impeded by Turners Falls dam.
4. Collect continuous temperature, dissolved oxygen, total suspended sediment and turbidity data during the summer period and under various hydropower operating conditions at the Northfield Mountain Project.

Relevant Resource Management Goals and Public Interest Considerations

The resource management goal is to ensure that the Connecticut River, which is designated as a Class B river for its entire length in Massachusetts, meets its designated uses of habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation. Class B waters must also have consistently good aesthetic value and meet minimum criteria for numerous water quality indicators to achieve compliance with the standards set forth in the regulations. The other resource management goal is to protect prime farmland soils, which are eroding, and riparian habitat. Eco-based tourism is important to the economy of Franklin County so maintaining the water quality of the river for boaters and kayakers is important, too.

Public Interest Considerations if Requester is not a Resource Agency.

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Existing Information and Need for Additional Information

The PAD provides a summary of existing water quality data. While a number of monitoring efforts have taken place and include sample sites within the project boundary, none of those studies was designed to comprehensively investigate whether all relevant project areas currently meet Class B standards: The Massachusetts DEP's Connecticut River watershed assessment monitoring occurred in 2003, it had only two stations located within the project area (both upstream of the Turners Falls dam) and only collected five to six samples from late April to early October. The Connecticut River Watershed Council's volunteer monitoring program only had one sample site within the project area (at Barton's Cove in the Turners Falls impoundment) and while those data are more recent, only three samples were collected in 2007 and only six samples in 2008 (over the course of three to four months each year). The U.S. Geological Survey's long-term water quality monitoring station located downstream of the Cabot Station tailrace only collects information roughly once per month (and no dissolved oxygen data are provided).

No directed, site-specific surveys have been conducted to determine whether waters within the Project area meet state standards. This information gap needs to be filled so that resource agencies can evaluate properly the potential impact of project operations on water quality.

Nexus to Project Operations and Effects

The project creates a 20-mile-long impoundment where there would naturally be a free-flowing river. It currently operates in a peaking mode, with allowable river fluctuations of up to 9 feet, with proposals to continue with river fluctuations. Portions of the impoundment are nearly 100 feet-deep. There is a 2.7 mile-long reach of river bypassed by the Turners Falls power canal with only a nominal seasonal release required (equal to 0.05 cfsm). The below-project flow requirement is equal to 0.20 cfm (1,433 cfs). Water quality is directly affected by the operating mode of a hydropower project. Impoundments can stratify, resulting in a near-hypoxic hympolimnion. If the project intake draws off of these deep waters then it could cause low dissolved oxygen levels downstream from the project discharge.

The FRCOG requests that the applicant conduct a water quality survey of the impoundment, bypass reach and tailrace reach in order to determine whether state water quality standards are being met under all currently-licensed operating conditions (i.e., during periods of generation and non-generation). Results of the survey would be used, in conjunction with other studies requested herein, to determine an appropriate below-project flow prescription, bypass reach flow(s), and to recommend an appropriate water level management protocol for the impoundment (e.g., limiting impoundment fluctuations to protect water quality). Operation of upstream hydroelectric projects as well as the Turners Falls Project and Northfield Mountain Project may impact water quality through the use of water for hydropower generation.

Methodology Consistent with Accepted Practice

Turners Falls: Water quality samples should be collected from a minimum of six locations: upstream of the impoundment, at a deep location within the impoundment, in the forebay near the intake, in the bypass reach, in the canal near Cabot Station and downstream of the confluence of the Cabot Station discharge and the bypass reach but upstream of the confluence with the Deerfield River. In order to ensure that data are collected under "worst case" conditions (low flow, high temperature, antecedent of any significant rainfall event), we recommend deploying continuous data loggers at all six locations, with biweekly vertical profiles taken at the deep impoundment location from June 1 through September 30. Results should include date, time of sampling, sunrise time, GPS location, generation status (estimated flow through canal and bypass reach), precipitation data, water temperature, DO concentration and percent saturation.

In addition, impoundment sediment adjacent to the Turners Falls dam should be analyzed for metals and polychlorinated biphenyls (PCBs).

A proposed water quality sampling plan should be submitted to USFWS and MADEP for approval. A section on quality assurance and quality control must be included.

If river flow and temperature conditions are representative of an "average" or "low" water year, then one year of data collection should be sufficient to perform the study. If conditions are not representative (i.e., a "wet" or cool year) then a second year of data collection may be necessary.

Northfield Mountain: The water quality study will include two components: a) continuous dissolved oxygen and temperature monitoring at specific locations in the Northfield Mountain Project area and b) monthly *in-situ* dissolved oxygen, temperature profiles, total suspended solids and turbidity within the Northfield Mountain Upper Reservoir. It is anticipated that the study will be conducted from approximately June 1 through September 30.

Level of Effort and Cost

Cost would depend on the specific methodology chosen. If continuous data loggers are installed at all six locations and biweekly vertical profiles taken at the deep impoundment location from June 1 through September 30 then the estimated cost of the water quality study is approximately $55,000, including at least one full year of data collection. It is expected to take two technicians approximately one day to deploy the loggers, eight days to collect the vertical profiles, one day to remove the loggers, one day to download the data, and five days to write the report.

In the PAD, the applicant proposes to assess the effects of the Turners Falls and NFMPS project operations on dissolved oxygen and temperature by continuously monitoring DO and temperature at locations within the project areas and gathering vertical profiles within the TF impoundment and NFMPS upper reservoir.

Study Request 5 – Quantify the Impacts of Water Level Fluctuations on Riparian and Aquatic Vegetation Including Invasive Species and their Associated Habitats in the Turners Falls Dam Project Impoundment

Conduct a study to quantify the impacts of river level fluctuations due to project operations on riparian, wetland, Emergent Aquatic Vegetation (EAV), Submerged Aquatic Vegetation (SAV), littoral zone and shallow water aquatic habitats in the Turners Falls Dam impoundment.

Goals and Objectives

The goal of this study is to obtain baseline information on riparian, wetland, emergent and submerged aquatic vegetation, and associated shallow water aquatic habitats (subject to operational inundation and exposure to near exposure) known to occur in the project area. Information would be used to determine whether riparian, wetland, EAV and SAV, littoral, and shallow water (e.g., mid river bars and shoals) habitats are impacted by current water level fluctuations permitted under the Turners Falls and Northfield projects' licenses and whether these vegetation types and shallow water habitats can be protected and restored by modifications to project operations or other mitigation measures. This analysis needs to take into account existing and potential future limits on river level fluctuations intended to limit recreation impacts, and the interactions of any changes in river level fluctuation range or frequency and discharge changes under a new licenses of the Turners Falls and upstream projects. This information is needed to determine whether the projects' operation affects plants, habitat, and wildlife in the project area, whether aquatic vegetation and its habitats can be enhanced by modifications to project operations or other mitigative measures, and whether there is any unique or important shoreline or aquatic habitats that should be protected.

The specific objectives of the field study, at a minimum, include:

1. Quantitatively describe and map wetland types within 200 feet of the shoreline, and describe associated wildlife;
2. Delineate, quantitatively describe, and map all wetland types including invasive species and wildlife observed (e.g., bald eagle nesting, water fowl nesting) within 200 feet of the shoreline, and the extent of this habitat if it extends beyond 200 feet; and
3. Quantitatively describe (e.g., substrate composition, vegetation type and abundance) and map shallow water aquatic habitat types subject to project operation inundation and exposure, noting and describing additional areas where water depths at lowest operational range are wetted to a depth less than one foot (flats, near shore areas, gravel bars, with very slight bathymetric change).

A second year of study may be required should river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period.

The field study should produce a habitat inventory report that includes:

1. The results of the field study in the form of maps and descriptions;

2. An assessment of project effects on wetland, riparian, littoral zone vegetation and shallow water habitats, invasive plant species, and wildlife habitat at the project; and
3. Recommendations for any necessary plant, habitat type, or wildlife, protection and/or invasive species control measures.

Relevant Resource Management Goals and Public Interest Considerations

Protect and restore native riparian, wetland, EAV, SAV, littoral and shallow water habitat (i.e., spawning and or nursery areas for aquatic organisms) in the Turners Falls impoundment.

Public Interest Considerations if Requester is not a Resource Agency

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Existing Information and Need for Additional Information

Existing information in the PAD does not quantify EAV and SAV in this area, or other shallow aquatic habitat types and physical features (e.g., depths, substrates, wood structure) that are the environment for aquatic biota in the project area. The PAD does provide some limited monitoring data for 2012 (2 locations) on water surface elevations that show daily fluctuations, in the upper third of this impoundment, that varied over 4 feet on a daily cycling frequency, with fluctuations generally in the 2 foot range in low flow months for the data provided in the PAD. The current license does permit a greater pool elevation operational fluctuation, up to a 9 foot change in elevation, based on the Turners Falls Dam water elevation. In the PAD it is noted these operational fluctuations under most circumstances at the Turners Falls Dam are within 3.5 feet.

In the PAD it is noted that FirstLight would like to expand its NMPS upper reservoir capacity (by up to 24%). How this may affect project operations and the habitats noted in this request is unknown. It is also noted that water is typically pumped to the upper reservoir in evening and generation back to the river occurs once to twice daily, in daytime hours, based upon power needs and power value. Under current license conditions, and provided that set thresholds for minimum flow and Turners Dam current license elevations are met, the NMPS may operate with no restriction in timing, frequency, or magnitude for pumping or generation. No data were provided on the operation of the NMPS plant over time relative to data on pumping and generation on an hourly basis, only averaged values were provided over monthly periods. It is unclear what the actual timing, frequency and magnitude of these NMPS operations are over the course of a year and how that relates to: aquatic plant species establishment, growth, survival, littoral zone or other shallow water habitat fish spawning periods and their effects on these fishes (reproduction success and subsequent recruitment, e.g., bass and fall fish nests) based on the available and utilized habitat, and how the quantity and quality of these shallow water habitats are affected by project operational manipulation/alteration, as currently permitted or proposed.

The PAD provides lists of plant and wildlife species whose native ranges overlap with the project area, but it does not provide any baseline information on known occurrences of these species in the wetlands, riparian, littoral and shallow water habitats, within or adjacent to, the project area. Plant and wildlife occurring in these habitats may benefit from protection, mitigation, and enhancement (PMEs) measures, given the potential effects of continuing the current semiautomatic peaking operating regime. In addition, a large scale sediment discharge from NMPS resulted in regulatory actions by FERC, the EPA and MADEP in 2010. Continuing and as yet unresolved management plan measures relative to sediment and NMPS project operations are further concerns for shallow water, littoral zone, and wetland habitats.

The Atlantic States Marine Fisheries Commission, Atlantic Coast Diadromous Fish Habitat: A Review of utilization, threats, recommendations for conservation, and research needs (ASMFC 2009)[2], contains a review of habitat information for these species. Recommendations in this report include: maintain water quality and suitable habitat for all life stages of diadromous species in all rivers with populations of diadromous species.

Nexus to Project Operations and Effects

Water level fluctuations due to project operations could likely affect EAV and SAV habitat as well as the quantity and quality of littoral and shallow water habitat. These operational water level fluctuation effects are expected to impact fish species' use of these habitats and may affect spawning fishes reproductive success and subsequent population recruitment including but not limited to American shad, blueback herring, sea lamprey, fall fish, and bluegill, which spawn in mid to late spring through early summer in areas subject to daily or more frequent water level fluctuations.

The current operating mode, as well as the unknowns with the proposed upper reservoir expansion, may affect wetland riparian, littoral and other shallow water habitats and promote the introduction and expansion of invasive plant species through fluctuating water levels. A study that explains the relationship between the proposed mode of operation and the type and quantity of wetland, riparian, littoral, shallow water habitats, and invasive species affected would help inform a decision on the need for protection and/or control of these resources in the license.

Methodology Consistent with Accepted Practice

The PAD currently contains maps portraying general wetland types from the Cabot Station tailrace upstream to the Vernon Dam. In addition, we understand that recent bathymetry exists for the Turners Falls impoundment (Field, 2007). The proposed study should utilize this existing information in conjunction with field surveys designed to describe the characteristics of each mapped wetland, riparian, littoral and shallow water habitat including plant species composition, relative abundance/density, habitat quality, and land use. These surveys should be conducted to describe these habitats at the lowest

[2] Atlantic States Marine Fisheries Commission. 2009. Atlantic coast diadromous fish habitat: A review of utilization, threats, recommendations, for conservation, and research needs. Habitat Management Series #9. Washington, D.C.

water level operational range permitted on a daily operation schedule, under low flow conditions. Information collected should include:

1. Plant species composition, and their relative abundance/density and condition/structure (e.g., seedlings);
2. Structured data, including estimates of average heights and aerial cover of each vegetation layer (specifically denoting invasive species);
3. Aquatic habitat substrate composition, quantity (i.e., percent types and area), wood structure (relative abundance measure applied by area), water depths (inundated, exposed, and water less than one foot);
4. Predominate land use(s) associated with each cover type;
5. Wildlife sightings should be noted;
6. Field-verified wetland, riparian, and littoral and shallow water habitats and invasive species occurrences, should be geo-referenced as polygons and overlain on orthophoto at a suitable scale.

Level of Effort and Cost

In the PAD, First Light identified impacts of the project operations on wetlands, riparian and littoral zone habitat as a potential issue to be addressed in relicensing, and proposed wetland vegetation mapping. However, additional analysis as described above is needed to understand the impacts of the project on these resources and habitats.

A wetlands, riparian, littoral/shallow water, invasive species inventory, of the scope envisioned, would likely require 6-8 months to complete and cost an estimated $40,000 to $50,000.

Study Request 6 - Model River Flows and Water Levels Upstream and Downstream from the Turners Falls Project Dam Generating Stations and Integration of Project Modeling with Upstream and Downstream Project Operations.

Develop a river flow model(s) that is designed to evaluate the hydrologic changes to the river caused by the physical presence and operation of the Turners Falls Hydroelectric Project and the Northfield Mountain Pumped Storage Project and the interrelationships between the operation of all five hydroelectric projects up for relicensing (i.e., P-1889 Turners Falls Hydroelectric Project, P-2485 Northfield Mountain Pumped Storage, P-1904 Vernon Hydroelectric Project, P-1855 Bellows Hydroelectric Project, P-1892 Wilder Hydroelectric Project) and river inflows. The river flow model(s) and analyses should include the following components:

1. A quantitative hydrologic modeling of the hydrologic influences and interactions that exist between the water surface elevations of the Turners Falls Project impoundment and discharges from the Turners Falls Dam and generating facilities and the upstream and downstream hydroelectric projects.

   Data inputs to and outputs from the model(s) should be sorted and analyzed by monthly, weekly, daily and sub-daily increments and include:
   i. Withdrawals from the Turners Falls impoundment by the Northfield Mountain Pumped Storage Project, FERC No. 2485,
   ii. Discharges to the Turners Falls impoundment by the Northfield Mountain Pumped Storage Project,
   iii. Discharges into the Turners Falls impoundment from the Vernon Project, FERC No. 1904 and other sources.
   iv. Existing and potential discharges from the Turners Falls Project generating facilities and spill flows.
   v. Existing and potential water level fluctuation restrictions (maximum and minimum pond levels) of the Turners Falls impoundment and downstream flows from the project
   vi. Existing and potential required minimum flows and/or other operation requirements at each of the four upstream projects.
   vii. Minimum discharge flows ranging between 2,500 and 6,300 cfs in the bypass reach from April 15th through June 22nd to support spawning, rearing, and outmigration of shortnose sturgeon at Rock Dam.

2. Document how the existing and potential outflow characteristics from the four upstream projects affect the operation of the Turners Falls Project including downstream flow releases and Turners Falls impoundment levels.
3. Assess how the operation of the existing Turners Falls Project and upstream projects affect Holyoke Project (P-2004) operations including:
   i. How Turners Falls Project flow fluctuations affect Holyoke impoundment water levels, with emphasis on the influence on the water levels on listed

Puritan tiger beetle habitat at Rainbow Beach in Northampton, MA and assess what changes would be needed in Turners Falls operations to stabilize water levels at Rainbow Beach.

ii. How Turners Falls Project operations affect Holyoke Project discharges and what changes in Turners Falls operations would be needed to reduce fluctuations in the discharges from the Holyoke Project.

iii. To the extent predictable and practical, incorporate the potential effects of climate change on project operations over the course of the license.

Goals and Objectives

The goal of this study request is to determine the extent of alteration of river hydrology caused by operation of the project and the interactions between upstream project operations, Turners Falls operations and downstream operations at the Holyoke Project. The objectives of this study request are as follows:

1. Determine what changes can be made to each of the five project's flow releases and/or water levels restrictions, and how those changes affect downstream resources. For example, for the Turners Falls Project continuous minimum discharge flows in the Turners Falls bypass reach need to be no less than 2,500 cfs during shortnose sturgeon spawning, rearing, and outmigration (April 15th – June 22nd). Incorporating these parameters into the model will inform what changes, if any, need to be made to operations of upstream projects to accommodate such flows.
2. As other specific modifications of the operations of each of the projects are identified based on results of other requested studies, these desired conditions will need to be input into the models to assess how each change affects that project and other project operations and the implications of those changes on other resources and/or the ability to achieve desired operational changes at other projects.

Relevant Resource Management Goals and Public Interest Considerations

The resource management goal and public interest consideration is to provide adequate information to mandatory conditioning agencies to ensure that the mitigation, protection and enhancement measures for the projects are commensurate with project effects and help conserve, protect, and enhance the habitats for fish, wildlife, and plants, including rare and endangered species.

Public Interest Considerations if Requester is not a Resource Agency

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Existing Information and Need for Additional Information

Available information in the PAD does not indicate how project operations have altered downstream hydrology, which may affect resident and migratory fish, macroinvertebrates, rare, threatened, and endangered species, aquatic plants and other biota and natural processes in the Connecticut River from below the Vernon Dam downstream to the Holyoke Dam.

Information in the PAD also does not reflect data analyzed in Kynard et al. 2012, which identifies minimum discharge thresholds for shortnose sturgeon spawning and rearing at the Rock Dam spawning site. Spawning success was observed at Rock Dam when discharge was between 2,500 cfs and 22,000 cfs during the spawning period (April 27–May 22nd) (Kynard et al. 2012, chapter 3). In 1995 at the Cabot spawning area, the greatest level of spawning and spawning success occurred (i.e., 21 late stage females present, 342 ELS captured, spawning period was 17 days) even though no spawning was detected at Rock Dam (Kynard et al. 2012, chapter 3). Discharges in 1995 at Rock Dam had dropped below 2,500 cfs by March 26th (Kynard et al. 2012, chapter 3), showing that even though 1995 saw the largest number of pre-spawning adults, none spawned at Rock Dam. This may indicate the need to have adequate flow well in advanced of spawning. Discharge reductions at the Rock Dam site that occurred during spawning caused females to leave the spawning site and not return even if flow increased to acceptable levels later during the spawning period. Researchers observed that substrate did not change during fluctuating flows and thus cessation of spawning is likely due to velocities falling below the range preferred by females. Given the current flow dynamics at Rock Dam, spawning does not occur most years (Kynard et al. 2012, chapter 3). These data represent the best available scientific information and indicates that the current minimum flow thresholds at the project are not adequate for the protection of endangered shortnose sturgeon. All modeling efforts described above must incorporate the identified minimum flow and temporal parameters.

Nexus to Project Operations and Effects

The Turners Falls Project is currently operated with a seasonally-varying minimum bypass flow (400 cfs from 5/1 through 7/15, then 120 cfs through the winter until river temperature rises to ≥ 7°C) and year-round minimum flow below the projects of 1,433 cfs. The project operates as a daily peaking project, often with large, rapid, daily flow fluctuations between the minimum and project capacity (15,928 cfs) and fluctuations in impoundment elevation (175’ to 186’ MSL). These changes affect biotic habitat and biota upstream and downstream of the project. Project operations and potential changes to operations to mitigate impacts are influenced by inflows and operations of upstream hydroelectric projects and the Northfield Mountain Pumped Storage Project operations. Potential changes in operations of each project could affect the ability to achieve desired operational changes at other projects. Results of river flow analyses will be used to develop flow-related license requirements and/or other mitigation measures.

Methodology Consistent with Accepted Practice

River hydrology statistics and modeling are commonly employed at hydroelectric projects to assess implications of project operations on the river environment.

Level of Effort and Cost

Level of effort and cost of model development are expected to be moderate. To be valuable in developing license conditions, the model(s) will need to be run under various scenarios throughout the relicensing process to assess the implications of changes to the operations of each project on other projects and other resources. Therefore, ongoing consultation and re-running of the model(s) are likely to be needed throughout the relicensing process. The modeling exercise will also require coordination and cooperation between First Light and the upstream licensee to assure that the model inputs and outputs can be accurately related.

We would anticipate that the expected level of effort and anticipated costs will be comparable to that experienced on similar FERC relicensing projects of this size (e.g., Conowingo, FERC No. 405).

Study Request 7 – Develop A Comprehensive And Predictive Model Of The Electrical Generation System Consisting Of Five Generation Projects Along The Connecticut River To Study The Impact and Feasibility Of Various Changes In Operations On Environmental Resources

If the five generation facilities (i.e., P-1889 Turners Falls Hydroelectric Project, P-2485 Northfield Mountain Pumped Storage, P-1904 Vernon Hydroelectric Project, P-1855 Bellows Hydroelectric Project, P-1892 Wilder Hydroelectric Project) were to be viewed as a single system, rather than separate entities, and if those five systems could work in concert with each other, it is possible that many of the environmental concerns could be addressed by choreographing operational parameters.

Developing a tool which could simulate the interactions among all generation entities, and report the condition of a variety of parameters would be of great help in evaluating the feasibility and effectiveness of different scenarios.

1) Inputs would be:
    a) Normal flow and height of the river entering the system around a median point
    b) Start time and duration of discharge into the river from each generation facility and dam within the project area
    c) discharge rate into the river by the stations of each generation facility and dam within the project area
    d) Operation of Northfield Mountain Pumped Storage (P-2485):
        i) Start time and duration of filling
        ii) Intake rate
        iii) Start time and duration of discharge
        iv) Discharge rate
    e) Event to effect lag times, both spatial and temporal
2) Constraints on the system
    a) Maximum and minimum on river heights
    b) Maximum and minimum on discharge rates
    c) Maximum and minimum depth of upper reservoir at P-2485 Pump Storage
3) Other parameters of interest could be overlaid
    a) Demand curves for electricity generation
    b) Cost of electricity
    c) Availability of excess generation capability
    d) Abnormal conditions i.e. Vernon Nuclear off line, spring freshet or other weather related emergencies like floods
4) Outputs of the model would be:
    a) River height at any number of locations
    b) Flow rate at any number of locations
    c) Rate of change of river height and flow
    d) Alarms when limits are exceeded

Goals and Objectives

Determine whether operating the system as a whole under a single set of operation parameters can serve to mitigate the environmental shortcomings of the current method of operation. Specifically, the model will be able to predict whether necessary modifications in timing of releases and rates, can maintain the required stability of river height, minimum and maximum flow while making sure that electrical demand is met and business concerns are taken into consideration. The model will also be able to identify the contribution to fluctuations in output by each facility, thereby determining what kind of modification will have the greatest effect.

Another specific goal would be to help inform the analysis conducted as part of Study Request 3 – Study the Feasibility of Converting the Northfield Mountain Pumped Storage (NMPS) Facility to a Closed-loop or Partially Closed-loop System. If a majority of the environmental concerns can be met by coordinating operating parameters of the installations along the river, the need becomes less. However, if the environmental concerns cannot be met, the need for a closed loop system increases in importance.

Relevant Resource Management Goals and Public Interest Considerations

1. Determine the need and extent of protective and mitigating projects to aid in the protection of the ecology of the system area.
2. Assist FERC and the operational management of the system after the relicensing project is complete. This model will be able to instruct what day by day adjustments need to be made to maintain stability of the system.
3. Long-term changes in conditions based on climate change or changes in operation further upstream can be tracked and adjusted for by modifying the input conditions. Annual measurements of normal flow can be made and the model can easily be adjusted.
4. Catastrophic events can be simulated and preparedness and emergency management plans can be based on outputs of the model.

Public Interest Considerations if Requester is not a Resource Agency

The Franklin Regional Council of Governments (FRCOG) is a regional organization that offers diverse programming, products and services, both on the municipal and regional level, to our 26 member towns. The FRCOG is also the Regional Planning Agency for Franklin County, Massachusetts, which is the most rural county in the state. The FRCOG serves the town governments, municipal boards and committees, businesses, and our citizens. In the early 1990's, the FERC recognized the creation of an ad hoc committee, the Connecticut River Streambank Erosion Committee, convened by the FRCOG and FRPB to bring together the NMPS operator, state and municipal entities, landowners, and NGOs to carry out bioengineering projects to stabilize and repair areas of bank erosion. We advocate on behalf of our communities and the county at the federal, state and regional levels. We work together to advocate for legislative action, social policy, and governmental programming that recognize the unique character and conditions of our rural area.

Existing Information and Need for Additional Information

None of the existing information attempts to coordinate the operations of all five installations as a system. Most of the information available tells of parameters of individual locations and consequences of single events around a single location. There does not seem to be information of larger interactions among various events and time-lines of events are not shown with enough information to draw conclusions on overall effects in the entire project area.

Nexus to Project Operations and Effects

This study and resultant model will show the advantages of coordinated operation of the facilities along the river. This, then, can be accomplished by coordinated license requirements mandating the level of cooperation, communication, and coordination of the system. Initial use of the model will help dictate the license requirements to achieve the most protective and most efficient operation of the system. Ongoing use of the model will help to maintain the protective and efficient practices.

Methodology Consistent with Accepted Practice

Computer modeling is standard practice in many fields. The predictive model analyzing interactions, over time is also used extensively. Many standard templates for this kind of modeling are readily available in the scientific community.

Level of Effort and Cost

The level of effort and cost is expected to be moderate. Virtually all of the input data is available in one place or another. Much of the effort will be in locating and obtaining the data, and making sure that the units used will be compatible.

The model will have to be run numerous times to help analyze multiple scenarios as submitted by other commenters. Input parameters will have to be changed prior to each run to reflect the scenario being tested, and a variety of reports must be produced depending on what variables are of interest.

The project will require the cooperation of FirstLight and TransCanada, the owners of the facilities in the project area.

Landowners and Concerned Citizens for License Compliance
Connecticut River, Turners Falls Pool, Massachusetts

February 11, 2013

Ms. Kimberly Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, D.C. 20426

Re: Northfield Mountain Pumped Storage Project No. P-2485 and
Turners Falls Project No. P-1889

Request to officially file the attached photos presented at FERC's Scoping Meeting on January 30, 2013 in Turners Falls, MA and to make a related Information Request

Dear Secretary Bose,

As a member and representative of the Landowners and Concerned Citizens for License Compliance (LCCLC), Michael Bathory presented photos documenting the erosion on the Bathory / Gallagher and Wallace / Watson sections of conservation riverbanks currently being restored as a part of FirstLight's Phase III Restoration for the Connecticut River in the Town of Gill, Massachusetts. We, the LCCLC, request that the attached photos and this letter officially be filed with FERC and made a part of the licensing proceeding and made available in the elibrary under the licensing sub-docket.

The 2008 Full River Reconnaissance (FRR) stated that the rate of erosion is decreasing in the Turners Falls Pool in the Connecticut River, which FirstLight continues to maintain in Section 4.2.4.1 of the PAD under FRR Studies. This contention is in spite of numerous challenges by the Connecticut River Streambank Erosion Committee and professional studies commissioned by LCCLC all of which have been filed with FERC.

Clearly FirstLight and their consultant were not looking at the erosion on our land. Rather than repeat the information that we have already sent to you in multiple filings and commissioned studies, we take this opportunity to file photos of the erosion of our riverbanks. We also take this opportunity to advocate for a standard FRR methodology going forward that is repeatable and comparable from one FRR to the next rather than a new FRR methodology being used each time.

Scoping Meeting Photo Presentation

Our scoping meeting presentation demonstrated why the current and previous owners of this conservation land have been so persistent in drawing FERC's attention to the severity of erosion of our riverbanks and why the current restoration effort is several decades too late.

The previous owners of this approximately 2300' of riverfront conservation land, the Kaufholds and the Werts, consistently pointed out two markers on our riverbanks that graphically document the significant erosion that has occurred during the operation of the Northfield Mountain Pumped Storage Project.

1. <u>Stump on Wallace / Watson land</u>

In the photo at the top of page 9, John Kaufhold is sitting with Jerry Wert on a tree that was growing at the base of a secondary lower terrace in 1960 below the 17' high upper bank. In the intervening years the terrace has been washed away and this same tree is now the stump that is featured in the photos on pages 8-9.

2. <u>Oak tree at the downstream end of the Bathory / Gallagher land (not included in the photos)</u>

In 1960 this Oak tree stood approximately 30' from the top edge of the bank. It is now less than 6' from the top edge of the heavily eroded bank. This tree marks the site of Cross Section 8A which is a site that has been used by the Licensees over the years to monitor erosion in the Turners Falls Pool on the Connecticut River.

Information Request

We request that FERC direct the current Licensee to provide the data from Cross Section 8A from the start of erosion monitoring to the present and make it available on the licensing proceeding with a copy to the signees below.

Thank you for assisting us with our requests and for your continued attention to the erosion issues in the Turners Falls Pool of the Connecticut River. We were impressed with the organization of the Scoping meetings and found the Cumulative Effects discussion to be particularly instructive.

Sincerely,

/s/ Michael Bathory, Town of Gill Landowner
/s/ Maryanne Gallagher, Town of Gill Landowner
144 River Road
Gill, MA 01354

/s/ Alan Wallace, Town of Gill Landowner

/s/Barbara Watson, Town of Gill Landowner
143 River Road
Gill, MA 01354

encl: Photos presented at FERC Scoping Meeting, January 30, 2013

cc: Kenneth Hogan and Chris Chaney, Federal Energy Regulatory Commission
Tom Miner, Connecticut River Streambank Erosion Committee
Andrea Donlon, Connecticut River Watershed Council
John Howard, FirstLight Power Resources
Jennifer Soper, MA Department of Conservation and Recreation
Paul Jahnige, MA Department of Conservation and Recreation

TOWN OF GILL

MASSACHUSETTS

www.gillmass.org

March 1, 2013

Honorable Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

RE: Relicensing of the Northfield Mountain Pumped Storage Project (FERC No. 2485-063)
and the Turners Falls project (FERC no. 1889-08
Comments on the Preliminary Application Document, Scoping Document 1, and Study Requests

Dear Secretary Bose:

The Town Of Gill, incorporated in September 28, 1793, is situated on the west bank of the Connecticut River, extending from just below the Route 10 Bridge to the Turners Falls Dam. It is where dinosaur footprints were first discovered in the United States.

The Connecticut River has been closely tied to and is an integral part of the Town's development and community history. Gill is no stranger to the manipulation of the river for economic purposes. As early as 1792, rapids and natural falls were eliminated in the effort to make the river more navigable. Over the years, canals and dams, log drives, and hydroelectric structures have changed the contour and current of the river.

The Town of Gill is taking this opportunity to be actively engaged in the process of relicensing the Turners Falls Dam and Northfield Mountain Pumped Storage Projects. The Town boundaries include over twelve miles of shoreline on the Connecticut River and it has an important regulatory role in accordance with the Massachusetts Wetlands and Rivers Protection Acts. The relicensing process is a critical opportunity to scrutinize our human tendency to manipulate natural resources for our own comfort and advancement. We are more aware than we were fifty years ago, (when the Northfield Pumped Storage Station was constructed), of the costs of energy consumption to the environment. These areas of concern include erosion of streambanks, declining water quality, changes to the habitat and fisheries. We are better able to acknowledge ways in which earlier experiments associated with the

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Northfield Pumped Storage Station and Turners Falls Dam might have fallen short, and we desire now to make things better.

The Pumped Storage Project was built on the premise of storing surplus base-load energy from nuclear and coal generation. Deregulation has changed this formula and that raises a number of questions. A second license spanning thirty to fifty years requires careful consideration given these new realities since the first license. In FERC's Scoping Document 1, FirstLight identifies a number of environmental issues and concerns by resource areas to be explored for the Turners Falls Project and the Northfield Pumped Storeage Project. The Developmental Resource area is defined as "the effects of potential operational changes on the energy and capacity benefits of the projects and effects of protection, mitigation, and enhancement measures on the cost of power." The Town of Gill raises a number questions with its proposed Study Requests that attempt to address some of these Developmental Resource issues from the perspective of the Connecticut River as a public resource and not just as a source of fuel.

We are increasingly aware of the costs of the two Projects to the riverbanks, the habitat and water quality. Energy uses, energy demands, and the effects of climate change are likely to change over the course of the next license in ways we cannot predict. Consideration of all possible solutions to these questions is in order, including investigating a full-closed loop system to any number of partial-loop systems, thereby eliminating some of the negative consequences.

The relicensing process is a once-in-a-lifetime opportunity to ensure that impacts on these areas are fully understood and defined, and that subsequent relevant resource management goals and public interest considerations are effectively addressed.

We appreciate the opportunity to submit our comments on the Preliminary Application Document (PAD), Scoping Document 1, and fourteen Study Requests. For ease of reference, our comments on the PAD and Scoping Document 1 are organized by sections from each document. Study Requests that we support are summarized by Scoping Document 1 resource areas. The full narratives of the studies that we are requesting to be undertaken may be found in the Appendix.

We would like to state that First Light's hard work and leadership in the annual Connecticut River Watershed Council's Source to the Sea clean-up is an example of commendable stewardship. It makes a significant difference toward the ongoing cleanliness of our waterways and watershed, and FirstLight spends thousands of dollars between staff time (planning and hauling) and disposal. Further, the Town acknowledges the importance of FirstLight as a taxpayer in Gill, an employer, and a patron of local businesses.

<u>Preliminary Application Document (PAD)</u>

Section 3.4 Other Turners Falls Project and Northfield Mountain Project Information

<u>3.4.1 Current License Requirements</u>

We are concerned that the list of "key license requirements" for the two projects did not include Article 19 for the Turners Falls Dam (P-1889) and Article 20 for the Northfield Mountain Pumped Storage Project (P-2485). Given the amount of money the applicant has spent to address the severe and ongoing erosion in the Turners Falls Pool, we believe that the section on "key license requirements" should include Articles 19 and 20. Article 19 states, "[i]n the construction, maintenance, or operation of the project, the Licensee shall be responsible for, and shall take reasonable measures to prevent, soil erosion on lands adjacent to streams or other waters, stream sedimentation, and any form of water or air pollution. The Commission, upon request or upon its own motion, may order the Licensee to take such measures as the Commission finds to be necessary for these purposes, after notice and opportunity for hearing." Article 20 contains similar language, "[t]he Licensee shall be responsible for and shall minimize soil erosion and siltation on lands adjacent to the stream resulting from construction and operation of the project. The Commission upon request, or upon its own motion, may order the Licensee to construct and maintain such preventive works to accomplish this purpose and to revegetate exposed soil surface as the Commission may find to necessary after notice and opportunity for hearing."

3.4.3 Proposed Modifications

The applicant listed the following proposed project modifications in the PAD:

- Upgrading Station No. 1 with new or rehabilitated turbines.
- Closing Station No. 1 and adding a turbine generator at Cabot of similar hydraulic capacity to that at Station No. 1.
- Utilizing the full hydraulic capacity of the Cabot turbines including currently unused capacity.
- Utilizing more storage in the Northfield Mountain Project's upper reservoir.
- Increasing the unit and station capacity at the Northfield Mountain Project.

We are concerned that no specific information about these proposed modifications was included in the PAD. We request that the applicant provide information to the public on the need and justification for these proposed modifications as soon as possible. We also request that any studies undertaken by the applicant to evaluate environmental impacts of the projects also include the environmental impacts of the proposed modifications to the project operations. If the applicant is earnest about these proposed modifications, we hope that these analyses are done early in the relicensing process.

Section 4 Description of Existing Environmental and Resource Impacts

4.2.4 Reservoir Shoreline and Streambanks

While numerous studies have been conducted since 1979 to study erosion of the streambanks along the Connecticut River, there has been controversy over the findings and conclusions of several of the reports. We see the need for consistent application of scientific methodology from one study to the next. We are also concerned that the summary of the 1979 U.S. Army Corps of Engineers' (USACE) study provided in the PAD doesn't reference specific findings related to the Turners Fall Pool but instead includes general summary statements that are not informative or specific to this reach of the river.

Below are excerpted general and specific findings in the 1979 USACE study that pertain to the Turners Falls Pool:

- *In the Executive Summary – "Note that forces exerted on the bank of a channel by the flowing water can be increased as much as 60 percent by such factors as flood stage variations, pool fluctuations, boat and wind waves, etc. Evaluation of forces causing bank erosion verifies the relative importance of causative factors. In descending order of importance they are: shear stress (velocity), pool fluctuations, boat waves, gravitational forces, seepage forces, natural stage variations, wind waves, ice, flood variations, and freeze-thaw."*

- *On page 21 of the report it states that the "Turners Falls Dam was raised by 5.5 feet in 1971 as a part of the Northfield Mountain Project. Prior to that time it operated similarly to the three upstream dams. Conditions have dramatically changed since completion of this project. Soils that were rarely wet are subject to frequent inundation. Pool fluctuations and variations in discharges and velocities have increased. In fact, the entire hydraulics of the system has changed."*
- *On page 51 – "Sediment and cross-sectional data are the two most important data gaps preventing a quantitative analysis of the Connecticut River."*
- *On pages 118-120 – "The impacts of hydropower development on bank stability in Turners Falls Pool have been and continue to be more severe than for the other pools. The increase in pool level, the larger pool fluctuations and flow reversals caused by the present hydropower operation all contribute to the documented bank instabilities in this part of the study reach. In analyzing the causes of bank erosion in Turners Falls Pool it is suggested that the erosion analysis presented in Table 2 and subsequent tables should be utilized. From this analysis coupled with consideration of adverse hydraulic conditions related to power generation it is concluded that:*

    1. *The maximum tractive forces that can be exerted on the banks of the river will occur during periods of moderate and major floods. Hence, power generation has not altered this condition.*
    2. *The flow reversals, turbulence and changes in river stage caused by present power generation methods have increased the tractive force sufficiently to induce bank erosion in those locations where the bank alignment and bank material causes the rate to be vulnerable to these forces.*
    3. *The increase in pool fluctuations on bank stability in Turners Falls Pool is a very significant factor. Pool fluctuations on the order of 5 feet are at least twice as destructive to banks or pool fluctuations of about 1-3 feet as experienced in the other hydropower pools.*
    4. *To stabilize the eroding banks in Turners Falls Pool will require special attention.*

    In summary, if upper bank erosion is to be controlled it will be necessary to implement some measure of upper bank protection capable of withstanding the forces to which it will be subjected; also the means to provide lower bank protection to prevent failure of upper bank protection must be considered, and the cost of such bank stabilization treatments is large. Conversely, if upper bank protection is not provided where such erosion is in progress, erosion will continue until a stable terrace or bench is formed. It is estimated that upper bank erosion will slow down and in many cases stabilize within a 5-10 year period unless conditions for further upper bank erosion are set up by lower bank erosion. Furthermore, in the Turners Falls Pool upper bank erosion may extend landward on the order of 20-25 feet at vulnerable sites before some semblance of upper bank stability is achieved."

The record of concerns with the methodology and findings and conclusions of the 2008 Full River Reconnaissance (FRR), which are well documented in correspondence from the Franklin Regional Council of Governments (FRCOG) and the Landowners and Concerned Citizens for License Compliance (LCCLC) to FirstLight and FERC, has not been included. (The LCCLC membership primarily includes Gill and Northfield farm and conservation landowners.) Accurate data and a reproducible methodology is needed for documenting the type and stage of erosion in the pool and evaluating whether the pace of erosion control work is keeping up with the rate of erosion. We request that the record reflect the continuing objections to the findings of the 2008 Full River Reconnaissance, and specifically, objections to including statements in the PAD that reference the 2008 FRR, and all of the text on page 4-12 of the section *4.2.4.2 Shoreline and Streambank Characterization.*

4.2.4.3 <u>Geomorphic Studies</u>
We are pleased to see a reference to the 2007 Fluvial Geomorphology Study of the Turners Falls Pool on the Connecticut River between Turners Falls, MA and Vernon, VT prepared for FirstLight by Field Geology Services. We support the findings and encourage FirstLight to implement the study's recommendations. We are disappointed to see that the PAD does not accurately present the important findings and recommendations of this study that are specific to the Turners Falls Pool. Instead, the PAD includes a brief, generalized discussion of erosion. In particular, the Executive Summary of the report is compelling and should have been included in the PAD. Dr. John Field also offered detailed recommendations for future work in the Turners Falls pool, which, if implemented, could provide for: a) an improved understanding of the causes of erosion; b) more accurate monitoring of erosion; and c) more successful bank stabilization efforts. Following are excerpts from the Executive Summary of the report that could have been used to inform the readers of the PAD:

> *"Four types of bank erosion are present in the Turners Falls Pool and occur together through time at any given location. Undercutting and notching at the base of the banks results in topples and slides as the stability of the upper bank is compromised. The slide and topple blocks are disassociated into flows and deliver loose sediment to the base of the bank. This loose sediment can be carried away from the bank by water currents generated by flood flows, boat waves, pool fluctuations, groundwater seeps, and overland flow. Where sediment is moved directly offshore, beaches can form that may promote the stabilization of the bank if the accumulated sediment is not removed or beach face inundated by flood flows. The monitoring of several cross sections since 1990 shows that bank recession rates are on the order of 1.0 ft/yr, but as much as 9.0 ft of erosion has occurred in a single year (i.e., Kendall Site). The average erosion rate of 1.0 ft/yr is corroborated by the measurement of bank recession adjacent to fixed bank points along sections of river armored with rock.*
>
> *The raising of the Turners Falls Dam in 1970 destabilized previously stable portions of the bank by increasing the pore pressure in bank sediments higher up the bank. An increase in pool fluctuations with the opening of the Northfield Mountain Pumped Storage Project in 1972 and an increase in*

boat waves accompanying greater recreational use of the Turners Falls Pool could have played a role in the increase in erosion documented by mapping in 1978 and 1990. The lack of a riparian buffer in a few localities makes the banks more susceptible to erosion due to a lack of roots to bind the soil together and an increase in runoff over the bank that can cause gullying. An increase in overall bank stability between 1990 and 2001, as documented by erosion maps, may be related to the development of beaches observed throughout much of the Turners Falls Pool.

Comparisons of erosion maps from different years must account for variations in mapping season, mapping methods, and mapping personnel. Comparisons of two different erosion maps completed in 1990 reveal several discrepancies in the location and amount of erosion. The minor increases in erosion between 2001 and 2004 are less than the discrepancies between the 1990 maps. Consequently, policy decisions based on the erosion mapping data should be carefully reviewed, because apparent differences in erosion from year to year may simply be an artifact of the mapping process. Currently 20 percent of the bank length has been protected with rock armor. As bank stabilization efforts proceed, new approaches should be considered, because the continued reliance on armoring at the base of the bank with rock, in both riprap and bioengineering projects, could lead to increased erosion elsewhere. While the development of beaches is an indication of increasing bank stability, erosion is likely to persist as natural flood flows rework beach deposits and inundate the beach face.

However, promoting the development and preservation of beaches through the addition of large woody debris could improve bank stability by buttressing the banks against erosion and by further trapping fine sediment on the beaches. Given the complexity of issues surrounding erosion in the Turners Falls Pool the results of this study should be considered preliminary in nature. Many areas of additional study are necessary including surveys of erosion using a systematic and explicit method for mapping the types of erosion present in order to eliminate artifacts in the mapping process. Experimentation with large woody debris placements on beach faces should also begin to determine their value in improving bank stability. Only with a thorough understanding of the character and causes of erosion can effective and sustainable bank stabilization efforts be implemented throughout the Turners Falls Pool."

The final report listed in section 4.2.4.3 is the 2012 Riverbank Erosion Comparison along the Connecticut River prepared for FirstLight by Simons & Associates (S&A). We object to the findings and conclusions stated in this report and repeated in the PAD. Unlike the USACE reports and the Field Geology Services report, the S&A report does not include a documented methodology, the analysis lacks a robust data set, and the analysis itself is qualitative and subjective.

Along with the Franklin Regional Council Of Governments, the Town objects to the conclusion that the Turners Falls Impoundment is in better condition than all other reaches of the river studied. This conclusion is drawn solely from an analysis of a few erosion sites in the Holyoke, Turners Falls, Vernon and Bellows Falls impoundments, documented photographically in 1998 and again in 2008, the results of the 2008 FRR, and the findings of a detailed fluvial geomorphic study that focused on the free-flowing reach of the Connecticut River farther upstream of these four impoundments (Field Geology Services, 2005). The S&A report notes that erosion was continuing in all but one of the 23 sites evaluated in the Holyoke, Vernon, and Bellow Falls impoundments. In contrast, the report claims that in the Turners Falls impoundment, most of the eroded sites were either stabilized, in the process of stabilization through erosion control measures, or experiencing some degree of natural stabilization. This conclusion is based on the results of the 2008 Full River Reconnaissance. The FRCOG and the Gill and Northfield landowners group previously documented and filed their objections to the findings of the 2008 FRR with FERC. The 2012 S&A report goes on to state that the segment of the river with the greatest extent of eroding riverbanks is the free-flowing reach of the Connecticut River farther upstream of these four impoundments. However, we are not convinced that such a direct comparison can be made based on the paucity of data in the S&A report and dissimilar methodologies used between the S&A report and the Field Geology Services report.

Scoping Document 1

3.5 Alternatives to the Proposed Action

On page 8 of the Scoping Document, the text reads that "[i]n accordance with NEPA, the environmental analysis will consider the following alternatives, at a minimum: (1) the no-action alternative, (2) the applicant's proposed action, and (3) alternatives to the proposed action." The Town of Gill strongly urges the FERC staff to consider a closed-loop alternative for the lower reservoir serving the pumped storage project and requests that the applicant complete a study of this alternative to the proposed action.

6.0 Request for Information and Studies (See Appendix for full Studies)

Geology and Soil Resources

The Town of Gill has concerns that relate to the environmental effects of the frequent and significant water level fluctuations and river flow dynamics resulting from the operation of the Northfield Mountain Pump Storage Project and the Turners Falls Dam. These concerns include riverbank stability, shoreline habitat, farmland, wetlands, riparian and littoral habitat, and water quality. We request that the following studies be conducted to address our concerns on these issues: (Full narratives are to be found in the Appendix.)

- **Study of Shoreline Erosion Caused by Northfield Mountain Pumped Storage (NMPS) Operations. (See Study Request #1)**
- **Study the Impact of Operations of the Northfield Mountain Pumped Storage Project and Turners Falls Dam on Sedimentation and Sediment Transport in the Connecticut River (#2)**

- **Study of the Feasibility of Converting the Northfield Mountain Pumped Storage (NMPS) Facility to a Closed-loop or Partially Closed-loop System (#3)**
- **Study Climate Change as it Relates to Continued Operation of Northfield Mountain Pumped Storage and Turners Falls Projects (#4)**

Water Resources

Many of our residents are riverside dwellers, and many express on-going concern for what they observe happening to the River on a daily basis. Residents report that swimming and boating have become increasingly unpleasant, and at times water levels are so low as to ground boats. Our River has historically provided diverse recreational opportunities with benefits to our regional economy. The Gill 2011 Open Space and Recreation Plan Public Survey results, on recreational use by Town residents, show that 90% of the respondents use the Connecticut River and Barton Cove for recreation at least yearly. With this in mind, the Town wishes to explore levels of turbidity and suspended sediment in the river and what fluctuations in the water levels might have on the spread of exotic and invasive species, such as water chestnuts, and thus requests the following studies:

- **Study the Impact of Operations of the Northfield Mountain Pumped Storage Project and Turners Falls Dam on Sedimentation and Sediment Transport in the Connecticut River (#2)**
- **Water Quality Monitoring in the Turners Falls Impoundment and Downstream of the Turners Falls Project (#5)**
- **Quantify the Impacts of Water Level Fluctuations on Riparian and Aquatic Vegetation Including Invasive Species and their Associated Habitats in the Turners Falls Dam project Impoundment (#6)**

Socioeconomic Resources

As noted in the introduction, the Town of Gill is increasingly aware of the costs of the two Projects to the river banks, the habitat and water quality. The relicensing process is a once-in-a-lifetime opportunity to ensure that impacts on these areas are fully understood and defined, and that subsequent relevant resource management goals and public interest considerations are effectively addressed.

Consideration of all possible solutions to these questions is in order, from investigating a full-closed loop system to any number of partial-loop systems, thereby eliminating some of the negative consequences.

With this in mind we request:

- **Study of the Feasibility of Converting the Northfield Mountain Pumped Storage (NMPS) Facility to a Closed-loop or Partially Closed-loop System (#3)**
- **Study Climate Change as it Relates to Continued Operation of the Vernon, Bellows Falls, Wilder, Northfield Mountain Pumped Storage, and Turners Falls Projects (#4)**

Aquatic Resources

The Town of Gill wishes to conserve, protect, and enhance habitats for fish, wildlife, and plants. The fact that land directly across from the tailrace (the old Stacey's Ferry Landing) and upstream has been eroding since the project went into operation, serves to heighten our concern that Project operations negatively affect resident and migratory fish species.

With this the mind we request the following studies:

- **Impacts of Water Level Fluctuations on Riparian and Aquatic Vegetation Including Invasive Species and their Associated Habitats in the Turners Falls Dam Project Impoundment (#6)**
- **Model Flows in the Northfield Mountain Pumped Storage Project Discharge Tailrace and Connecticut River 1 Kilometer Upstream and Downstream of the Discharge Using Two-Dimensional Computational Fluid Dynamics (CFD) Model Techniques (#7)**
- **Telemetry Study of Upstream and Downstream Migrating Adult American Shad to Assess Passage Routes, Effectiveness, Delays, and Survival (#8)**
- **Impact of Project Operations on Shad Spawning, Spawning Habitat, and Egg Deposition in the Project Areas of the Turners Falls, Northfield Mountain Pumped Storage and Vernon Project Areas and Downstream from Bellows Falls Dam. (#9)**
- **Impacts of the Turners Falls and Northfield Mountain Pumped Storage Project Operations on Tributary and Backwater Area Access and Habitats (#10)**
- **Determine the Fish Assemblage in the Turners Falls and Northfield Mountain Pumped Storage Project-Affected Areas (#11)**
- **Impacts of the Turners Falls and Northfield Mountain Pumped Storage Projects on Fish Spawning and Spawning Habitat. (#12)**
- **Impacts of Project Operations on Downstream Migration of Juvenile American Shad. (#13)**
- **Entrainment of Migratory and Riverine Fish from the Connecticut River into the Northfield Mountain Pumped Storage Project. (#14)**

In Conclusion:

Heal-All-Brook is the name of the stream that runs through the southern part of Gill into the Connecticut River. The Native Americans, inhabitants of this area for thousands of years, named it, believing that the springs which supply its water possessed medicinal properties. In this spirit, we are reminded that the River confers on us gifts far beyond its power to create power—we benefit from its beauty, its rich flora and fauna, its recreational opportunities. We should remember the River flows through all our lives and is not just a commodity but a living thing. The Connecticut River belongs to the citizens of the Commonwealth and its use for commercial purposes must be carefully examined and weighed.

Respectfully Submitted,

The Town of Gill, Massachusetts Selectboard and the Gill Conservation Commission

Gill Selectboard:

/s/Ann H. Banash, Chair /s/John R. Ward /s/Randy P. Crochier

Gill Conservation Commission:
/s/Paul Sievert, Chair   /s/Amy Gordon   /s/Christopher Polatin

cc: John Howard, First Light Hydro generating Company
Robert McCollum, MA Department of Environmental Protection
Peggy Sloan, Franklin Regional Planning Board
Tom Miner, Connecticut River Streambank Erosion Committee
Ken Hogan, Federal Energy Regulatory Commission
Congressman James McGovern
Jennifer Soper, MA Department of Conservation and Recreation
Paul Jahnige, MA Department of Conservation and Recreation

Appendix
The Town of Gill Selectboard and Town of Gill Conservation Commission Study Requests

Numerical listing of Studies with full documents to follow:

Study Request 1: Study of Shoreline Erosion Caused by Northfield Mountain Pumped Storage (NMPS) Operations.

Study Request 2: Study the Impact of Operations of the Northfield Mountain Pumped Storage Project and Turners Falls Dam on Sedimentation and Sediment Transport in the Connecticut River

Study Request 3: Study of the Feasibility of Converting the Northfield Mountain Pumped Storage (NMPS) Facility to a Closed-loop or Partially Closed-loop System

Study Request 4: Study Climate Change as it Relates to Continued Operation of the Vernon, Bellows Falls, Wilder, Northfield Mountain Pumped Storage, and Turners Falls Projects

Study Request 5: Water Quality Monitoring in the Turners Falls Impoundment and Downstream of the Turners Falls Project

Study Request 6: Quantify the Impacts of Water Level Fluctuations on Riparian and Aquatic Vegetation Including Invasive Species and their Associated Habitats in the Turners Falls Dam project Impoundment

Study Request 7: Model Flows in the Northfield Mountain Pumped Storage Project Discharge Tailrace and Connecticut River 1 Kilometer Upstream and Downstream of the Discharge Using Two-Dimensional Computational Fluid Dynamics (CFD) Model Techniques

Study Request 8: Telemetry Study of Upstream and Downstream Migrating Adult American Shad to Assess Passage Routes, Effectiveness, Delays, and Survival

Study Request 9: Impact of Project Operations on Shad Spawning, Spawning Habitat, and Egg Deposition in the Project Areas of the Turners Falls, Northfield Mountain Pumped Storage and Vernon Project Areas and Downstream from Bellows Falls Dam.

Study Request 10: Impacts of the Turners Falls and Northfield Mountain Pumped Storage Project Operations on Tributary and Backwater Area Access and Habitats

Study Request 11: Determine the Fish Assemblage in the Turners Falls and Northfield Mountain Pumped Storage Project-Affected Area

Study Request 12: Impacts of the Turners Falls and Northfield Mountain Pumped Storage Projects on Fish Spawning and Spawning Habitat.

Study Request 13: Impacts of Project Operations on Downstream Migration of Juvenile American Shad.

Study Request 14: Entrainment of Migratory and Riverine Fish from the Connecticut River into the Northfield Mountain Pumped Storage Project.

Study Request 1 - Study of Shoreline Erosion Caused by Northfield Mountain Pumped Storage (NMPS) Operations

Development of the current configuration of the Northfield Mountain Pumped Storage project included raising the dam height at Turners Falls by 5.9 feet in 1970 in preparation for NMPS operations. Operations began in 1972; since then all project operations have operated under this raised dam environment. The additional 5.9 foot in elevation changed the elevation of the Turners Falls impoundment, which extends some 20 miles upstream. The increase in river elevation also resulted in motorized boat traffic becoming more popular and makes the use of larger boats more possible. The presence of motorized recreational boats increases wake energy that can accelerate bank erosion rates.

The operation of NMPS causes alterations to the river as a direct feature of plant functionality. The alterations include: 1) daily fluctuating pond levels which at times in some places can exceed six feet (the license allows fluctuations up to 9 feet measured at an undisclosed location near and upstream of the Turners Falls dam), 2) altered flow and velocity profiles of river and 3) changes to the downstream hydrograph. Elevation data for the river in Appendix E of the PAD indicate that stage changes of 2 to 3 feet during the summer of 2012 were not uncommon.

Raising the level of the river can saturate bank soils. These same soils can quickly become dewatered when the river is lowered by the NMPS pumping cycle. Repeated saturation and dewatering of banks can lead to bank instability which in turn can lead to bank failure and eroded material entering the river. See Field (2007)[1] for an extended discussion on bank erosion and failure mechanics. Elevated levels of turbidity and suspended solids in the water column can diminish rearing and migratory habitat for fish. When too much fine grain material is deposited on channel bed substrates, particularly those substrates used for spawning, spawning success of resident and migratory fish is compromised, potentially reducing recruitment and carrying capacity.

Goals and Objectives

The goals of this study request would be to determine the environmental effects of the presence and operation of the licensed facilities on river bank stability, shoreline habitat, agricultural farmland, wetland resources, bed substrate, and water quality in the Turners Falls impoundment. We recognize that data from other studies will be made available and we think that the data from these other studies could be used to help meet the objectives of this study request.
Objectives of the study include the following:

1. Calculate the total volume of eroded material, calculate resulting nutrient loading of eroded material, and document and describe the three dimensional changes to the bank, including lateral bank recession, changes to bank slope, and the presence and subsequent inundation of pre-project beaches and shoreline since the Turners Falls Dam was raised and the Northfield Mountain Pumped Storage facility came on-line.
2. Document and describe the changes to banks upstream and downstream of riverbank restoration projects, including bank recession.
3. Identify the changes that have occurred to bed substrate as a result of fine grain material being eroded from the banks and being deposited on the channel bed.

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[1] Field Geology Services. (2007). *Fluvial geomorphology study of the Turners Falls Pool on the Connecticut River between Turners Falls, MA and Vernon, VT*. Prepared for Northfield Mountain Pumped Storage Project. Farmington, ME: Field Geology Services.

Relevant Resource Management Goals and Public Interest Considerations

Our management goal is to ensure high quality habitat for migratory diadromous fish. Shortnose sturgeon, American shad and American eel all require suitable spawning, rearing, migratory and foraging habitat. Eroding banks and subsequent increases in turbidity and deposition of fine grained material onto bed substrates in the Turners Falls impoundment, the bypass reach and downstream of the Turners Falls project reduces the quality of habitat for these species. Elevated levels of suspended sediment are associated with a diminution in water quality which also affects the quality of habitat encountered by trust resource species.

In addition to habitat effects, soil erosion contributes to nutrient loading. In 2001, the U.S. EPA approved New York and Connecticut's Long Island Sound (LIS) dissolved oxygen TMDL. As a result, the New England Interstate Water Pollution Control Commission (NEIWPCC) established the Connecticut River Workgroup and the Connecticut River Nitrogen Project. This project is a cooperative effort involving staff from NEIWPCC, the states of Connecticut, Massachusetts, New Hampshire, and Vermont, and EPA's Region 1 and Long Island Sound (LIS) offices. All are working together to develop scientifically-defensible nitrogen load allocations, as well as an implementation strategy, for the Connecticut River Basin in Massachusetts, New Hampshire, and Vermont that are consistent with TMDL allocations established for LIS. Since its inception, the Connecticut River Workgroup has participated in a number of projects to better understand nitrogen loading, transport, and reductions in erosion.

Public Interest Considerations if Requester is not a Resource Agency

The Town of Gill in the Commonwealth of Massachusetts operates with an Open Town Meeting form of government where any voter is permitted to attend and vote on legislative matters: budgets, bylaws, zoning, etc. The executive authority in the Town is performed by an elected 3-member Board of Selectmen that oversees all aspects of managing town services.

Gill is a member of the Franklin Regional Council of Governments (FRCOG) and has members on FRCOG's Ad Hoc committee, the Connecticut River Streambank Erosion Committee (CRSEC). The CRSEC was convened in 1994 to bring together the Northfield Mountain Pumped Storage Project operator, state and municipal entities, landowners, and NGO's to carry out bioengineering projects to stabilize and repair areas of bank erosion.

The Town of Gill is taking this opportunity to be actively engaged in the process of relicensing the Turners Falls Dam and Northfield Mountain Pumped Storage Projects. The Town boundaries include over twelve miles of shoreline on the Connecticut River. Through its appointed Conservation Commission, the Town has an important regulatory role in accordance with the Massachusetts Wetlands and River Protection Acts.

Existing Information and Need for Additional Information

The PAD makes reference to several studies in section 4.2.4 including the Erosion Control Plan (Simons & Associates, 1999), previous Full River Reconnaissance studies (1998, 2001 – maps but no report

generated, 2004, and 2008), Field Geology Services' 2007 fluvial geomorphic investigation of the Turners Fall impoundment, and 2012 investigations by Simons & Associates.
Field Geology Services' 2007 investigation provided several good recommendations for future work in section 9.3 of its report which, if implemented, could provide for: a) an improved understanding of the causes of erosion; b) more accurate monitoring of erosion; and c) more successful bank stabilization efforts. This document is a good point of reference. The Simons & Associates' (2012) documents are qualitative and based on several unstated assumptions that may not be valid. Full River Reconnaissance efforts have been undertaken using varying methodologies, making for difficult comparisons from one report to the other.

We believe that these existing studies do have data that can be useful if certain new analyses are undertaken. These analyses of existing data would help fill in our gaps of understanding of bank erosion in the Turners Fall impoundment. We are also asking for some additional field collected data. With the existing information, it should be possible to better display what changes have occurred to streambanks over time. Current Geographic Information System (GIS) software allows for various types of data to be assembled into a map and into a database such that change over time analysis can be conducted fairly easily. The change over time analysis is a critical analysis that is needed, and was already started under Field (2007).

Photos that have been taken at or near the same location but at different times exist. For example, the last three Full River Reconnaissance efforts have included continuous videotaping of the riverbanks with locational information. With these data, "snapshots" of the bank at various locations could be extracted and compared over time. Field (2007) photo locations could be re-shot as well. This existing information should be presented such that it is easy to discern where the photo was taken and what changes have occurred over time. A comparison of the bank every 100 ft could be compared over the years.

Historic aerial photography for the Turners Fall impoundment should be gathered and analyzed. Examples of good photographic datasets include the Field 2007 appendices and 1929 aerials. The location of the shoreline over time should be noted such that it is easy to discern where bank retreat has been most severe and where the river has been relatively stable since the earliest aerial photograph was taken.

Very little turbidity data for the Turners Falls impoundment, the bypass reach or stretches of the Connecticut River downstream of the Turners Fall project exist. Thus far, implementation of the *Northfield Mountain Pumped Storage Project Sediment Management Plan* (revised February 15, 2012) has yielded few results, and many technological difficulties (see *2012 Sediment Management Plan – 2012 Summary of Annual Monitoring* dated November 30, 2012). Suspended sediment monitoring equipment is installed at the Route 10 Bridge upstream of the project and inside the powerhouse, theoretically taking readings representative of pumping and discharging through the turbines. An analysis of how turbidity might change relative to rapidly changing impoundment levels would be very useful information.

Nexus to Project Operations and Effects

The construction of the NMPS project was contingent upon the Turners Falls project raising the dam crest elevation by 5.9 feet. The NMPS project operations rely on the Turners Falls impoundment as the source of water to be pumped up and then discharged back into the river through turbines. The importance of this river reach to the NMPS operation is made clear by FirstLight's reference to this portion of the river as the "lower reservoir." Daily pumping and discharging changes the ponded elevation of the Connecticut River which in turn leads to bank material that repeatedly becomes saturated and then dewatered. Weakened bank material can then become eroded and the fine grain material from the banks can enter the water column and be transported in suspension in the river and eventually settle onto bed material. The raising of the Turners Falls impoundment also made recreational boating more popular, including the introduction of large, high-horsepower powerboats that were not previously present. Because of the fluctuating water levels, boat wakes impact the shoreline to a much greater extent than would occur if levels were more constant, thus exacerbating both the effects of the wakes and the fluctuating levels. For these reasons, erosion caused or contributed by NMPS project operation can negatively affect spawning, rearing and migratory habitat for trust species and the endangered shortnose sturgeon. The requested study will help inform the Commission when contemplating mitigation measures and or operational modifications.

Proposed Methodology

1. This study should determine the net soil loss in cubic yards between 1970 and the present; a density estimate of the eroded material should also be provided. Provide an analysis of where the greatest loss has occurred, location of proximity to the tailrace, soil type, riparian land use, and vegetative cover in that area. Calculate nutrient loadings (nitrogen and phosphorus compounds) to the river system based on soil loss.

2. Obtain copies of the original survey plans for the project, and complete a new survey using the same landmarks used previously. The Field (2007) report states on page 11 that the original survey plans of the river are still retained by Ainsworth and Associates, Inc. of Greenfield MA. Use pre-operation aerial photos and current aerial photos to complete a 10-foot topographic map of the section of river between Turners Falls Dam and Vernon Dam and the 200-foot buffer regulated under the Massachusetts Rivers Protection Act. The Field (2007) report on page 11 states that Eastern Topographics, Inc. determined that sufficient information is known about the 1961 aerial photos (e.g., height of airplane) to create a 10-foot topographic map of that time period, and that 1961 aerial photos could be accurately overlayed with recent aerial photos. Field (2007) states that this analysis would enable a more reliable determination of small-scale shifts in channel position and changes in bank height that may have resulted from the erosion of a low bench that previously existed along portions of the river. Among other things, create a single map showing areas of erosion and deposition, and also overlay the Field report's hydraulic modeling analysis of the river channel.
3. With respect to the January 22, 2013 submittal from FirstLight to FERC regarding its long term monitoring transects in the Turners Fall impoundment, we ask that any data errors (as discussed in Field, 2007) and problems that have occurred over the years at each site be mentioned. We also ask that an analysis for each cross section extending to the top of the bank and including a portion of the floodplain be provided.
4. Take the information presented in Figure 4.2.3-1 "Soils in the vicinity of Turners Falls and Northfield Mountain projects" in the PAD and convert from 63 categories to just a few that are defined in a key that will allow readers to understand which soils are easily erodible, which aren't, and where there is bedrock along the banks.
5. Complete detailed surficial mapping (topographic map or LIDAR) to identify the various geomorphic surfaces, height of benches/terraces above the river level, and types of sediments underlaying the surfaces. This will allow one to determine how erosion varies with geomorphic conditions. One could then normalize the amount of erosion to a specific type of bank material/geomorphic surface/terrace.

6. Another information request covers the range of daily water level fluctuations. In this study request, we ask for an analysis on the degree to which boat wakes increase that fluctuation range. The task would be to observe boat wakes under a range of boat sizes and flow rates on the river. We recommend implementation of the 2007 Field report recommendation that states, "A more thorough study of boat waves is merited to better document how many boats use the Turners Falls Pool, how fast they travel, the type and size of waves they produce, and their impact on shoreline erosion."

A component of this study request is not necessarily for new data, but for existing data to be presented in a more clear, coherent and comprehensive manner. All existing photographs of banks that have been collected either by FirstLight, on behalf of FirstLight or on behalf of the Franklin Regional Council of Governments' (FRCOG) Streambank Erosion Committee should be georeferenced in such a way that it is easy to discern where the photograph was taken and the date should be easily discernible as well. These photos should be presented in a manner that makes it easy to visually see how a particular section of bank has changed over time. Providing geographic context for photographic data of river banks and making these photos comparable over time should be standard practice. The 2007 Field report contains the following recommendation on page 47: "An attempt should be made to overlay the 1961 aerial photographs with a current flight and to create a topographic map from the 1961 flight. The feasibility of this effort has been confirmed by Eastern Topographics, Inc. This effort will identify the previous extent of the low bench and identify areas of the most significant bank recession the past 45 years." Given that this statement was written in 2007, we request that that the analysis is extended to current conditions.

Given the complexity of this study request and the expertise necessary to implement it, we request that the FRCOG and the mandatory conditioning agencies be involved with the selection of the hired consultant.

Level of Effort and Cost

The level of effort to compile existing information and to make the data available in a map and searching for existing bed substrate material data should not take more than a few days. The level of effort for the bed sampling work will vary based upon how much existing historic information exists. Much of the effort of this study request is essentially office work that compiles and better presents existing data. While an estimate on the amount of field time required is difficult to make, we estimate that up to two weeks of field work could be required and that some of the data collection could be done while other field studies are occurring.

Study Request 2 – Study the Impact of Operations of the Northfield Mountain Pumped Storage Project and Turners Falls Dam on Sedimentation and Sediment Transport in the Connecticut River

Goals and Objectives

The goal of this study request is to provide hydraulic and sediment transport modeling of both the intake and discharge conditions (current and proposed) at the Northfield Mountain Pumped Storage Project. The results of the study should provide information sufficient to enable MA DEP staff and stakeholders to understand current and proposed effects on water level fluctuations and relate to potential increase in sedimentation to the Connecticut River. MA DEP staff and stakeholders should be able to identify techniques that could be used to mitigate the effects of project operations or other mitigation techniques that could be developed to reduce riverbank erosion within the impoundment. In addition, an assessment of means to minimize the sediment load passing through the Turners Falls Canal during and after maintenance drawdowns should be conducted.

The specific objectives of this study are as follows:

- Assess hydraulic and sediment dynamics in the Connecticut River from Vernon Dam to Turners Falls Dam, the upper reservoir at Northfield Mountain, and downstream of the Turners Falls Dam.

- Identify management measures to minimize erosion and sedimentation.

- Determine areas of sediment deposition and beach formation in the Project Area and 1 km downstream of Cabot Station and describe habitat features of these areas, recreational uses and effects on invasive species, if any. Habitat areas include but are not limited to coves (e.g. Barton Cove), back channels, islands, wetland habitats, shorelines, shoals, deep water areas and channels.

- Identify management measures to mitigate for substrate (habitat) impacts and recreational impacts in sediment-starved areas below the dam and sediment accumulation areas upstream of the dam.

Relevant Resource Management Goals and Public Interest Considerations

The resource management goal is to ensure that the Connecticut River, which is designated as a Class B river for its entire length in Massachusetts, meets its designated uses of habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation. Class B waters must also have consistently good aesthetic value and meet minimum criteria for numerous water quality indicators to achieve compliance with the standards set forth in the regulations. The other resource management goal is to protect prime farmland soils, which are eroding, and riparian habitat. Eco-based tourism is important to the economy of Franklin County so maintaining the water quality of the river and protecting scenic landscapes along the river from erosion are important.

Public Interest Considerations if Requester is not a Resource Agency

The Town of Gill in the Commonwealth of Massachusetts operates with an Open Town Meeting form of government where any voter is permitted to attend and vote on legislative matters: budgets, bylaws, zoning, etc. The executive authority in the Town is performed by an elected 3-member Board of Selectmen that oversees all aspects of managing town services.

Gill is a member of the Franklin Regional Council of Governments (FRCOG) and has members on FRCOG's Ad Hoc committee, the Connecticut River Streambank Erosion Committee (CRSEC). The CRSEC was convened in 1994 to bring together the Northfield Mountain Pumped Storage Project operator, state and municipal entities, landowners, and NGO's to carry out bioengineering projects to stabilize and repair areas of bank erosion.

The Town of Gill is taking this opportunity to be actively engaged in the process of relicensing the Turners Falls Dam and Northfield Mountain Pumped Storage Projects. The Town boundaries include over twelve miles of shoreline on the Connecticut River. Through its appointed Conservation Commission, the Town has an important regulatory role in accordance with the Massachusetts Wetlands and River Protection Acts.

Existing Information and Need for Additional Information

The PAD provides a summary of the work that has been done to characterize streambank conditions of the Turners Falls Impoundment, to understand the causes of erosion, and to identify the most appropriate approaches for bank stabilization. There has been no work undertaken to gather and assess the data that this study request would provide. Implementation of the *Northfield Mountain Pumped Storage Project Sediment Management Plan* (revised February 15, 2012) was begun in 2011 and is scheduled to end in 2014. This is a limited study related to sediment problems in the upper reservoir, not the entire river.

Nexus to Project Operations and Effects

The Turners Falls and Northfield Mountain Pumped Storage projects operate in a peaking mode, with allowable impoundment fluctuations of up to 9 feet, with the intent to continue as such. It is proposed to evaluate increasing the volume of flow from the Northfield Mountain Pumped Storage Project through increased use of the upper reservoir, which is expected to result in additional water level fluctuations. Upstream hydroelectric facilities also operate in a peaking mode of operation. Periodically, the upper reservoir at Northfield Mountain and the power canal at the Turners Falls dam need to be dewatered for maintenance purposes. Historically, both procedures have resulted in the discharge of large quantities of sediment. Sediment from shoreline erosion and riverbank failure is one of the major contributors that negatively affect water quality and habitat by increasing the turbidity and sedimentation, smothering aquatic habitat. Repetitive water level fluctuations and flow alterations caused by hydroelectric peaking operations are known to be a major contributor to shoreline erosion.

The Proposed Massachusetts Year 2012 Integrated List of Waters shows two river segments, from the VT/NH state line to the Turners Falls dam (MA34-01 & MA34-02) impaired and considered a “Water Requiring a TMDL” due to “Other flow regime alterations”, “Alteration in stream-side or littoral vegetative covers” and “PCB in Fish Tissue”. In addition, the segment below the Turners Falls dam to the confluence with the Deerfield River (MA34-03) is impaired by these causes as well as total suspended solids.

Proposed Methodology

We concur with the proposed methodology developed by the MA Department of Environmental Protection, which is consistent with accepted practices:

Assess hydraulic and sediment dynamics

- FirstLight to continue implementing the Northfield Mountain Pumped Storage Project Sedimentation Management Plan over the full range of river flows and pumping/generating cycles. An unfulfilled task in the Plan is to develop a correlation over the full range of flow conditions between the overall suspended sediment transport through the entire cross section of the river compared to the continuous sampling at the single fixed location. Environmental Protection Agency approval of a Quality Assurance Project Plan is required for valid data acquisition.
- Provide data on the daily water level fluctuation changes from the past five years from stations listed in the PAD, and estimate fluctuations within Turners Pool assuming proposed operations and hydraulic conditions.
- Identify the most appropriate techniques for bank stabilization given the existing and proposed hydraulic conditions.

Determine areas of sediment deposition in the Project Area

- Field (2007) conducted a bathymetric study as part of his report. Use previous bathymetric data, if available (Field 2007 recommends putting additional effort into finding a bathymetric survey from 1913 that was partially shown in Reid 1990), and current bathymetric information to look at areas of sediment accumulation. Determine areas of sediment deposition in the Project Area and 1 km downstream of Cabot Station and describe habitat features of these areas. Habitat areas include but are not limited to coves (e.g., Barton Cove), back channels, islands, wetland habitats, shorelines, shoals, deep water areas and channels.
- Identify recreational uses and impacts in areas known to be impacted by accumulated sediment, such as Barton Cove.
- Identify invasive species (plant or animal) present in the reaches and determine if erosion and sedimentation in any way contributes to the establishment and/or proliferation of these species.
    - Investigate the formation of beaches using remote sensing, LIDAR at low pool levels or some other mapping technique to understand the processes of beach deposition the distribution of beaches in the pool, the impact of beach deposition on habitat and species, and how can this be related to operation of NMPS.
    - Evaluate management strategies to address the release of accumulated sediment through Northfield Mountain Project works during upper reservoir drawdown or dewatering activities. FirstLight should specifically evaluate the feasibility of the installation of a physical barrier across the bottom of the intake channel designed to prevent the migration of sediment during future drawdowns of the upper reservoir
- Evaluate management strategies to minimize flow fluctuations within Turners Pool including coordination with upstream users.

- Evaluate management strategies to minimize sediment released through spillway gates and the log sluice located near the bottom of the forebay adjacent to the Cabot Powerhouse during canal dewatering activities.
- Identify a prioritized list of locations for bank stabilization projects in the Project Area
- Develop a map of land owned by FirstLight within 200 feet of the Connecticut River with an overlay of land use and vegetation cover. Provide land use options aimed at reducing bank erosion.

<u>Management measures to change sediment flow below and above the dam.</u>

- Any historic information of existing bed substrate material in the Turners Falls impoundment, bypass reach or downstream of the project should be collected and assembled. To the extent possible, the location of each sample should be made available on a map. The request for new data would stem from being able to make any valid comparison to changes in bed substrate at a given location, assuming the historic data exist.
- Identify measures that could be taken to mitigate impacts to recreational use, habitat, or invasive species from sedimentation.
- Identify measures that could be taken to change or mitigate sediment starved reaches below the Turners Falls dam.

Level of Effort and Cost

Many erosion studies have already been conducted and the cost of expanding the scope of some should be reasonable. A Full River Reconnaissance under the *Erosion Control Plan for the Turners Falls Pool of the Connecticut River* (Simons & Associates, Inc. dated June 15, 1999) is scheduled for 2013 and could accomplish many of the objectives listed above.

Study Request 3 - Study the Feasibility of Converting the Northfield Mountain Pumped Storage (NMPS) Facility to a Closed-loop or Partially Closed-loop System

Building and operating the Northfield Mountain Pumped Storage project required the Turners Falls Dam be raised 5.9 feet. The Turners Falls impoundment of the Connecticut River acts as the lower reservoir and is subject to large sub-daily fluctuations in water level. The collateral environmental consequences of using the Connecticut River during the pumping and generation cycles for the last 40 years are not fully understood, but have likely contributed to extensive erosion of streambanks, downstream sedimentation, entrainment of large numbers of resident and migratory fishes, and destruction of important spawning and nursery habitat, both within the Turners Falls Pool and downstream. Intrinsic consequences include radical fluctuations in the hydrograph at a sub-daily level, which also negatively impact recreation, habitat, and likely disrupt key life history stages of resident and migratory fishes, benthic invertebrates, and macrophytes. The vast majority of proposed new pumped storage projects currently being considered by FERC are closed-loop because of a growing consensus that open-cycle pumped storage causes unacceptable environmental damage.

Resource agencies have identified restoration of a more natural hydrograph to the Connecticut River as a key management goal, and view the current relicensing process for five projects on the Connecticut River mainstem as an opportunity to achieve this. Converting to closed-loop or partial closed-loop would allow the restoration of ecological flows to the Connecticut River, and provide much greater flexibility in operational guidance for both NMPS and the other hydropower stations on the Connecticut River. It will also eliminate or partially eliminate many of the environmental concerns expressed by Federal and state agencies and other stakeholders, which are outlined in the numerous study requests and comment letters that FERC will receive on the NMPS project and the other four hydropower projects.

Goals and Objectives

The goal of this study request is to provide resource managers, stakeholders, and the licensee with an analysis of possible options for converting the plant to a close-loop or partially closed-loop system.

The objectives of this study request would be to determine:

- Candidate locations for placement of a lower reservoir
- Costs and logistics of construction and modification of the current facility to convert to a closed-loop or partially closed-loop system
- Projected savings associated with eliminating need for ongoing mitigation measures, both for stabilizing river banks as well as likely modification to operations that the facility that will be required to implement in order to protect habitat and native fauna.
- Other ancillary costs or savings, such as eliminating requested studies, operational changes, or mitigation measures

Relevant Resource Management Goals and Public Interest Considerations

The resource management goal is to ensure high quality habitat for migratory diadromous fish. Shortnose sturgeon, American shad, blueback herring, and American eel all require suitable spawning, rearing, migratory and foraging habitat. Eroding banks and subsequent increases in turbidity and deposition of fine grained material onto bed substrates in the Turners Falls impoundment, the bypass reach and downstream of the Turners Falls project reduces the quality of habitat for these species. Elevated levels of suspended sediment are associated with a diminution in water quality that also affects the quality of habitat encountered by endangered species. Entrainment into the facility could be lethal to any of these fish. Juvenile and larval stages of resident and migratory species, including rare, threatened, and endangered species of vertebrates and invertebrates are particularly vulnerable to entrainment. This damage is aggravated by the repeated cycling of the facility—unlike standard hydro, where organisms are likely only exposed to passage events a single time and may bypass the system safely, NMPS continuously recycles river water, and therefore increases the risk of exposure to entrainment and death.

Public Interest Considerations if Requester is not a Resource Agency

The Town of Gill in the Commonwealth of Massachusetts operates with an Open Town Meeting form of government where any voter is permitted to attend and vote on legislative matters: budgets, bylaws, zoning, etc. The executive authority in the Town is performed by an elected 3-member Board of Selectmen that oversees all aspects of managing town services.

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The Town of Gill is taking this opportunity to be actively engaged in the process of relicensing the Turners Falls Dam and Northfield Mountain Pumped Storage Projects. The Town boundaries include over twelve miles of shoreline on the Connecticut River. Through its appointed Conservation Commission, the Town has an important regulatory role in accordance with the Massachusetts Wetlands and River Protection Acts.

Existing Information and Need for Additional Information

Some data on environmental effects of NMPS and facilities that use fresh or salt water for generation and/or cooling are widely available and consistently point to these types of facilities as damaging to native and migratory fauna. Once plentiful populations of blueback herring have been entirely eliminated from this portion of the Connecticut River. Populations of American eel are in steep decline throughout this reach, and American shad that initially used fish passage facilities downstream of NMPS have experienced dramatic reductions above Turners Falls Dam.

Section 4.4.6 of the PAD (page 4-146) discusses entrainment at Northfield Mountain of migratory fish species. Previous studies estimated 28.6% of Atlantic salmon entrained, which was reduced to 6.7% after the installation of a guide net only during upstream passage season. LMS Engineers estimated in

1993 that the facility impacted 0 to 12.4% of adult American shad passing the water intake. No studies have looked at impacts to resident fish or other migratory fish or other times of the year, but several study request address this information gap.

Other facilities in the region (Brayton Point Power Station, a coal plant in Mt. Hope Bay) have been required by EPA to switch from open- to closed cycle at very significant cost because of the extensive damage done to fragile habitats by open-cycle pumping.

Streambank erosion has been a major concern since NMPS began operation in 1972. Section 4.2.4 of the PAD summarizes the extensive work that has been done to study and mitigate erosion along the river banks. Significant loss of agricultural land has resulted from unnatural river fluctuations and increased boat wakes from a raised impoundment, and in some cases poor mitigation efforts like helicopter removal of trees along the banks. Since 1996, the licensee has reportedly spent $750,000 - $1,000,000 annually on erosion control measures. In some cases, these projects will need to be re-done in the future. Converting the plant to closed-loop operation could provide significant cost savings over the life of the upcoming license, eliminating erosion control projects, proposed studies related to use of the Connecticut River as a lower reservoir, and any mitigation or operational changes that may be contemplated as a result of relicensing.

Nexus to Project Operations and Effects

In conjunction with other study requests, parties to the relicensing process will be reviewing data and considering operation and facility conditions that will best achieve the balance between natural resource protection, property and infrastructure protection, and power generation. Making the plant closed-loop or partially closed-loop is one important consideration to the scenario and would eliminate any operation changes that might result from concerns about fishery resources, water quality effects, and farmland losses.

Proposed Methodology

- Collate existing geological and hydrologic information of areas surrounding Northfield Mountain, including preliminary design plans for suitable facilities able to accommodate the existing and proposed discharge. These plans should include any and all possible locations, including modifications to infrastructure near the current outfall, and any other locations that could accommodate the necessary volume of water.
- Provide an engineering analysis of structural modifications necessary to accommodate a full or partial lower reservoir in an alternate nearby location.
- Provide information on whether and how a smaller lower reservoir, with ties to the Connecticut River, would act as a buffer to river level fluctuations and change the hydrologic pattern of flow on the Connecticut River in the Turners Falls pool (fluctuations), the water quality effects, and decrease the possibility of entrainment.
- Provide an analysis on water losses from evaporation and leakage and how much make-up water would be needed during normal operations by season or month.
- Identify and make available any similar studies conducted during the planning phase of the existing facility in the 1960's or any other time.
- Provide a cost estimate of each option considered and evaluated.

- Provide an itemized cost estimate of how halting the use of the Connecticut River as a lower reservoir would affect other costs, such as eliminating the erosion control program, any ancillary changes to generation at Turners Falls Dam and NMPS, and fish protection measures.

These methods are consistent with accepted practice for weighing costs and benefits of environmental impacts.

Level of Effort and Cost

The level of effort to compile existing information and to make the data available in a map should be low. Development of contingency scenarios would be low. The majority of the effort of this study request is essentially office work, with some engineering and design work required to scope likely costs of various scenarios.

Study Request 4 - Climate Change as it Relates to Continued Operation of the Vernon, Bellows Falls, Wilder, Northfield Mountain Pumped Storage, and Turners Falls Projects

Goals and Objectives

The goal of this study is to determine how climate change relates to the continued operation of the Vernon, Bellows Falls, Wilder, Northfield Mountain Pumped Storage, and Turners Falls projects.

The objectives of this study are:

1. Quantify the amount of thermal loading contributed by each respective impoundment (including the NMPS upper reservoir).
2. Using climate change prediction models, calculate how much warmer the project impoundments are projected to get in the next 30-50 years.
3. Model the effect of various project modifications on river temperature under current conditions and climate change predictions (e.g., converting to run-of-river, deep-water releases, dam removal, large-scale riparian revegetation, etc.).
4. Using climate change prediction models, determine if the projects actually provide an environmental benefit with respect to mitigating against climate change impacts (vis a vis warming of air and water temperatures) by producing low greenhouse gas emitting energy. The Northfield Mountain Pump Storage assessment must be based on net energy production (i.e., NMPS generates1,143,038 MWh annually, but consumes 1,567,506 in its pumping operations; for a net consumption of 424,468 MWh annually).
5. Determine how climate change predictions will impact management of high flow events at the three projects and evaluate if changes to dam structures would mitigate adverse impacts of the existing flood management protocols.

Resource Management Goals

The Town of Gill supports the United State Fish and Wildlife Service' (Service) goals. The Service seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to climate change, the Service's goals are:

1. Minimize current and potential negative project operation effects that could hinder management goals and objectives.

2. Minimize deep headpond drawdowns associated with the loss of stanchion logs during high flow events, which are predicted to increase due to climate change.
3. Minimize project-related sources of thermal increases to Connecticut River waters to mitigate against predicted climate change impacts.

The Service, along with the National Oceanic and Atmospheric Administration (NOAA) and the Association of Fish and Wildlife Agencies developed a draft *National Fish, Wildlife and Plants Climate Adaptation Strategy* in 2012. The public comment period closed on March 5, 2012, and the agencies are working to finalize the document. Goal #7 of the Strategy calls for reducing non-climate stressors to help fish, wildlife, plants, and ecosystems adapt to a changing climate. The Strategy notes that some stressors (such as habitat loss and fragmentation and pollution) "are not only some of the things decision makers can control, they are also likely to interact with climate change to magnify negative impacts on fish, wildlife, and plants."

Goal #7 contains a number of strategies and associated actions, including:
Strategy 7.1: Slow and reverse habitat loss and fragmentation
Actions:

- Consider application of offsite habitat banking linked to climate change habitat priorities as a tool to compensate for unavoidable onsite impacts and to promote habitat conservation or restoration in desirable locations
- Identify options for redesign and removal of existing structures/barriers where there is the greatest potential to restore natural processes.

Strategy 7.2: Slow, mitigate, and reverse where feasible ecosystem degradation from anthropogenic sources through…water resource planning, pollution abatement…
Actions:

- Work with water resource planners to identify potentially conflicting needs and opportunities to minimize ecosystem degradation resulting from development and land and water use.
- Reduce existing pollution and contaminants and increase monitoring of air and water pollution.
- Increase restoration, enhancement, and conservation of riparian zones and buffers in agricultural and urban areas to minimize non-point source pollution.

The Service's study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), and the Federal Power Act (16 U.S.C. §791a, *et seq*.)

Public Interest Considerations if Requester is not a Resource Agency

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Existing Information

The PADs contains no information relative to climate change and how climate change predictions may impact future operation of the hydroelectric plants, nor of how the projects either mitigate for or exacerbate predicted climate change impacts to freshwater ecosystems.

TransCanada's PADs provide a summary of water quality data collected in 2012. Table 1 below is a synthesis of the temperature data collected by TransCanada. It should be noted that the upper and mid-impoundment stations at each project represent the average of temperature readings taken over the entire water column, while the continuous loggers (Lower Cont. and TR) were located near the water surface. These data indicate that from the upstream end of the Wilder headpond to the Vernon tailrace, water temperature increased approximately 6°C.

Table 1. Median water temperature at monitoring stations located within the impoundments and tailraces of the three hydropower projects.

	Median Water Temperature °C			
Project	Upper Imp.	Mid-Imp.	Lower Cont.	TR
Wilder	20.86	21.83	24.08	23.59
BF	22.43	23.67	24.86	24.38
Vernon	23.81	24.49	26.73	26.35

Relative to existing flood management protocols at each station, TransCanada's PADs identify that all three dams utilize stanchion bays (two at Vernon, three at Bellows Falls, and four at Wilder). When inflows to each dam reach certain levels, the stanchion bays are removed, and cannot be replaced until inflows subside. The depth of these bays and the flows they are removed at are outlined in Table 2, below.

Table 2. Summary of pertinent stanchion bay Information for the Vernon, Bellows Falls, and Wilder projects.

Project	Stanchion Height (feet)	Flow Triggering Complete Stanchion Removal
Wilder	17	145,000 cfs
BF	13	50,000 cfs
Vernon	10	105,000 cfs

The PADs provide no information on the history of stanchion removal at any of the projects (frequency, duration, timing), nor a discussion of how predicted climate change might alter management of the stanchion bays in the future (with respect to the frequency and seasonality of occurrence). There also is no discussion of potential impacts to headpond resources that occurs as a result of stanchion bay removal. These information gaps need to be filled so resource agencies can assess the relative and cumulative impact of project operations with respect to the Service's management goals and objectives, including those identified in the Climate Adaptation Strategy document.

Data provided by the National Oceanic and Atmospheric Administration, Climate Data Center, illustrates long-term increasing air temperatures in the Northeast (Figure 1). Long-term, monthly mean water temperature data for the Vernon Dam impoundment, monitored by Vermont Yankee, has shown significant differences over time (ANOVA analyses, $P < 0.05$) that when plotted and further analyzed by linear regression, show a significant increasing trend for the period 1974 – 2011 for the months of January, September, and October (Figure 2). These analyses were performed with data from Vermont Yankee, analyzed by the Massachusetts Department of Environmental Protection.

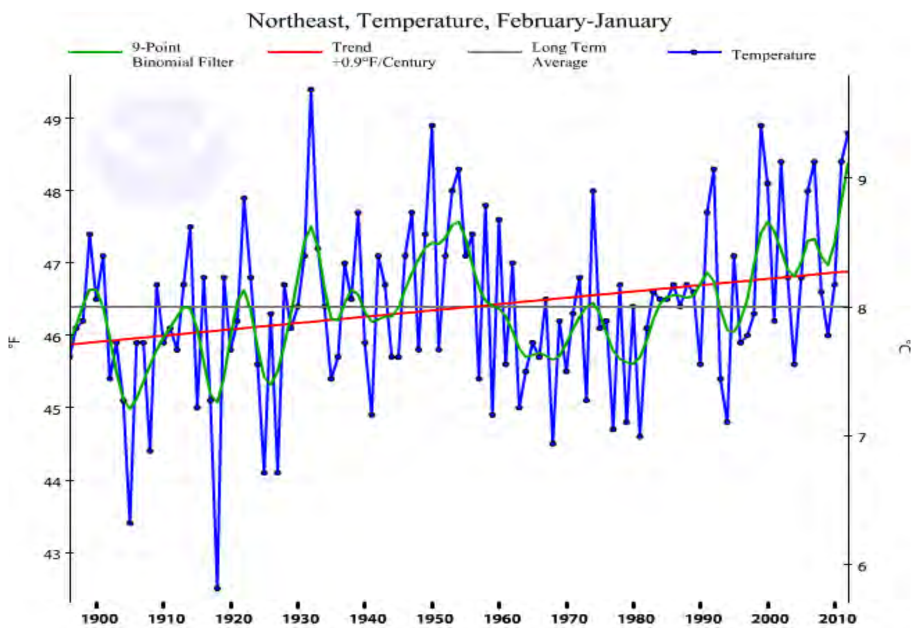

Figure 1. NOAA National Climate Data Center, Northeast 12-month average temperature for the period 1896 through 2012 (October).

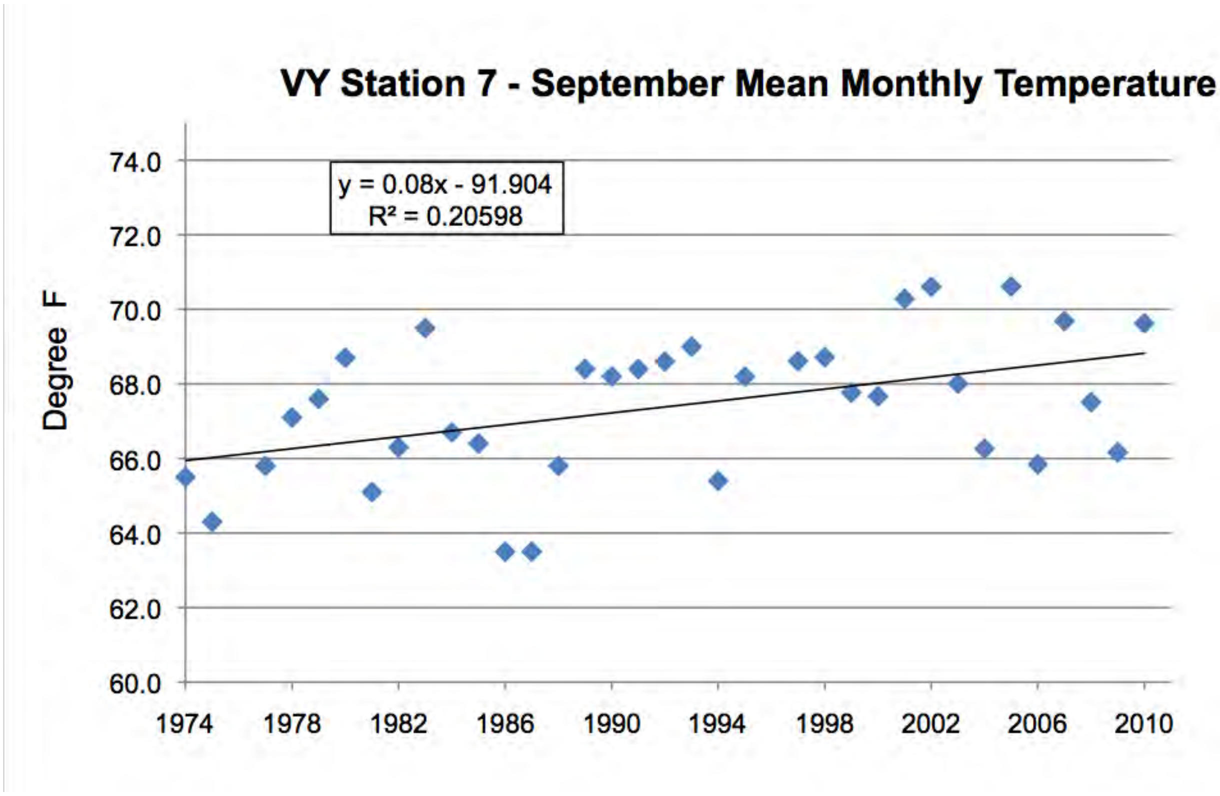

Figure 2. A plot of September's mean temperatures for Vermont Yankees' Station 7 (excludes outlier 1996 data point) for the period 1974 through 2011.

The PAD for Turners Falls and Northfield Mountain Pump Storage projects provides a summary of existing water quality data compiled by FirstLight, including water temperature data obtained from the Service. The PAD also notes a 1991 study by the former licensee that modeled thermal effects of pumping to the upper reservoir. That model reported a maximum temperature difference attributable to NMPS operation of 0.21°C in the Turners Falls reach of the Connecticut River in low flow (4,000 CFS) simulation.

Nexus to Project Operations and Effects

The four mainstem projects have very long impoundments capable of storing large volumes of water (Table 3, below). These impoundments effectively have converted large portions of the Connecticut River into a series of in-river "lakes." Because water velocities slow in these impounded sections of river, it allows for increased thermal loading and resultant higher water surface temperatures than in free-flowing sections of river.

Table 3. Relevant characteristics of the reservoirs behind the Wilder, Bellows Falls, Vernon, Turners Falls dams and NMPS.

Project	Headpond Length (miles)	Gross Storage Volume (acre-ft.)	Average Depth (ft.)	Surface Area (acres)	Flushing Rate (days)
Wilder	45	34,350	11	3,100	3
BF	26	26,900	10	2,804	<2
Vernon	26	40,000	16	2,550	2
Turners	20	21,500		2,110	

NMPS	n.a.	17,,050		246	n.a.

Depending on where the hydropower intakes withdraw water, these warmer surface waters may be discharged downstream, raising the temperature of those waters as well (the data in Table 1 above suggest that the projects do draw water from the upper levels of the reservoirs). This effect may be felt for miles downstream. If there are a series of impoundments (like on the Connecticut River), the cumulative impact is an overall warming of the river. Even small run-of-river dams have been shown to elevate downstream water temperature (Lessard and Hayes 2003; Saila et al. 2005). The most recent climate change prediction models specific to the northeast forecast warmer air temperatures, more frequent high precipitation events, more heat waves, and an increase in the incidence of short term droughts (Karl et al. 2009).

Resource concerns related to this project effect include the potential impacts to populations (reductions in abundance, structure, condition) or loss of species not tolerant of increases in temperature and other effects related to physiology such as energetic costs with warmer temperatures (Leggett 2004). As one example, American shad restoration target numbers for fish passage at mainstem dams into upstream historic habitat could be negatively impacted from artificially increased water temperatures. Water temperature has been identified as a factor in the timing (i.e., duration) of this species migration, as well as its role in gonad development and spawning (Glebe and Leggett 1981; Leggett 2004). These factors can be logical reasoned to potentially result in accelerated rates of energy reserve use and a reduced migration window, possibly reducing the ability of fish to reach up-river habitats and further reducing the ability to survive downstream outmigration.

With respect to project operations during high flow events, all TransCanada projects have stanchion bays that are used to manage water during high flow events. Each time these stanchion bays are removed, the headponds are lowered substantially (from 10 to 17 feet, depending on the project) and must remain lowered until inflows subside. Depending on the timing and duration of these deep drawdowns, headpond resources could be negatively impacted.

All of the dams also contain other mechanisms for managing flows, such as tainter gates, sluice gates, roller gates, skimmer gates and hydraulic flood gates. All of these gates have an advantage over stanchion bays in that they do not require flows to subside significantly before they can be closed to return impoundment levels back to normal. One climate change prediction for the northeast is that we will see more frequent high precipitation events which will result in high flow conditions on rivers. Therefore, it is likely that the stanchion bay removal protocol will have to be employed more frequently in the future.

Methodology Consistent with Accepted Practice

1. In order to quantify the amount of thermal loading contributed by each respective impoundment, detailed bathymetry will need to be collected. This bathymetry, combined with storage volume, tributary hydrology, and project operations, should be used to calculate the thermal loading of each headpond. The individual and cumulative increase in surface water temperature due to the impoundments should then be used to predict future warming based on climate change models.
2. Analyze different mitigation strategies to understand which have the greatest benefit in terms of building resilience against the impacts of climate change on water temperature. Potential scenarios to analyze include converting the projects to run-of-river, implementing deep-water releases, removing one or more dams, conducting large-scale riparian revegetation, etc.).

3. Input to climate change models the amount of GHG emissions that would be generated if fossil fuel plants were producing the equivalent amount of net energy as the five hydropower projects to determine the impact on air and surface water temperatures.
4. Climate change prediction model output should be assessed to determine if the frequency and timing of high flow events is likely to change in the future. If high flow events that necessitate initiating the stanchion bay removal protocol are predicted to increase in frequency and/or shift in timing, the applicant should evaluate structural and/or operational alternatives that would mitigate adverse impacts of the existing flood management protocols.

Level of Effort/Cost, and Why Alternative Studies will not suffice

The level of cost and effort for the thermal loading analysis would be low to moderate. Collecting bathymetry in the three TransCanada headponds would take two staff less than one week to collect (it took the Kansas Biological Survey two days to collect bathymetry at a 3,500 acre lake; Jakubauskas et al. 2011). Bathymetry for the Turners Falls pool and NMPS upper reservoir already exist. The remaining work would be desk-based; loading relevant information into an appropriate thermal loading model to compute the estimated thermal loading of each headpond and then comparing this information to surface water data from climate change prediction models.

The high flow flood protocol study is a desktop analysis that should require low cost and effort. Climate change models already exist and that output would be downloaded and analyzed. The remaining analysis requires a review of alternative means of managing flows without the use of stanchion bays.

The applicants did not propose any studies to meet this need in the PAD.

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Saila, S.B., Poyer, D., and D. Aube. 2005. Small dams and habitat quality in low order streams. Wood-Pawcatuck Watershed Association. April 29, 2005. 16 pp.

Stier, D. J. and J. H. Crance. 1985. Habitat suitability index models and instream flow suitability curves: American shad. U. S. Fish and Wildlife Service Biological Report No. 82 (10.88), Washington D.C.

Study Request 5 - Water Quality Monitoring in the Turners Falls Impoundment and Downstream of the Turners Falls Project

Goals and Objectives

Determine the current water quality of the Connecticut River within the Turners Falls impoundment. The results of the study should provide information sufficient to enable mandatory conditioning agency staff to understand water quality conditions at the project. The study plan for the water quality monitoring should be developed in consultation with the U.S. Fish and Wildlife Service (USFWS) and the Massachusetts Department of Environmental Protection (MA DEP).

The specific objectives of this study are as follows:

- Characterize water quality in the Turners Falls impoundment, bypass reach, canal and below the confluence of the bypass reach and canal discharge.
- Evaluate the potential effects of project operation on water quality parameters such as temperature, dissolved oxygen, total suspended sediment and turbidity in conjunction with various other water uses.
- Determine the level of contamination in sediment impeded by Turners Falls dam.
- Collect continuous temperature, dissolved oxygen, total suspended sediment and turbidity data during the summer period and under various hydropower operating conditions at the Northfield Mountain Project.

Relevant Resource Management Goals and Public Interest Considerations

The resource management goal is to ensure that the Connecticut River, which is designated as a Class B river for its entire length in Massachusetts, meets its designated uses of habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation. Class B waters must also have consistently good aesthetic value and meet minimum criteria for numerous water quality indicators to achieve compliance with the standards set forth in the regulations. The other resource management goal is to protect prime farmland soils, which are eroding, and riparian habitat. Eco-based tourism is important to the economy of Franklin County so maintaining the water quality of the river for boaters and kayakers is important, too.

Public Interest Considerations if Requester is not a Resource Agency

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The Town of Gill is taking this opportunity to be actively engaged in the process of relicensing the Turners Falls Dam and Northfield Mountain Pumped Storage Projects. The Town boundaries include over twelve miles of shoreline on the Connecticut River. Through its appointed Conservation Commission, the Town has an important regulatory role in accordance with the Massachusetts Wetlands and River Protection Acts.

Existing Information and Need for Additional Information

The PAD provides a summary of existing water quality data. While a number of monitoring efforts have taken place and include sample sites within the project boundary, none of those studies was designed to comprehensively investigate whether all relevant project areas currently meet Class B standards: The Massachusetts DEP's Connecticut River watershed assessment monitoring occurred in 2003, it had only two stations located within the project area (both upstream of the Turners Falls dam) and only collected five to six samples from late April to early October. The Connecticut River Watershed Council's volunteer monitoring program only had one sample site within the project area (at Barton's Cove in the Turners Falls impoundment) and while those data are more recent, only three samples were collected in 2007 and only six samples in 2008 (over the course of three to four months each year). The U.S. Geological Survey's long-term water quality monitoring station located downstream of the Cabot Station tailrace only collects information roughly once per month (and no dissolved oxygen data are provided).

No directed, site-specific surveys have been conducted to determine whether waters within the Project area meet state standards. This information gap needs to be filled so that resource agencies can evaluate properly the potential impact of project operations on water quality.

Nexus to Project Operations and Effects

The project creates a 20-mile-long impoundment where there would naturally be a free-flowing river. It currently operates in a peaking mode, with allowable river fluctuations of up to 9 feet, with proposals to continue as such. Portions of the impoundment are nearly 100 feet-deep. There is a 2.7 mile-long reach of river bypassed by the Turners Falls power canal with only a nominal seasonal release required (equal to 0.05 cfsm). The below-project flow requirement is equal to 0.20 cfm (1,433 cfs). Water quality is directly affected by the operating mode of a hydropower project. Impoundments can stratify, resulting in a near-hypoxic hympolimnion. If the project intake draws off of these deep waters then it could cause low dissolved oxygen levels downstream from the project discharge.

The Town of Gill requests that the applicant conduct a water quality survey of the impoundment, bypass reach and tailrace reach in order to determine whether state water quality standards are being met under all currently-licensed operating conditions (i.e., during periods of generation and non-generation). Results of the survey would be used, in conjunction with other studies requested herein, to determine an appropriate below-Project flow prescription, bypass reach flow(s), and to recommend an appropriate water level management protocol for the impoundment (e.g., limiting impoundment fluctuations to protect water quality). Operation of upstream hydroelectric projects as well as the Turners Falls Project and Northfield Mountain Project may impact water quality through the use of water for hydropower generation.

Methodology Consistent with Accepted Practice

Turners Falls: Water quality samples should be collected from a minimum of six locations: upstream of the impoundment, at a deep location within the impoundment, in the forebay near the intake, in the bypass reach, in the canal near Cabot Station and downstream of the confluence of the Cabot Station discharge and the bypass reach but upstream of the confluence with the Deerfield River. In order to ensure that data are collected under "worst case" conditions (low flow, high temperature, antecedent of any significant rainfall event), we recommend deploying continuous data loggers at all six locations, with biweekly vertical profiles taken at the deep impoundment location from June 1 through September 30. Results should include date, time of sampling, sunrise time, GPS location, generation status (estimated flow through canal and bypass reach), precipitation data, water temperature, DO concentration and percent saturation.

In addition, impoundment sediment adjacent to the Turners Falls dam should be analyzed for metals and polychlorinated biphenyls.

A proposed water quality sampling plan should be submitted to USFWS and MADEP for approval. A section on quality assurance and quality control must be included.

If river flow and temperature conditions are representative of an "average" or "low" water year, then one year of data collection should be sufficient to perform the study. If conditions are not representative (i.e., a "wet" or cool year) then a second year of data collection may be necessary.

Northfield Mountain: The water quality study will include two components: a) continuous dissolved oxygen and temperature monitoring at specific locations in the Northfield Mountain Project area and b) monthly *in-situ* dissolved oxygen, temperature profiles, total suspended solids and turbidity within the Northfield Mountain Upper Reservoir. It is anticipated that the study will be conducted from approximately June 1 through September 30.

Level of Effort and Cost

Cost would depend on the specific methodology chosen. If continuous data loggers are installed at all six locations and biweekly vertical profiles taken at the deep impoundment location from June 1 through September 30 then the estimated cost of the water quality study is approximately $55,000, including at least one full year of data collection. It is expected to take two technicians approximately one day to deploy the loggers, eight days to collect the vertical profiles, one day to remove the loggers, one day to download the data, and five days to write the report.
In the PAD, the applicant proposes to assess the effects of the Turners Falls and NFMPS project operations on dissolved oxygen and temperature by continuously monitoring DO and temperature at locations within the project areas and gathering vertical profiles within the TF impoundment and NFMPS upper reservoir.

Study Request 6 – Quantify the Impacts of Water Level Fluctuations on Riparian and Aquatic Vegetation Including Invasive Species and their Associated Habitats in the Turners Falls Dam Project Impoundment

Conduct a study to quantify the impacts of river level fluctuations due to project operations on riparian, wetland, Emergent Aquatic Vegetation (EAV), Submerged Aquatic Vegetation (SAV), littoral zone and shallow water aquatic habitats in the Turners Falls Dam impoundment.

Goals and Objectives

The goal of this study is to obtain baseline information on riparian, wetland, emergent and submerged aquatic vegetation, and associated shallow water aquatic habitats (subject to operational inundation and exposure to near exposure) known to occur in the project area. Information would be used to determine whether riparian, wetland, EAV and SAV, littoral, and shallow water (e.g., mid river bars and shoals) habitats are impacted by current water level fluctuations permitted under the Turners Falls and Northfield projects' licenses and whether these vegetation types and shallow water habitats can be protected and restored by modifications to project operations or other mitigation measures. This analysis needs to take into account existing and potential future limits on pond level fluctuations intended to limit recreation impacts, and the interactions of any changes in pond level fluctuation range or frequency and discharge changes under a new licenses of the Turners Falls and upstream projects. This information is needed to determine whether the projects' operation affects plants, habitat, and wildlife in the project area, whether aquatic vegetation and its habitats can be enhanced by modifications to project operations or other mitigative measures, and whether there is any unique or important shoreline or aquatic habitats that should be protected.

The specific objectives of the field study, at a minimum, include:

- Quantitatively describe and map wetland types within 200 feet of the shoreline, and describe associated wildlife;
- Delineate, quantitatively describe, and map all wetland types including invasive species and wildlife observed (e.g., bald eagle nesting, water fowl nesting) within 200 feet of the shoreline, and the extent of this habitat if it extends beyond 200 feet; and
- Quantitatively describe (e.g., substrate composition, vegetation type and abundance) and map shallow water aquatic habitat types subject to project operation inundation and exposure, noting and describing additional areas where water depths at lowest operational range are wetted to a depth less than one foot (flats, near shore areas, gravel bars, with very slight bathymetric change);

A second year of study may be required should river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period.

The field study should produce a habitat inventory report that includes:

- The results of the field study in the form of maps and descriptions;
- An assessment of project effects on wetland, riparian, littoral zone vegetation and shallow water habitats, invasive plant species, and wildlife habitat at the project; and

- Recommendations for any necessary plant, habitat type, or wildlife, protection and/or invasive species control measures.

Relevant Resource Management Goals and Public Interest Considerations

Protect and restore native riparian, wetland, EAV, SAV, littoral and shallow water habitat (i.e., spawning and or nursery areas for aquatic organisms) in the Turners Falls impoundment.

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Existing Information and Need for Additional Information

Existing information in the PAD does not quantify EAV and SAV in this area, or other shallow aquatic habitat types and physical features (e.g., depths, substrates, wood structure) that are the environment for aquatic biota in the project area. The PAD does provide some limited monitoring data for 2012 (2 locations) on water surface elevations that show daily fluctuations, in the upper third of this impoundment, that varied over 4 feet on a daily cycling frequency, with fluctuations generally in the 2 foot range in low flow months for the data provided in the PAD. The current license does permit a greater pool elevation operational fluctuation, up to a 9 foot change in elevation, based on the Turners Falls Dam water elevation. In the PAD it is noted these operational fluctuations under most circumstances at the Turners Falls Dam are within 3.5 feet.

In the PAD it is noted that FirstLight would like to expand its NMPS upper reservoir capacity (by up to 24%). How this may affect project operations and the habitats noted in this request is unknown. It is also noted that water is typically pumped to the upper reservoir in evening and generation back to the river occurs once to twice daily, in daytime hours, based upon power needs and power value. Under current license conditions, provided set thresholds for minimum flow and Turners Dam current license elevations are met, the NMPS may operate with no restriction in timing, frequency, or magnitude for pumping or generation. No data were provided on the operation of the NMPS plant over time relative to data on pumping and generation on an hourly basis, averaged values were provided over monthly periods. It is unclear what the actual timing, frequency and magnitude of these NMPS operations are over the course of a year and how that relates to: aquatic plant species establishment, growth, survival, littoral zone or other shallow water habitat fish spawning periods and their effects on these fishes (reproduction success and subsequent recruitment, e.g., bass and fall fish nests) in available and utilized habitat, and how the quantity and quality of these shallow water habitats are effected by project operational manipulation/alteration, as currently permitted or proposed.

The PAD provides lists of plant and wildlife species whose native ranges overlap with the project area, but it does not provide any baseline information on known occurrences of these species in the wetlands, riparian, littoral and shallow water habitats, within or adjacent to, the project area. Plant and wildlife occurring in these habitats may benefit from protection, mitigation, and enhancement (PMEs) measures, given the potential effects of continuing the current semiautomatic peaking operating regime. In addition, a large scale sediment discharge from NMPS resulted in regulatory actions by FERC, the EPA and MADEP in 2010. Continuing and as yet unresolved management plan measures relative to sediment and NMPS project operations, are further concerns for shallow water, littoral zone, and wetland habitats.

The Atlantic States Marine Fisheries Commission, Atlantic Coast Diadromous Fish Habitat: A Review of utilization, threats, recommendations for conservation, and research needs (ASMFC 2009)[2], contains a review of habitat information for these species. Recommendations in this report include: Maintain water quality and suitable habitat for all life stages of diadromous species in all rivers with populations of diadromous species.

Nexus to Project Operations and Effects

Water level fluctuations due to project operations could affect EAV and SAV habitat as well as the quantity and quality littoral and shallow water habitat. These operational water level fluctuation effects are expected to impact fish species use of these habitats and may affect spawning fishes reproductive success and subsequent population recruitment including but not limited to American shad, blueback herring, sea lamprey, fall fish, and bluegill, which spawn in mid to late spring through early summer in areas subject to daily or more frequent water level fluctuations.

The current operating mode, as well as the unknowns with proposed upper reservoir expansion, may affect wetland riparian, littoral and other shallow water habitats and promote the introduction and expansion of invasive plant species through fluctuating water levels. A study that explains the relationship between the proposed mode of operation and the type and quantity or wetland, riparian, littoral, shallow water habitats, and invasive species affected would help inform a decision on the need for protection and/or control of these resources in the license.

Methodology Consistent with Accepted Practice

The PAD currently contains maps portraying general wetland types from the Cabot Station tailrace upstream to the Vernon Dam. In addition, we understand that recent bathymetry exists for the Turners Falls impoundment (Field, 2007). The proposed study should utilize this existing information in conjunction with field surveys designed to describe the characteristics of each mapped wetland, riparian, littoral and shallow water habitat including plant species composition, relative abundance/density, habitat quality, and land use. These surveys should be conducted to describe these habitats at the lowest

[2] Atlantic States Marine Fisheries Commission. 2009. Atlantic coast diadromous fish habitat: A review of utilization, threats, recommendations, for conservation, and research needs. Habitat Management Series #9. Washington, D.C.

water level operational range permitted on a daily operation schedule, under low flow conditions. Information collected should include:

- Plant species composition, and their relative abundance/density and condition/structure (e.g., seedlings);
- Structured data, including estimates of average heights and aerial cover of each vegetation layer (specifically denoting invasive species);
- Aquatic habitat substrate composition, quantity (i.e., percent types and area), wood structure (relative abundance measure applied by area), water depths (inundated, exposed, and water less than one foot);
- Predominate land use(s) associated with each cover type;
- Wildlife sightings should be noted;
- Field verified wetland, riparian, and littoral and shallow water habitats and invasive species occurrences, should be geo-referenced as polygons and overlain on orthophoto at a suitable scale.

Level of Effort and Cost

In the PAD, First Light identified impacts of the project operations on wetlands, riparian and littoral zone habitat as a potential issue to be addressed in relicensing, and proposed wetland vegetation mapping. However, additional analysis as described above is needed to understand the impacts of the project on these resources and habitats.

A wetlands, riparian, littoral/shallow water, invasive species inventory, of the scope envisioned, would likely require 6-8 months to complete and cost $40,000 to $50,000.

Study Request 7 - Model flows in the Northfield Mountain Pumped Storage Project discharge tailrace and Connecticut River 1 kilometer upstream and downstream of the discharge using two-dimensional Computational Fluid Dynamics (CFD) model techniques.

Goals and Objectives

The goal of this study is to determine the potential impacts (both project-specific and cumulative) of the Northfield Mountain Pump Storage Project operations (pumping and generating) on the zone of passage for migratory fish near the Northfield Mountain turbine discharge/pump intake, on natural flow regimes in the area of the Connecticut River immediately upstream and downstream of the project, on the potential for entrainment during pumping operations, on the potential for creating flow reversals in Connecticut River during pumping cycles that may confuse migratory fish attempting to pass the project, and on bank erosion on both sides of the river in the vicinity of the tailrace.

Specific objectives of the study include:

- Develop a 2-dimensional CFD modeling capability for the area of the Northfield Mountain discharge and tailrace, along with the full width of the Connecticut River 1km upstream and 1 km downstream of the discharge.

- Model flow characteristics upstream and downstream of the project under existing project operations (pumping and generating) and at several representative river flow levels, as well as proposed operations such as those proposed in section 3.4.4 of the PAD, and any other modifications under consideration, to assess potential impacts to fish and wildlife resources, recreational use, agricultural resources, and historical resources.

- Assess velocities at and in proximity to the Northfield Mountain intake/discharge structure, when pumping or generating and their potential to interfere with fish migration.

- Assess the potential for velocity barriers in the mainstem river resulting from pumping and generation flows at the project, alone or in combination with generation flows from the upstream Vernon Project.

- Assess potential for Northfield Mountain project operations to create undesirable attraction flows to the intake/discharge that may result in entrainment or delay of migratory fish.

- Assess the potential of a mainstem instream local flow reversal associated with pumping operations to impact migrating fish. The Connecticut River in the area of the Northfield Mountain tailrace has been said to flow upstream potentially confusing migratory fish keying in to flow as a directional aid to upstream or downstream migration, causing delay and additional "fish" energy expense and possible entrainment.

- Model and then evaluate flow characteristics under alternative project operations with potential measures to avoid, minimize, or mitigate impacts to fish and wildlife resources.
- Assess the potential for unnatural flows and eddies in the main-stem associated with pumping or generation at the Northfield Mountain Project to impact bank erosion and recreational use.

Resource Management Goals

The Town of Gill supports the U.S. Fish and Wildlife Service's goals. The mission of the U.S. Fish and Wildlife Service (Service) is to work with others to protect, conserve and enhance fish, wildlife, plants and their habitats for the continuing benefit of the American public. Service trust resources include wetlands, endangered species, and migratory species, all of which have been documented to occur in the project area. The Service is also working with a number of federal, state, local, non-governmental organizations, and the public to restore and enhance trust resources in the Connecticut River Basin through comprehensive management plans and cooperative agreements. Instream flow is an important riverine habitat characteristic that can have a great impact on aquatic habitat for fish, wildlife, and plants. Flow is an important directional guidance cue for instream navigation and attraction to fishway entrances for migratory fish.

Public Interest Consideration if Requester is not a Resource Agency

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Gill is a member of the Franklin Regional Council of Governments (FRCOG) and has members on FRCOG's Ad Hoc committee, the Connecticut River Streambank Erosion Committee (CRSEC). The CRSEC was convened in 1994 to bring together the Northfield Mountain Pumped Storage Project operator, state and municipal entities, landowners, and NGO's to carry out bioengineering projects to stabilize and repair areas of bank erosion.

The Town of Gill is taking this opportunity to be actively engaged in the process of relicensing the Turners Falls Dam and Northfield Mountain Pumped Storage Projects. The Town boundaries include over twelve miles of shoreline on the Connecticut River. Through its appointed Conservation Commission, the Town has an important regulatory role in accordance with the Massachusetts Wetlands and River Protection Acts.

Existing Information

No project specific information exists that will allow for a comprehensive assessment of existing project operations (pumping and generating flows) on Connecticut River flows and on fish and aquatic organisms in the project area upstream and downstream of the project in the Connecticut River. Preliminary results from an ongoing study of radio-tagged American shad by the USFWS and USGS Conte lab indictate that shad are exposed to the intakes and some individuals spend substantial amounts of time in the vicinity of the intakes. The PAD does not contain any information or tool that will allow for predictions of impacts of alternative project operations, or potential mitigation measures to protect or enhance aquatic fish and wildlife resources.

As part of Field (2007; see appendix 4), a "Connecticut River Hydraulic Analysis – Vernon Dam to Turners Falls Dam" was completed by Woodlot Alternatives in July 2007. For this analysis, a 2-dimensional flow model was developed for the entire Turners Falls impoundment. This study was geared towards looking at shear stresses from high-flow events, and did not focus in detail around the tailrace or examine how pumping and generation may affect flows in the vicinity of the tailrace under a variety of flows.

As a result of the hydraulic analysis, Field (2007) on page 20 states that "While erosion does occur where high flow velocities and shear stresses approach near the bank, significant amounts of erosion also occur where flow velocitieis near the bank are low." No specific examination was done in the report on the ±1 km area near the tailrace and existing erosion sites. Banks immediately upstream and downstream and across river have all required bank stabilization projects over the last 15 years, in some cases needing several repairs.

Nexus to Project Operations and Effects

Existing project operations have a direct impact on instream flow and aquatic habitat in the pump/discharge area of the Connecticut River. The PAD in section 3.2.2 says that the velocity at the trash racks when operating at full capacity is 20,000 cfs and maximum pumping conditions are 15,200 cfs. Annual flow duration curves shown for below the Vernon Dam submitted in the PAD section 4.3.1.2 (for years 1944-1973; recent and near project flows are not available; see p. 459) indicate that river flows are ≤ 20,000 cfs more than 85% of the time. Flows released from the project must therefore influence flow patterns and velocities in the Connecticut River, particularly at flows below some unknown threshold level.

Recreational users of the Connecticut River in the Turners Falls impoundment have anecdotally described flow reversals in the mainstem river. Discharges from the project could potentially be larger than river flows or at least act like a major tributary to the Connecticut River. Project flows may influence the availability and extent of upstream and downstream migration zones, or may confuse fish and delay migration. Project flows may also impact stream banks in ways that natural river flow (or flows affected by upstream hydropower facilities) does not, and may also impact recreational use of the river.

Proposed Methodology

CFD modeling is consistent with generally accepted practice, and has been used to assess proposed modifications to the Holyoke Dam fish passage facilities, upstream of the intakes and downstream of the dam, as well as at hydroelectric projects on the Susquehanna River to assess existing and proposed project operations, and develop mitigation measures for fish and wildlife resources.

Level of Effort/Cost, and Why Alternative Studies will not suffice

This study will require a detailed elevation map of the study area upstream and downstream of the Northfield Mountain project. Information already exists in historic construction files for the project, the hydraulic analysis included in Appendix 4 of Field (2007), and possibly in conjunction with work done after the 2010 maintenance procedures that resulted a portion of the river being dredged after a large sediment dump) that are in the possession of the applicant. Additional elevation data will likely need to be collected in the field using standard survey techniques. Elevation data will then need to be entered into a CFD modeling program. The CFD computer program will need to simulate existing project operations that include all potential variations of pumping and generating, and static operation. No project specific instream flow analysis tool has been developed for the Northfield Mountain project that will allow for assessment of existing operations and alternative operational impacts on instream flow and aquatic habitat for fish and wildlife resources. The computer model, once built, can be used to simulate flow conditions in the vicinity of the project during migratory fish passage and can be used together with behavior studies (i.e., telemetry studies and entrainment studies requested herein) to assess the impacts of varying project operations or potential mitigation operations and measures on fish migration and aquatic habitat. We know of no other tool that will provide for these types of assessments. Cost is expected to be moderate to high.

Study Request 8. Telemetry Study of Upstream and Downstream Migrating Adult American Shad to Assess Passage Routes, Effectiveness, Delays, and Survival

Goals and Objectives

Assess behavior, approach routes, passage success, survival, and delay by adult American shad as they encounter the projects during both upstream and downstream migrations, under- permitted project operations conditions, proposed operational conditions, and study treatment operational conditions at First Light Power's Turners Falls and Northfield Mountain Pumped Storage projects and TransCanada's Vernon Project. The Town of Gill supports all these studies as there are multiple fishways and issues related to both upstream and downstream passage success at the projects. Some of these issues at the Turners Falls Project are similar to and/or pertain directly to the Northfield Mountain and Vernon projects. Therefore, the Town of Gill feels it is reasonable to address passage issues at all projects in a similar manner.

<u>Telemetry Study -</u> This requested study requires use of radio telemetry using both radio and Passive Integrated Transponder (PIT) tag types to provide information to address multiple upstream and downstream fish passage issues. The following objectives shall be addressed in these studies:

- Assessment of any migration delays resulting from the presence of the dam and peaking flow operations of the Turners Falls Project;
- Determine route selection and behavior of upstream migrating shad at the Turners Falls Project under various spill flow levels (e.g., movement to the dam, attraction to Cabot Station, attraction to Station 1 discharge, movement between locations, delay, timing, etc.). A plan and schedule for dam spill flow releases will need to be developed that provides sufficient periods of spill flow conditions, and various generating levels from Turners #1 Station coupled with Cabot Station generation flows (e.g., treatments will require multiple days of consistent discharge). Evaluated spill flows should include flows between 2,500 – 6,300 cfs, which relate to bypass flows identified as providing spawning opportunities for shortnose sturgeon in the lower bypass reach at the Rock Dam. (Kieffer and Kynard 2012). Sturgeon spawning and upstream shad passage occur concurrently;
- Assess near field, attraction to and entrance efficiency of the Spillway Ladder by shad reaching the dam spillway, under a range of spill conditions;
- Evaluate the internal efficiency of the Turners Falls Spillway Ladder;
- Continue data collection of Cabot Station Ladder and Gatehouse Ladder efficiency, to include rates of approach to fishway entrances, entry into fishways, and passage through them, under different operational conditions that occur in these areas;
- Evaluate modifications to the Cabot and/or Spillway fishways recommended by the Service if they are implemented;
- Assess upstream migration from Turners Falls to the Vernon Dam in relation to Northfield Mountain's pumping and generating operations and Vernon Project peaking generation operations. Typical existing and proposed project operation alterations should be evaluated;
- Assess near field, attraction to and entrance efficiency of the Vernon Dam Ladder;
- Assess internal efficiency of the Vernon Dam Ladder;

- Assess upstream passage past Vermont Yankee's thermal discharge (also located on the west bank of the river 0.45 mile upstream of fish ladder exit)
- Assess upstream migration from Vernon Dam in relation to the peaking generation operations of the Bellows Falls Project. Typical existing and proposed project operation alterations should be evaluated;
- Determine post-spawn downstream migration route selection, passage efficiency, delays and survival related to the Vernon Project, including evaluation of the impact of the Vermont Yankee heated water discharge plume on downstream passage route, migrant delay/timing, efficiency and survival;
- Assess impacts of Northfield Mountain operations on up- and downstream adult shad migration, including delays, entrainment, and behavioral changes and migration direction shifts under existing and proposed project operations;
- Determine downstream passage route selection, timing/delay, and survival under varied project operational flows into the power canal and spill flows at Turners Falls Dam;
- Determine downstream passage route selection, timing/delay in the canal, Cabot Station fish bypass facility effectiveness, and survival of Cabot-bypassed adult shad that enter the Turners Falls Canal system;
- Compare rates and or measures of delay, movement and survival etc., among project areas or routes utilized (e.g., spill at dam vs. power canal) under the range of permitted and proposed conditions; and
- Utilize available data sets and further analyze raw data (e.g., 2003- 2012 Conte Lab Studies) where possible to address these questions and inform power analyses and experimental design.

Information to address all of these questions would rely on the tagging of upstream migrating adult shad at Holyoke Dam and releasing them to migrate naturally from Holyoke through the Turners Falls and Vernon projects and back downstream after spawning. Additional tagged individuals would likely need to be released farther upstream (Turners Falls Canal, upstream of Turners Falls Dam, and upstream of Vernon Dam), to ensure that enough tagged individuals encounter project dams on both upstream and downstream migrations, that these individuals are exposed to a sufficient range of turbine and operational conditions to test for project effects, and to provide adequate samples sizes for statistically valid data analyses to address the many objectives listed. This study will require two years of field data collection to attempt to account for inter-annual variability in river discharge and water temperatures.

<u>Evaluation of Past Study Data</u>- In addition to collection and analysis of new telemetry data, substantial data has already been collected at Turners Falls from multiple years of passage assessments conducted for First Light by U.S. Geological Survey's Conte Anadromous Fish Research Center (Conte Lab) researchers and there are also data from the 2011 and 2012 full river study conducted by the Conte Lab that address Turners Falls, Northfield Mountain and Vernon project migration and passage questions that have not yet been analyzed. These data include several million records each year from more than 30 radio telemetry receivers deployed between Middletown, CT and Vernon Dam. This data will provide substantial information free from the field data collection costs and therefore should be analyzed as part of this study. This data analysis should be completed in 2013 to help inform the design of subsequent field studies.

<u>Evaluation of Methods to Get Shad Past Cabot Station for Spillway Passage at the Turners Falls Dam</u> – The poor passage efficiency of the Cabot Ladder, the first and most used fishway encountered by shad arriving at the Turners Falls Project, and at the entrance to the Gatehouse Ladder, which all Cabot fishway-passed fish must use, has resulted in very poor overall shad passage efficiency at the project. An alternative to passing fish at the Cabot Station is to install a fish lift at the dam that would put fish

directly into the Turners Falls pool, thereby eliminating problems with the Cabot Fishways, and the Gatehouse Fishway entrance and the variable passage efficiency of the Gatehouse Fishways. For this to be effective, attraction of shad to the Cabot Station discharge and associated delays would need to be overcome. It is possible that spillway flow releases coupled with behavioral measures at Cabot Station that dissuade shad from that tailrace could achieve this end. In order to assess the possibilities, we recommend the following study:

1. A literature search and desk-top assessment of the possible behavioral measures that could be effective in getting shad to pass Cabot Station tailrace and continue upstream to the dam.

2. Based on results of the desk-top assessment, possible evaluation of behavioral measures that are likely to be effective.

3. Field evaluation of the effect of different levels of spill at the dam that would induce fish to move past the Cabot Station into the bypass reach and up to the dam (as noted in objectives).

Besides passage success and delays at passage facilities, these studies would assess the impacts of project operations on migration passage delay, route, timing, injury, mortality, and passage structure attraction, retention, and success. Of particular interest will be fish behavior during periods when flow releases from the project increase from the required minimum flows to peak generation flows and when flows subside from peak generation flows to minimum flows and the operation of NMPS in pumping and generation modes.

Resource Management Goals

The Connecticut River Atlantic Salmon Commission (CRASC) developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually. (Table 1)

2. Achieve annual passage of 40 to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem.

3. Maximize outmigrant survival for juvenile and spent adult shad.

The Atlantic States Marine Fisheries Commission, Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010 includes the following objective:

1. Maximize the number of juvenile recruits emigrating from freshwater stock complexes

and recommendations:

Upstream Passage –
1. American shad must be able to locate, enter, and pass the passage facility with little effort and without stress.

2. Where appropriate, improve upstream fish passage effectiveness through operational or structural modifications at impediments to migration.
3. Fish that have ascended the passage facility should be guided/routed to an appropriate area so that they can continue upstream migration, and avoid being swept back downstream below the obstruction.

Downstream Passage –

4. To enhance survival at dams during emigration, evaluate survival of post spawning and juvenile fish passed via each route (e.g., turbines,, spillage, bypass facilities, or a combination of the three) at any given facility, and implement measures to pass fish via the route with the least delay and best survival rate.

Based on the CRASC plan, the Service seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to American shad movement and migration, the Service's goals are:

1. Minimize current and potential negative project operation effects such as migration delays, false attraction, turbine entrainment, survival of project passage routes, and trashrack impingement that could hinder management goals and objectives.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), Silvio O. Conte National Fish and Wildlife Refuge Act (P.L. 102-212; H.R. 794), the Federal Power Act (16 U.S.C. §791a, *et seq*.), the Atlantic States Marine Fisheries Compact (P.L. 539, 77th Congress, as amended by P.L. 721, 81st Congress), and the Atlantic Coastal Fisheries Cooperative Management Act (16 U.S.C. 5107).

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Existing Information

Passage of adult shad at the Turners Falls fishway complex has been the subject of intense study by the Conte Lab since before 1999. These studies have clearly demonstrated that passage through the existing fishways at Cabot and Spillway is poor (<10% in many years). Passage through the Gatehouse fishway is better, but still rarely exceeds 80%, despite the short length of this ladder. In addition to poor passage for fish entering the ladders, shad that ascend the Cabot Fishway experience extensive delays before entry into the Gatehouse Fishway. Shad that ascend Spillway frequently fall back into the canal and are also subject to these upstream delays. A new entrance to the Gatehouse Fishway installed in 2007 led to dramatic improvements in passage out of the canal (from 5% to over 50% in 2011), but passage still falls well short of management goals. In addition, shad spend considerable time (up to several weeks) attempting to pass. These delays likely influence spawning success and survival. Adult shad, unable to pass Gatehouse, experience similar delays in downstream passage, even after they have stopped trying to pass Gatehouse. Without spill, all outmigrating shad that have passed Gatehouse must enter the canal at the Gatehouse and may be subject to delays exiting the canal.

During the course of these studies a very large dataset has been compiled that could yield useful information for further improving passage of shad out of the canal in both the upstream and downstream directions. A unique feature of these data is a 2-dimensional array covering the canal just downstream of Gatehouse, documenting fine scale movements and occupancy of this zone. These data should be combined with computational fluid dynamics (CFD) and real-time hydraulic data to determine how canal hydraulics influence the ability of shad to locate and enter the fishway, and to identify modifications that are likely to lead to improvements in approach and entry rates. A separate CFD modeling study is requested that includes modeling of the Gatehouse Fishway entrance are at the head of the power canal.

In addition, whole-river shad telemetry studies performed in 2011 and 2012 will likely provide useful information and should be analyzed. These data should allow quantification of delay below Turners Falls, and could help guide studies requested above. Preliminary analyses of data through 2011 have been made available to FirstLight and the resource agencies (Castro-Santos and Haro 2005; Castro-Santos and Haro 2010).

The whole-river studies have also shown that, at least in 2011, most shad that pass Turners Falls rapidly progress upstream to Vernon Dam where extensive delays also occur. Data from the 2012 study were not available at this time, but Dr. Castro-Santos stated similar patterns were noted in the data between the years on the topic of upstream delay (personal communication, Dr. Theodore Castro-Santos). Similarly, concerns relative to the downstream passage of spent shad also remain relative to delays, with existing unpublished USGS telemetry data sets suggesting this is an issue within the Turners Falls canal.

Since the first year of operation of the Turners Falls upstream fishways (1980), the percent passage of American shad annually passed upstream of Turners Falls Dam compared to the number passed at the Holyoke Fish Lift has averaged 3.6% (1980-2012 data). The highest values for this metric has not exceed 11% and are well below the noted CRASC Management Plan target range for this objective noted earlier as 40-60% on a five year running average.

Since the first year of operation of the Vernon Dam upstream fish ladder (1981), the percent passage of American shad annually passed at Vernon compared to the number passed upstream of Turners Falls Dam (Gatehouse counts) has averaged 39.4%, ranging from 0.42% to 116.4% (> 100% due to counting error at one or both facilities, unknown).

Nexus to Project Operations and Effects

Existing project operations (peaking power generation) and limited bypass flows have a direct impact on instream flow and zones of passage (migration corridors). Project flow releases affect passage route selection, entry into fishways, and create delays to upstream migration. Inefficient downstream bypasses can result in migration delays and increased turbine passage. Mortality of adult shad passing through these turbines is expected to be high (Bell and Kynard 1985), additional stresses associated with passage and delay may cause mortality as shad are unable to return to salt water in a timely manner. The project's upstream and downstream passage facilities need to be designed and operated to provide timely and effective upstream and downstream fish passage to meet restoration goals of passage to upstream habitat and maximize post-spawn survival. These factors are all critically important to the success of restoration efforts.

Methodology

Use of radio including passive-integrated transponder (PIT) telemetry is widely accepted as the best method to assess fish migratory behavior and passage success and has been used extensively to assess migration and passage issues at Turners Falls as well as other Connecticut River projects. These studies include one conducted in 2011 and 2012 by the Service and U.S. Geological Survey's Conte Anadromous Fish Research Center, which has provided substantial information related to some of the issues identified here. The requested study will build and expand on the information collected over the past two years.

The study design must specify sample sizes, tag configurations and receiver configurations, to ensure that rates of entry and exit to the tailraces, fishways, downstream bypasses, and the bypassed reach can be calculated with sufficient precision to determine effectiveness of flow and ensonification treatments (separate Study Request). For project assessments at Turners Falls (e.g., Cabot, Spillway and Gatehouse ladder attraction and entry, route selection, operational effects), double tagged (radio and PIT) shad will be required for release from Holyoke Dam. Additional shad must be released directly into the Turners Falls Canal to support assessment of the various operational and structural conditions in effect, to be modified in this period, and proposed conditions within the Turners Falls power canal relative to entrances to the Gatehouse fishway. A related request on CFD modeling in the Cabot Station tailrace, the upper power canal near Gatehouse, and in the area around the entrance of the Spillway Ladder will address related project operational effects that will also address identified objectives in this telemetry request. Shad captured at Holyoke and tagged and release upstream of Turners Falls Dam, or tagged out of Gatehouse Ladder, would help to ensure an adequate sample size for evaluations in the vicinity of NMPS and to the Vernon Dam and the ability to address identified study objectives in those project areas. Additional tagged shad are expected to be required for release upstream of the Vernon Dam, which should ensure adequate sample for a separate study request, where shad spawn upstream of Vernon Dam as well as ensuring there is an adequate number of outmigrating spent adults to address related study objectives for adult outmigrants. The required number of tagged fish to address study objectives may be adjusted accordingly from area to area depending on target numbers (i.e., best information on resultant viable tagged fish and power analyses to detect effects) to account for typical passage rates, survival rates, and handling effects as examples.

Existing information on captured, handled, tagged fish performance (e.g., percent that drop back, unsuitable for tracking) and factors such as timing of tagging and potentially transport, must all be carefully considered to ensure an adequate sample size of healthy (e.g., viable to characterize behavior, survival, etc.) tagged fish is available to address the many questions identified in this request (as supported by a statistical power analysis). Additionally, ensuring adequate downstream adult fish sample sizes (to address project effect questions above) requires close consideration as expected losses of healthy tagged fish during upstream passage, natural mortality rates, and tagging related effects, are expected to reduce sample sizes on downstream passage objectives/questions as the season progresses. The use of single PIT tagged fish can help improve sample sizes, but will be of limited use to answer some of the passage questions we have identified.

Due to environmental variability, two years of study work will be necessary. A large array of stationary monitoring stations (radio and PIT) will be needed to address the issues identified among the project areas. A sufficient level of radio receiver and PIT reader coverage will be required, to provide an appropriate level of resolution, for data analyses, to answer these questions on project operational effects. The study will provide information on a variety of structural and operational aspects of fish migration, relative to route selection, timing, survival, and up and downstream passage attraction, retention, delay, efficiency, survival as some examples at three projects (Turners Falls, NMPS, and Vernon). The use of video monitoring may also be utilized for specific study areas such as the Spillway Ladder, to provide additional information on shad entrance activity, with the understanding of some data limitations associated with this approach (fish identification, water visibility). This study will be coordinated with the proposed study request to evaluate ensonification as a shad behavioral deterrent at the Cabot Station tailrace which will be an additional treatment of the telemetry study.

In addition to the tagging studies, use of video monitoring of the Spillway Fishway would provide additional overall data on Spillway Fishway efficiency as all shad attempting to pass could be monitored versus just those shad that have been tagged.

Level of Effort/Cost, and Why Alternative Studies will not suffice

The requested study is extensive and will require a substantial effort and cost to capture, PIT tag, and radio tag a sufficient number of shad at Holyoke to release at upstream locations. We are not aware of any other study technique that would provide project specific fish behavior and migration information to adequately assess existing project operations and provide insight in possible alternative operations and measures needed to address observed negative impacts to fish migration success. Cost for the entire multi-project tagging, tracking and data analysis are expected to range from $400,000 to $500,000 based on past Turners Falls' studies and the 2011 and 2012 shad telemetry studies. Video monitoring of the Spillway fishway would add a modest cost to this study.

Due to the fact tagged shad will move throughout the larger five project area, to varying degrees, there will be expected cost savings (e.g., radio tags) to both owner/operators, provided cooperation in study planning and implementation occurs.

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Study Request 9. Impact of Project Operations on Shad Spawning, Spawning Habitat, and Egg Deposition in the Project Areas of the Turners Falls, Northfield Mountain Pumped Storage and Vernon Project Areas and downstream from Bellow Falls Dam .

Conduct a field study of spawning by American shad in the Connecticut River mainstem downstream of Turners Falls Dam, in the Turners Falls Dam impoundment, and also in the Vernon Dam Project area, and downstream of Bellows Falls Dam to determine if project operations (including operations of the Northfield Mountain Pump Storage) negatively impact shad spawning behavior, spawning habitat use, areal extent and quality of those spawning areas, and spawning activity in terms of egg deposition in those areas.

Goals and Objectives

The Town of Gill supports the effort to determine if project operations (under the permitted and proposed operational ranges) affect American shad spawning site use and availability, spawning habitat quantity and quality, and spawning activity in the river reaches downstream from Cabot Station and in the project bypass reach of Turners Falls Dam, in the Turners Falls Dam impoundment and in relation to Northfield Mountain Pump Storage operations, downstream and upstream of the Vernon Dam, and in the project area downstream of Bellows Falls Dam. The following objectives will address this request:

- Determine areas utilized by American shad for spawning by conducting night-time visual observation of spawning activity, identify and define areas geospatially, and obtain data on physical habitat conditions effected by project operations (e.g., water depth, velocity, discharge, substrate, exposure and inundation of habitats);
- Determine project operation effects on observed spawning activity, under a range of permitted or proposed project operation conditions;
- Quantify effects (e.g., water velocity, depths, inundation, exposure of habitats) of project operation on identified spawning areas for a range of conditions, over the complete period of spawning activity;
- Quantify spawning activity as measured by night-time spawning/splash surveys and egg collection in areas of spawning activity, and downstream of these areas, to further determine project operation effects (location extent of exposure from changing water levels and flows and on associated habitats from project operations).

If it is determined that the Project operations are adversely affecting the spawning activity of American shad and impacting spawning area habitat, identify operational regimes that will reduce and minimize impacts spawning habitat and spawning success, within the project area. This study will require two years of field data to capture inter-annual variability to river discharge and water temperatures and to allow for evaluation of alternative flow regimes if year one studies determine that the present peaking regime negatively affects spawning.

Resource Management Goals

The Connecticut River Atlantic Salmon Commission developed A *Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following:

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.

2. Achieve annual passage of 40% to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem.

The Atlantic States Marine Fisheries Commission, Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010 includes the following objective:

2. Maximize the number of juvenile recruits emigrating from freshwater stock complexes

and recommendations:

3. To mitigate hydrological changes from dams, consider operational changes such as turbine venting, aerating reservoirs upstream of hydroelectric plants, aerating flows downstream, and adjusting in-stream flows.
4. Natural river discharge should be taken into account when instream flow alterations are being made to a river (flow regulation) because river flow plays an important role in the migration of diadromous fish.
5. Ensure that decisions on river flow allocation (e.g., irrigation, evaporative loss, out of basin water transport, hydroelectric operations) take into account instream flow needs for American shad migration, spawning, and nursery use, and minimize deviation from natural flow regimes.
6. When considering options for restoring alosine habitat, include study of impacts and possible alteration of dam-related operations to enhance river habitat.

The Town of Gill supports the Fish and Wildlife Service's efforts to seek the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to American shad, the Service's goals are:

1. Minimize current and potential negative project operation effects on American shad spawning and recruitment.

The study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), Silvio O. Conte National Fish and Wildlife Refuge Act (P.L. 102-212; H.R. 794),The Federal Power Act (16 U.S.C. §791a, *et seq*.), The Atlantic States Marine Fisheries Compact (P.L. 539, 77th Congress, as amended by P.L. 721, 81st Congress), and the Atlantic Coastal Fisheries Cooperative Management Act (16 U.S.C. 5107)

Public Interest Considerations if Requester is not a Resource Agency

The Town of Gill in the Commonwealth of Massachusetts operates with an Open Town Meeting form of government where any voter is permitted to attend and vote on legislative matters: budgets, bylaws, zoning, etc. The executive authority in the Town is performed by an elected 3-member Board of Selectmen that oversees all aspects of managing town services.

Gill is a member of the Franklin Regional Council of Governments (FRCOG) and has members on FRCOG's Ad Hoc committee, the Connecticut River Streambank Erosion Committee (CRSEC). The CRSEC was convened in 1994 to bring together the Northfield Mountain Pumped Storage Project operator, state and municipal entities, landowners, and NGO's to carry out bioengineering projects to stabilize and repair areas of bank erosion.

The Town of Gill is taking this opportunity to be actively engaged in the process of relicensing the Turners Falls Dam and Northfield Mountain Pumped Storage Projects. The Town boundaries include over twelve miles of shoreline on the Connecticut River. Through its appointed Conservation Commission, the Town has an important regulatory role in accordance with the Massachusetts Wetlands and River Protection Acts.

Existing Information

Since the construction of the first fish lift facility at Holyoke Dam in 1967, American shad have had access to spawning and rearing habitat upstream from Holyoke Dam. A number of improvements to the Holyoke fishway have occurred since that time, but while the numbers of shad lifted at Holyoke have reached as much as 721,764 and the overall shad population to the river exceeded 1.6 million shad in 1992 (CRASC 1992), total shad population, and numbers of shad passing Turners Falls and Vernon Dam have not met CRASC management plan objectives. Population number and passage numbers past Holyoke have declined substantially from those totals in recent years, with average Holyoke passage numbers over the last 10 years of 211,850. Since historically approximately half of the returning population of shad to the river passed upstream of Holyoke, recent returns are far below management goals. Effective upstream and downstream passage and successful in-river spawning and juvenile production are necessary to help achieve shad management goals for the Connecticut River.

American shad broadcast spawn in congregations over shallow flats and rocky or sandy substrates (Davis et al, 1970, Mansuetti and Kolb 1953), at depths less than 10 feet and often far shallower with spawning fish swimming vigorously near the surface in a closely packed circle (Marcy 1972, Mackenzie et al 1985). Fertilized eggs drift downstream until hatching (Mackenzie et al 1985).

American shad are known to spawn downstream from the Turners Falls Project. Layzer (1974) identified 6 spawning sites from an area below the mouth of the Deerfield River (river mile 191.9) to river mile 161.7 below the Mill River in Hatfield, MA. Kuzmeskus (1977) verified 16 different spawning sites ranging from downstream of the Cabot tailrace to just upstream of the Holyoke dam (river mile 87.1). The only parameter that all spawning sites had in common was current (Kuzmeskus 1977). The Service is not aware of any more recent studies that document whether these 16 sites are still viable spawning locations for shad. We are not aware of any studies that have determined American shad spawning habitat or spawning sites upstream of Vernon Dam to Bellows Fall Dam (historic extent of upstream range).

First Light Power conducted studies in the late spring and summer of 2012, examined habitat conditions downstream of the Turners Falls Dam. The study documented that in low flow conditions, Cabot Station project operations produced fluctuations in water level elevations that can range over 4 feet in magnitude (daily operation) at the USGS Montague Gage Station, to lower values of 2 to 3 feet at the Route 116 Bridge, Sunderland, MA (PAD). Similar short-term, limited monitoring in the upper Turners Falls Dam impoundment identified water level changes due to project operations that d cyclically varied several feet on a sub-daily frequency.

Nexus to Project Operations and Effects

American shad are known to spawn at five locations downstream from the Turners Falls Project from an area below the mouth of the Deerfield River (river mile 191.9) and ten other locations downstream to river mile 161.7 below the Mill River in Hatfield (Layzer 1974, Kuzmeskus 1977).

Shad spawning is likely influenced by river flow, which fluctuates greatly due to the project's peaking mode of operation. These fluctuations may impact shad spawning activity by altering current velocities and water depth at the spawning sites. Effects on spawning behavior could include suspension of spawning activity, poor fertilization, flushing of eggs into unsuitable habitat due to higher peaking discharges, eggs dropping out into unsuitable substrate and being covered by sediment deposition and/or eggs becoming stranded on dewatered shoal areas as peak flows subside.

While a number of shad spawning and egg deposition studies were conducted in the 1970s, that research was aimed at assessing the potential impact of developing a nuclear power station in the Montague Plains section of the Connecticut River. The Service is not aware of any studies being conducted specifically designed to determine if a relationship between spawning behavior, habitat use, and egg deposition and project operations effects of the Turners Falls, Northfield Mountain Pump Storage and Vernon projects and downstream of Bellows Falls Dam..

Fish and Wildlife, supported by the Town of Gill, is concerned that peaking operations may be altering spawning behavior and contributing to the failure of the Connecticut River shad population to meet management targets.

Methodology

The first year of study should examine known spawning areas downstream of the Turners Falls Dam project, to determine operation effects on shad spawning behavior, activity, and success. In areas upstream of Turners Falls Dam to the Bellow Falls Dam tailrace, the study should identify areas utilized for spawning by American shad. In the second year, should results from year one determine project operations affected spawning activity, access to habitat, or success, downstream of Turners Falls Dam, then an identical more detailed assessment (identified objectives) should be conducted in spawning areas upstream of Turners Falls Dam to the Bellows Falls Dam tailwater. Measures to reduce or eliminate any documented project operation impacts should be explored and evaluated in year two, downstream of Turners Falls Dam.

The impacts to spawning behavior would best be studied by night-time observations of actual in-river spawning behavior (Ross et al. 1993). Project discharge increases or decreases during actual observed spawning activity will provide empirical evidence of change in behaviors. The observational methodology should follow the protocol specified in Layzer (1974) and/or as described in Ross et al. (1993). The analysis should utilize the observational field data in conjunction with operational data from the projects (station generation and spill on a sub-hourly basis). To assess the impacts of changes in generation flows, the study should include scheduled changes in project operation to ensure that routine generation changes that occur during the nighttime spawning period affect downstream spawning habitats selected for study while shad are spawning. Stier and Crance (1985) provide optimal water velocities during spawning to range between 1 to 3 ft/sec.

In areas used for spawning, the characteristics of those areas (e.g., location, depth, flow, substrate) should be recorded. The effect of project operations (discharge, water velocity, inundation and exposure) should be assessed. Drift nets will be used to collect eggs to quantify egg production before and after flow changes at the spawning site.

In the reaches above the Turners Falls dam, night time observations of splashing associated with shad spawning should be done in each reach as sufficient numbers of shad are passed above each dam. Observations should be done regularly until the end of the spawning season. The use of radio-tagged adult shad from a separate Study Request will aid in this effort. An estimate of the total area used for spawning and an index of spawning activity should be recorded for each site.

Level of Effort/Cost, and Why Alternative Studies will not suffice

Neither First Light nor TransCanada propose any studies to meet this need. Estimated cost for the study is expected to be moderate (up to $40,000) for each owner, with the majority of costs associated with fieldwork labor.

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Stier, D. J. and J. H. Crance. 1985. Habitat suitability index models and instream flow suitability curves: American shad. U. S. Fish and Wildlife Service Biological Report No. 82(10.88), Washington, D.C.

Study Request 10. Impacts of the Turners Falls and Northfield Mountain Pumped Storage Project Operations on Tributary and Backwater Area Access and Habitats

Goals and Objectives

One goal of this study is to determine if water level fluctuations from the Turners Falls and Northfield Mountain Pumped Storage projects result in a barrier(s) to fish movement in and out of tributaries and backwaters to the impoundments and riverine reaches below dams.

A second goal is to determine if water level fluctuations in the Turners Falls and Northfield Mountain Pumped Storage project impoundments impact water levels, available fish habitat and water quality in tributaries and backwaters to the impoundments and riverine reaches below dams, and if impacts are found, to ascertain how spatially far reaching they are and develop mitigation measures.

Results of this study may also be used to help determine the adequacy of existing downstream minimum flow requirements.

Specific objectives include:
1) Conduct a field study of tributaries and backwaters, including water velocity and habitat data where appropriate, to evaluate potential impacts of impoundment fluctuation on fish access to tributaries and backwater areas. The study should also evaluate if changes in impoundment fluctuation range would mitigate for any identified impacts and if other mitigative measures would improve access.

2) Conduct a field study to examine potential impacts of impoundment fluctuations on water levels, available habitat and water quality in tributaries and backwaters. The evaluation should also evaluate if changes in impoundment fluctuation range would mitigate for identified impacts and if other mitigative measures would lessen these impacts.

Resource Management Goals

This requested study will help promote tributary and backwater access and protect valuable fish habitat and maintain appropriate water quality conditions for diadromous and riverine fish species in project-affected areas. Maintaining connectivity between the mainstem of the Connecticut River and tributaries and backwaters is vital to the fish populations in these systems, as many fish species utilize these areas for spawning, rearing, refuge, and feeding.

Public Interest Considerations if Requester is not a Resource Agency

The Town of Gill in the Commonwealth of Massachusetts operates with an Open Town Meeting form of government where any voter is permitted to attend and vote on legislative matters: budgets, bylaws, zoning, etc. The executive authority in the Town is performed by an elected 3-member Board of Selectmen that oversees all aspects of managing town services.

Gill is a member of the Franklin Regional Council of Governments (FRCOG) and has members on FRCOG's Ad Hoc committee, the Connecticut River Streambank Erosion Committee (CRSEC). The CRSEC was convened in 1994 to bring together the Northfield Mountain Pumped Storage Project operator, state and municipal entities, landowners, and NGO's to carry out bioengineering projects to stabilize and repair areas of bank erosion.

The Town of Gill is taking this opportunity to be actively engaged in the process of relicensing the Turners Falls Dam and Northfield Mountain Pumped Storage Projects. The Town boundaries include over twelve miles of shoreline on the Connecticut River. Through its appointed Conservation Commission, the Town has an important regulatory role in accordance with the Massachusetts Wetlands and River Protection Acts.

Existing Information

To our knowledge, limited information exists related to this requested study.

Nexus to Project Operations and Effects

Project operations have the potential to impact fish species life history requirements, biological interactions, and habitat quantity and quality. For example, water level changes due to project operations could create conditions that could impede free movement of fish between tributaries/backwaters and the mainstem of the Connecticut River, thus limiting access to spawning habitat and/or growth opportunities. Additionally, water level changes could also alter tributary and backwater fish habitat quality, quantity, and also water quality, thus decreasing productivity and available habitat.

Methodology Consistent with Accepted Practice

Common tools to evaluate water level impacts would be used including: bathymetric mapping, substrate, depth and velocity measurements, and water quality information (dissolved oxygen, temperature, turbidity, and pH). Studies should be conducted throughout the year.

The study area for tributary and backwater fish sampling should cover all tributaries and backwaters within the project-affected areas of the Turners Falls and Northfield Mountain Pumped Storage projects. A second year of study may be required if first year data collection is limited due to environmental or other conditions, or if river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period.

Level of Effort/Cost, and Why Alternative Studies will not suffice

First Light does not propose any studies to meet this need. Estimated cost for the study is moderate.

Study Request 11. Determine the Fish Assemblage in the Turners Falls and Northfield Mountain Pumped Storage Project-Affected Areas

Goals and Objectives

The goal of this request is to determine the occurrence, distribution, and relative abundance of fish species present in the Project affected areas of the Turners Falls and Northfield Mountain Project Areas, which potentially includes Species of Greatest Conservation Need (SGCN) for Massachusetts, New Hampshire, and Vermont.

Specific objectives include:
1) Document fish species occurrence, distribution and abundance within the project affected area along spatial and temporal gradients.

2) Compare historical records of fish species occurrence in the project affected area to results of this study.

Resource Management Goals
The Massachusetts Division of Fisheries and Wildlife, New Hampshire Fish and Game Department and the Vermont Fish and Wildlife Department each have as a mission the protection and conservation of fish and their habitats. The Town of Gill supports these organizations in these efforts. Riverine fish species are an important component of the river's ecology and are the basis for the sport fishery. Furthermore, several of the states' SGCN have been documented in the project-affected area.

Determining species occurrence, distribution, and abundance will better clarify what species occur in the project area both spatially and temporally, relative to habitats which may be affected by project operations of the Turners Falls or Northfield Mountain Pump Storage projects. This information will better inform other results from other study requests that will be examining project operation effects on various aquatic habitats, water quality and other related concerns such as entrainment concerns at NFMPS. This information will be used to make recommendations and provide full consideration for all species, including those that might not otherwise be known to occur in the project-affected area and impacts that may affect their population status through direct or indirect effects of the projects.

Public Interest Considerations if Requester is not a Resource Agency

The Town of Gill in the Commonwealth of Massachusetts operates with an Open Town Meeting form of government where any voter is permitted to attend and vote on legislative matters: budgets, bylaws, zoning, etc. The executive authority in the Town is performed by an elected 3-member Board of Selectmen that oversees all aspects of managing town services.

Gill is a member of the Franklin Regional Council of Governments (FRCOG) and has members on FRCOG's Ad Hoc committee, the Connecticut River Streambank

Erosion Committee (CRSEC). The CRSEC was convened in 1994 to bring together the Northfield Mountain Pumped Storage Project operator, state and municipal entities, landowners, and NGO's to carry out bioengineering projects to stabilize and repair areas of bank erosion.

The Town of Gill is taking this opportunity to be actively engaged in the process of relicensing the Turners Falls Dam and Northfield Mountain Pumped Storage Projects. The Town boundaries include over twelve miles of shoreline on the Connecticut River. Through its appointed Conservation Commission, the Town has an important regulatory role in accordance with the Massachusetts Wetlands and River Protection Acts.

Existing Information

A thorough and comprehensive assessment of the fish assemblage present in the project-affected areas of the Turners Falls and NFMPS projects is lacking. The PAD for these projects sites notes resident fish surveys conducted by the State of Massachusetts in the early to mid 1970s and a limited 2008 sampling effort by Midwest Biodiversity Inst. (contracted by EPA). The PAD identifies a total of 22 fish species in the project area which omits, as an example of its limited information basis, northern pike, tessellated darter, burbot, eastern silvery minnow, and channel catfish (Ken Sprankle, USFWS, and Jessie Leddick, MADFW, personal communication). It is unknown how many other species may inhabit or utilize aquatic habitats in the projects area, potentially including species of greatest conservation need.

The most relevant recent fish survey study related to the project affected areas is a Connecticut River electrofishing survey conducted in 2008 (Yoder et al., 2009). While some sampling was conducted in both project areas during the 2008 survey, this survey did not have the same goals and objectives as those outlined above. Due to the design of the study limitations in geographic/habitat type coverage both spatially and temporally, and the use of a single gear type, limits the use of these data and that synthesized data may not be a full representation of species occurrence in the project affected areas. It follows that since information is limited regarding the composition of the fish community and their use of habitats in the project-affected area, project impacts on fish species are also unknown.

Nexus to Project Operations and Effects

Project operations have the potential to directly impact fish species life history requirements, biological interactions, and habitat quantity and quality. For example, headpond and tailwater water level fluctuations could dewater important spawning areas, or affect habitat availability, thus limiting productivity of fish species by direct impacts to their spawning success or indirectly by limiting the spawning success of forage fish species. Accordingly, a thorough understanding of the current fish assemblage structure and associated metrics are needed in order to examine any potential project-related impacts.

Methodology Consistent with Accepted Practice

An accepted and robust field sampling design (e.g., as described in Pollock et al. 2002 or MacKenzie et al. 2006) and accepted methods for collecting fish species likely to be present in the project-affected areas (Bonar et al. 2009) should be used to conduct field surveys. Randomly sampling multiple habitat types using a multi-gear approach will be required to ensure that all fish species present are sampled. The spatial scope of the study will be from the headwaters of the Turners Falls pool downstream to Sunderland, Massachusetts, and will omit the upper reservoir of Northfield Mountain Pump Storage Project. Sampling should occur at each selected site across multiple seasons (spring, summer, and fall). Digital photographs should be taken to avoid misidentification of certain species such as Cyprinids.

The sampling design should include replicate samples for estimation of species detection probability. Sample replicates may be gathered temporally, using different methods, by independent observers, or by randomly sampled spatial replicates (MacKenzie et al. 2006). For each replicate sample, data that may be important for describing variation in species occurrence and presence/absence should be collected and recorded, such as gear type, mesohabitat type, depth, velocity, flow, water temperature, substrate, time of day, day of year, presence of cover, proportion of vegetation cover, size of individuals collected (juveniles may select different habitat), and/or other factors as determined by a qualified biologist. Species detection, occurrence, and/or abundance and related habitat measures on these parameters should be estimated using methods as described by Kery et al. (2005), MacKenzie et al. (2006), Wenger and Freeman (2008), or Zipkin et al. (2010).

This will be a one year study provided river discharge conditions fall within 25th to 75th percentile for weekly averages. Based upon this study's results, and the additional information obtained on requests to survey aquatic habitats and littoral zone fish spawning, an additional study may be required if evidence of project operation affects on population status or habitat for identified species.

Level of Effort/Cost, and Why Alternative Studies will not suffice
The cost of the study will be moderate to high as seasonal sampling with several types of gear will be required. However, cost will also be partially dependent on the number of sites sampled, the number of sample replicates, and the extent of the covariate data that are measured, all which may be flexible. Based on first year study results, a second year of sampling or specific studies examining impacts of project operations on specific fish species may be needed and requested. Provided the collected data are of high quality, analysis and synthesis should take approximately 10-20 days. FirstLight did not propose any studies specifically addressing this issue.

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Study Request 12. Impacts of the Turners Falls and Northfield Mountain Pump Storage Projects Fish Spawning and Spawning Habitat

Goals and Objectives

The goal of this study is to determine if project operations and water level fluctuations in the Turners Falls Project impoundment negatively impact anadromous and resident fish species including but not limited, to sea lamprey, white sucker, fall fish, smallmouth bass, yellow perch, spottail shiners, bluegill, black crappie, chain pickerel, northern pike, common sunfish, and walleye, and if impacts are found to occur, to develop appropriate mitigation measures. This study complements a separate study requests specific to American shad spawning and also on habitats affected by water level manipulations. An additional instream flow study request will address fish habitat effects for species of concern downstream of the Turners Falls Dam.

Specific objectives include:

1) Conduct field studies in the main stem, tributaries and backwaters of project affected areas to assess timing and location of fish spawning.

2) Conduct field studies in the main stem, tributaries and backwaters of project affected areas to evaluate potential impacts of impoundment fluctuation on nest abandonment, spawning fish displacement and egg dewatering. The study should also evaluate if changes in impoundment fluctuation range would mitigate for identified impacts and if other mitigative measures would lessen these impacts.

A second year of study may be required should river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period (end of March through mid July). Similarly, water temperatures should be closely considered, to ensure representative conditions occurred to reduce bias in observations.

Resource Management Goals

The Town of Gill supports the US Fish and Wildlife Services' (Service) goals in this area. The Service has identified its mission as: working with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people. The Service has identified the following Northeast Regional goals to support the Service's mission and vision, the national Fisheries Program mission, and Service priorities: 1) Conservation, and management of aquatic species: Maintain, restore, and recover populations of species of conservation and management concern to self-sustaining levels; 2) Conservation and management of aquatic ecosystems: Maintain and restore the ecological composition, structure, and function of natural and modified ecosystems to ensure the long-term sustainability of populations of species of conservation and management concern.

A mission of both the New Hampshire Fish and Game Department and the Massachusetts Division of Fisheries and Wildlife is to protect and conserve fish and their habitats. Resident fish species are an important component of the river's ecology and in some cases are the basis for a sport fishery. This requested study will help protect and conserve resident fish species by ensuring Project operations do not negatively impact their spawning success and spawning habitats.

Public Interest considerations if requester is not a resource agency
The Town of Gill in the Commonwealth of Massachusetts operates with an Open Town Meeting form of government where any voter is permitted to attend and vote on legislative matters: budgets, bylaws, zoning, etc. The executive authority in the Town is performed by an elected 3-member Board of Selectmen that oversees all aspects of managing town services.

Gill is a member of the Franklin Regional Council of Governments (FRCOG) and has members on FRCOG's Ad Hoc committee, the Connecticut River Streambank Erosion Committee (CRSEC). The CRSEC was convened in 1994 to bring together the Northfield Mountain Pumped Storage Project operator, state and municipal entities, landowners, and NGO's to carry out bioengineering projects to stabilize and repair areas of bank erosion.

The Town of Gill is taking this opportunity to be actively engaged in the process of relicensing the Turners Falls Dam and Northfield Mountain Pumped Storage Projects. The Town boundaries include over twelve miles of shoreline on the Connecticut River. Through its appointed Conservation Commission, the Town has an important regulatory role in accordance with the Massachusetts Wetlands and River Protection Acts.

Existing Information
To the Town's knowledge, no information exists related to this requested study. The Massachusetts Integrated List of Waters shows the Project Area from the VT/NH state line to the Turners Falls Dam impaired due to "other flow regime alterations."

Nexus to Project Operations and Effects
Project operations have the potential to impact fish species by influencing spawning success and spawning habitat quality and quantity. For example, water level changes due to Project operations could create conditions where fish eggs are exposed to air, where spawning habitat is dewatered, and/or where fish abandon nests containing eggs.

Methodology Consistent with Accepted Practice
Common tools to evaluate fish spawning would be used including visual observations of habitats and sampled fish (i.e., in spawning condition, coloration, gonads mature, and other external features that become developed with spawning) collected by gears such as electrofishing, seining and other net gears during defined environmental and or time windows for spawning activity. Project operation impacted areas, should be quantified to identify and define areas subject to dewatering and mapped relative to observations of fish nests, spawning fish, egg deposits. During identified spawning periods for these species, suitable spawning habitats subjected to daily project operational fluctuations will be surveyed to document the type and extent of project effects on nests or spawning habitat (fall fish nests, lamprey nests, bass and sunfish nests, white sucker eggs/larvae) and observable eggs or larvae, relative to water level and other environmental condition, including water temperature and water velocity in noted areas.

Level of Effort/Cost, and Why Alternative Studies will not suffice

FirstLight Power does not propose any studies to meet this need. Estimated cost for the study is moderate.

Study Request 13. Impact of Project Operations on Downstream Migration of Juvenile American Shad

Conduct a field study of juvenile American shad outmigration in the Turners Falls impoundment and the power canal and at Turners Falls Dam,t, Station #1, and Cabot Station to determine if project operations negatively impact juvenile American shad survival and production.

Goals and Objectives

Determine if project operations affect juvenile American shad outmigration survival, recruitment, and production. The following objectives will address this request:

- Assess project operations effects of NMPS and Turners Falls Dam on the timing, orientation, routes, migration rates, and survival of juvenile shad;
- Determine the proportion of juvenile shad that select the Gatehouse into the power canal versus the dam spill gates as a downstream passage route, under varied operational conditions, including a range of spill conditions up to full spill;
- Determine if there are any delays with downstream movement related to either spill via dam gates or through the Gatehouse and within the impoundment due to operations (i.e., NMPS pumping and generation);
- Determine survival rates for juvenile spilled over/through dam gates, under varied operation conditions, including up to full spill during the annual fall power canal outage period;
- Determine the juvenile downstream passage timing and route selection in the power canal to: Station 1; Cabot Station; and the Cabot Station log sluice bypass, and assess delays associated with each of these locations and with project operations (e.g., stockpiling in the canal);
- Based upon year 1 study results on route selection, determine the survival rate for juvenile shad entrained into Station 1; and
- Determine the survival rates for juvenile shad entrained into Cabot Station units;

If it is determined that the Project operations are adversely affecting juvenile shad survival, migration timing, or other deleterious population effects , identify operational solutions or other passage measures that will reduce and minimize these impacts within the project area. This study will require two years of field data to capture inter-annual variability of river discharge, water temperatures, and variability in the timing and abundance of juvenile production and their outmigration timing, which may relate to spring, summer, and fall conditions. This study will compliment the NMPS Fish Entrainment Study Request which includes assessment of impacts to juvenile shad.

Resource Management Goals

The Connecticut River Atlantic Salmon Commission developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following:

3. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the

Connecticut River annually.

4. Maximize outmigrant survival for juvenile and spent adult shad.

The Atlantic States Marine Fisheries Commission *Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management*), approved in 2010 includes the following objective:

1. Maximize the number of juvenile recruits emigrating from freshwater stock complexes.

and Recommendation:

1. To enhance survival at dams during emigration, evaluate survival of post spawning and juvenile fish passed via each route (e.g., turbines, spillage, bypass facilities, or a combination of the three) at any given facility, and implement measures to pass fish via the route with the best survival rate.

The Town of Gill supports the Service in its effort to seek the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

3. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
4. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to American shad, the Service's goals are:

2. Minimize current and potential negative project operation effects on juvenile American shad survival, production, and recruitment.

The study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), Silvio O. Conte National Fish and Wildlife Refuge Act (P.L. 102-212; H.R. 794), the Federal Power Act (16 U.S.C. §791a, *et seq*.), the Atlantic States Marine Fisheries Compact (P.L. 539, 77th Congress, as amended by P.L. 721, 81st Congress), and the Atlantic Coastal Fisheries Cooperative Management Act (16 U.S.C. 5107).

Public Interest Considerations if Requester is not a Resource Agency

The Town of Gill in the Commonwealth of Massachusetts operates with an Open Town Meeting form of government where any voter is permitted to attend and vote on legislative matters: budgets, bylaws, zoning, etc. The executive authority in the Town is performed by an elected 3-member Board of Selectmen that oversees all aspects of managing town services.

Gill is a member of the Franklin Regional Council of Governments (FRCOG) and has members on FRCOG's Ad Hoc committee, the Connecticut River Streambank Erosion Committee (CRSEC). The CRSEC was convened in 1994 to bring together the Northfield Mountain Pumped Storage Project operator, state and municipal entities, landowners, and NGO's to carry out bioengineering projects to stabilize and repair areas of bank erosion.

The Town of Gill is taking this opportunity to be actively engaged in the process of relicensing the Turners Falls Dam and Northfield Mountain Pumped Storage Projects. The Town boundaries include over twelve miles of shoreline on the Connecticut River. Through its appointed Conservation Commission, the Town has an important regulatory role in accordance with the Massachusetts Wetlands and River Protection Acts.

Existing Information

Since the construction of the Turners Falls Dam upstream fishways in 1980, American shad have had access to spawning and rearing habitat upstream of Turners Dam. A number of modifications to the Turners Falls fishways have occurred since that time, with the numbers of adult shad passed at Gatehouse Ladder (into Turners Falls Dam impoundment) reaching as much 60,089 in 1992 when a record 721,764 shad passed upstream of Holyoke Dam. However, since 1980 an average of only 3.6 % of the adult shad passed upstream of Holyoke Dam subsequently have passed upstream of Turners Falls Dam, and this value has never exceeded 11%. This value is well below the CRASC 1992 Shad Plan objective of 40-60% passage from the previous dam. In addition, population number and passage numbers past Holyoke have declined substantially, with the average Holyoke passage number over the last 10 years being 211,850. Because historic data suggests that approximately half the returning adult shad to the Connecticut River pass the Holyoke Dam, recent adult returns are far below management goals. Effective upstream and downstream passage and successful in-river spawning and juvenile production are necessary to help achieve shad management restoration goals for the Connecticut River, which extends to the Bellows Falls Dam. In 1990, FirstLight's predecessor, Northeast Utilities, CRASC and its member agencies, signed an MOA on downstream fish passage to address both juvenile and adults at the Turners Falls Project and Northfield Mountain Pumped Storage Project.

American shad broadcast spawn with the highest spawning activity occurring in runs and lowest activity in pools and riffle/pools (Ross et al. 1993). Field research by Ross et al. (1993) in the Delaware River further noted that a combination of physical characteristics that seems to be avoided by spawning adults is slow current and greater depth. American shad year-class strength has been shown to depend on parent stock size and environmental conditions during the larval life stages (Creeco and Savoy 1984). Delays in juvenile American shad outmigration may affect survival rates in the transition to the marine environment (Zydlewski et al. 2003). One published study on the Connecticut River, identified that juvenile shad outmigration began when declining autumn temperatures reached 19C and peaked at 16C (O'Leary and Kynard 1986).

Juvenile American shad production has been monitored upstream of the Vernon Dam and immediately downstream of that dam by Vermont Yankee Nuclear as part of an annual monitoring program using both boat electrofishing (since 1991) and beach seining (since 2000). Sampling of juvenile shad was also conducted by a contractor hired by Northeast Utilities in the Turners Falls impoundment in 1992. O'Donnell and Letcher (2008) examined juvenile shad early life history and migration upstream and downstream of Turners Falls Dam. Their study results led to the decision by the agencies to require earlier operation of downstream fishways to protect early season juvenile shad out-migrants (1 September prior to 2010, 15 August in 2010, and since 2011, 1 August).

Downstream juvenile clupeid passage studies at Turners Falls were conducted in the fall of 1991 which included the objectives of determining the percentage of juvenile shad and herring that pass via the bypass log sluice or that were entrained in the Cabot Station turbines and related data (e.g., catch rates) were compared. The 1991 Downstream Clupeid Study did not assess survival rates for juveniles for either of these passage routes. The 1991 study report documented a higher rate entrainment into the project turbines (23.0 fish per minute) versus through the bypass sluice (11.6 fish per minute). It was concluded that only an estimated 54% (average bypass rate, weighted by estimated number bypassed) of the juvenile American shad approaching Cabot Station were bypassed via the log sluice. The range of the percent bypassed varied widely by date, between nearly 0 and 83%, with 'no clear explanation as to why." The report did not identify the percentage entrained into the turbines but it can be reasoned to be substantial based on the data presented in the report or assumed as the remaining balance (46%). as there were no spill events reported during this study, and therefore nowhere else for them to pass. It was further noted that entrainment rates for juveniles were consistently greatest for units 1 and 6 (ends), not uniform across all units. Although no concurrent bypass sampling occurred during the first entrainment sampling events, it was noted that "entrainment rates were relatively high during the end of September." Additional modifications have occurred over time without quantitative evaluation to improve downstream passage attraction and use to the bypass sluice, including lighting systems.

The 1994 Downstream Juvenile Shad Study report assessed juvenile shad survival from passage via the log sluice, reported to be 98%, based on tagged and recaptured fish (held for up to 48 hours). Scale loss (<20%) (22 of treatment fish) compared with scale loss of >20% (5 of treatment fish) was examined and determined to occur in an overall total of 10% of study fish (adjusted by control fish data).

Nexus to Project Operations and Effects
Adult American shad passed upstream of Turners Falls Dam utilize upstream spawning habitat. Juvenile American shad production occurs in these habitats upstream of Turners Falls Dam on an annual basis. Juvenile American shad require safe and timely downstream passage measures to have the opportunity to contribute to the fishery agencies' target restoration population size.

The Town is not aware of any studies being conducted specifically designed to determine:

- When spill gates are open at the Turners Falls Dam?
- What proportion of juvenile out-migrant shad take that route of passage?
- What is the rate of survival under a range of spill and gate configurations?
- What is the timing, duration, and magnitude of juvenile shad outmigrants in summer and fall to the Turners Falls Dam and Gatehouse?
- Are there delays in migration/movement at the dam, Gatehouse, Cabot Station, or Station 1?
- For juveniles that enter the power canal, what proportion subsequently enter the Station 1 power canal?
- As there are no downstream passage facilities at Station #1, and trash rack spacing is 2.6 inches, what is the survival rate of juvenile shad entrained at Station #1?
- What is the rate of movement through the Turners Power Canal, relative to r delay to outmigrant juvenile shad and the potential accumulation of juveniles (e.g., prior to the canal drawdown in September)?
- What proportion of juvenile shad use the downstream sluice bypass versus the Cabot Station turbines under varied operational conditions given that project operations may change (PAD notes possible increase in turbine capacity at Cabot)?
- Based upon earlier facility studies (1991 Downstream Clupeid) a large proportion and number of juvenile shad are entrained into Cabot Station turbines. What are the associated impacts in terms of short-term and longer term survival and injury (i.e., scale loss)?

The Town is concerned that project operations may impact juvenile shad outmigration survival and be contributing to the failure of the Connecticut River shad population to meet management targets. In the PAD, proposed modification include; Station 1 may be upgraded with new turbines, Station 1 may be closed, and/or the turbine capacity at Cabot may be increased. It is unclear how these scenarios will affect the questions identified in this request.

Methodology Consistent with Accepted Practice

The impact to juvenile shad outmigrants by project operations would be best studied by a combination of approaches including hydroacoustic, radio telemetry, and turbine balloon tags. Project discharge over a full range of existing and, to the extent possible, potential future operational conditions at Station 1 and Cabot, at the dam (likely increased bypass reach flows in new license) and in relation to the Gatehouse, should be examined relative to timing, duration, and magnitude of juvenile shad migration to and through these areas, with hydroacoustic equipment for natural/wild fish evaluation. In addition, study fish should be collected and tagged (PIT, radio, other mark, balloon) to also empirically determine rates of survival for fish passed over or through the dam's gates, under varied operations, including up to full spill condition that occurs annually in fall with canal outage period. The understanding of the timing, magnitude, duration of the wild fish outmigration will help inform the design, data/results, and assessment of tagged study fish. The release of tagged or marked fish (radio, PIT) upstream of the Gatehouse induction into the power canal, will provide data on concerns of delay and route selection to Station 1, Cabot Station downstream bypass, Cabot Station spill gates, and Cabot Station turbines. Additional hydroacoustic assessment at Cabot Station forebay will provide information on wild/natural juvenile fish timing, magnitude, and duration to and through this area. Based upon Year 1 study findings relative to the frequency, magnitude, timing of juvenile American shad that end up in the forebay of Station 1, the determination of whether an entrainment survival study at that site is necessary will be made. Release sites for tagged fish will be determined based upon further consultation among the parties.

Radio tagged juvenile shad will be released in areas upstream of the NMPS facility at multiple release locations, to determine operation effects on migration rates, route, orientation, entrainment, and survival, over a full range of permitted and operational conditions.

Level of Effort/Cost, and Why Alternative Studies will not suffice

First Light does not propose any studies to meet this need. Estimated cost for the study is expected to be high, between $200,000 and $300,000, with the majority of costs associated with equipment (hydroacoustic gear, radio tags, radio receivers, and PIT readers) and related fieldwork labor.

Literature Cited:

Atlantic States Marine Fisheries Commission. 2010. Amendment #3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management). Washington, D.C.

Crecco, V. A. and T. F. Savoy. 1984. Effects of fluctuations in hydrographic conditions on year- class strength of American shad (Alosa sapidissima) in the Connecticut River. Canadian Jounral of Fisheries and Aquatic Sciences 41: 1216-1223.

Layzer, J.B. 1974. Spawning Sites and Behavior of American Shad, *Alosa sapidissima* (Wilson), in the Connecticut River Between Holyoke and Turners Falls, Massachusetts, 1972. Master of Science Thesis. University of Massachusetts, Amherst, Massachusetts. Pp. 22- 32.

O'Donnell, M and B. H. Letcher. 2008. Size and age distributions of juvenile Connecticut River American shad above Hadley Falls: influence on outmigration representation and timing. River Research Applications #24: 929-940.

O'Leary, J. A. and B. Kynard. 1986. Behavior, length, and sex ration of seaward-migrating juvenile American shad and blueback herring in the Connecticut River. Transactions of the American Fisheries Society 115: 529-536

Ross, R. M., T. W. Backman, and R. M. Bennett. 1993. Evaluation of habitat suitability index models for riverine life stages of American shad, with proposed models for premigratory juveniles. Biological Report 14. U. S. DOI, U. S. Fish and Wildlife Service. Washington, D.C.

Zydlewski, J., S. D. McCormick, and J. G. Kunkel. 2003. Late migration and seawater entry is physiological disadvantageous for American shad juveniles. Journal of Fish Biology #63, 1521-1537.

Study Request 14. Entrainment of Migratory and Riverine Fish from the Connecticut River into the Northfield Mountain Pump Storage Project.

Goals and Objectives

The goal of the study is to determine the impact of Northfield Mountain Pump Storage Project (NFMPS) during the pumping cycle on entrainment of juvenile American shad, adult shad, adult American eel, and riverine fish, including early life stages.

The objective of the study is to quantify the number of resident and migratory fishes entrained at the NFMPS intake on an annual basis in order to evaluate potential impacts to riverine fish populations in the Turners Falls pool and diadormous fish migrants moving through the project area. This will be accomplished through a combination of hydroacoustic monitoring and netting using various gear types to quantify and identify species of different life stages.

Resource Management Goals

The Connecticut River Atlantic Salmon Commission (CRASC) developed A *Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following

4. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually. (Table 1)

5. Achieve annual passage of 40 to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem.

6. Maximize outmigrant survival for juvenile and spent adult shad.

Based on the CRASC plan, the Town of Gill supports the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

3. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.

4. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

The Atlantic States Marine Fisheries Commission has developed two documents related to the management of American eel:

1. Interstate Fishery Management Plan for American Eel. April 2000. Atlantic States Marine Fisheries Commission.
2. Addendum II to the Fishery Management Plan for American Eel. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

Objectives of the management plan include: (1) protect and enhance American eel abundance in all watershed where eel now occur; and (2) where practical, restore American eel to those waters where they had historical abundance but may now be absent by providing access to inland waters for glass eel, elvers, and yellow eel and adequate escapement to the ocean for pre-spawning adult eel.

Addendum II contains specific recommendations for improving upstream and downstream passage of American eel, including requesting that member states and jurisdictions seek special consideration for American eel in the FERC relicensing process.

In addition, the Connecticut River Atlantic Salmon Commission (CRASC) developed A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin in 2005. The goal of the plan is "to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem…" Management objectives in the plan include the following:

1. Protect and enhance eel populations where they currently exist;
2. Where practical, restore populations to waters where they had historical abundance;
3. Provide effective upstream and downstream fish passage around dams and other barriers within the species' range in the basin; and
4. Comply with all requirements of the Fishery Management Plan of the ASMFC.

Specific to resident riverine and migratory fish entrainment, the goals of the study are:

2. Minimize current and potential negative project operation effects such as turbine entrainment that could hinder management goals and objectives.

3. Minimize project-related sources of mortality to resident and migratory fishes in order to restore natural food web interactions and ecosystem functions and values.

The study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), and the Federal Power Act (16 U.S.C. §791a, *et seq*.).

Public Interest Considerations if Requester is not a Resource Agency

The Town of Gill in the Commonwealth of Massachusetts operates with an Open Town Meeting form of government where any voter is permitted to attend and vote on legislative matters: budgets, bylaws, zoning, etc. The executive authority in the Town is performed by an elected 3-member Board of Selectmen that oversees all aspects of managing town services.

Gill is a member of the Franklin Regional Council of Governments (FRCOG) and has members on FRCOG's Ad Hoc committee, the Connecticut River Streambank Erosion Committee (CRSEC). The CRSEC was convened in 1994 to bring together the Northfield Mountain Pumped Storage Project operator, state and municipal entities, landowners, and NGO's to carry out bioengineering projects to stabilize and repair areas of bank erosion.

The Town of Gill is taking this opportunity to be actively engaged in the process of relicensing the Turners Falls Dam and Northfield Mountain Pumped Storage Projects. The Town boundaries include over twelve miles of shoreline on the Connecticut River. Through its appointed Conservation Commission, the Town has an important regulatory role in accordance with the Massachusetts Wetlands and River Protection Acts.

Existing Information

Limited project-specific information exists regarding entrainment of fish and aquatic organisms at the NFMPS. As part of a Memorandum of Agreement between then-owner Northeast Utilities Service Company (NUSCO) and regulatory agencies (including the Service), NUSCO conducted studies to determine the impact of NFMPS on anadromous fishes, including Atlantic salmon, American shad, and blueback herring. Results of a pilot study conducted in the fall of 1990 indicated that trap netting at the intake was ineffective at collecting fish. Gill netting and boat-shocking did result in collection of some juvenile shad, but further refinement in both methods was recommended to improve effectiveness. A total of 78 fish were collected at the intake (77 of which were American shad) by gill netting and 11 shad were collected by boat electrofishing. Hydoacoustic monitoring was deemed an effective method for monitoring entrained fish during pumpback operation. Hydroacoustic sampling over a two-week period (September 12-27, 1990) produced hourly entrainment estimates that cumulatively equaled 14,816 fish.

Based on the results of the pilot study, NUSCO developed a two-year plan to quantitatively determine the number of shad and salmon entrained at NFMPS station. In 1992, an entrainment study targeting juvenile American shad life stages was conducted in the lower (mainstem river) and upper reservoirs of NMPS. The study used several gear types to quantify egg through juvenile shad densities in different areas. Entrained juveniles were sampled using an upper reservoir net. Pumping operations were modified to only run three (77% of sample time) and sometimes two (23% of sample time) of the station's four units during the study and effort was limited to a total of 80 hours over a period spanning 9 August through 27 October (80 days). An estimated total of 1,175,900 shad eggs, 2,744,000 yolk-sac larvae, 10,525,600 post yolk-sac larvae, and 37,260 juveniles were reported entrained.

There are no reliable data on the timing, magnitude and duration of entrainment of larval riverine fishes in the NFMPS area. Unlike anadromous shad and river herring, riverine species occurrence and susceptibility relative to space and time exposure windows to NFMPS pumping, are undocumented. The complete lack of any long-term fish population monitoring data for riverine species in the Turners Falls impoundment leaves questions unanswered on the types and extent of impacts to these populations that may be linked to the near daily cycling of river water up and down through the NFMPS operations system. As a starting point, it is necessary to obtain baseline data on project operation impacts for all species potentially impacted by NFMPS. An additional study request seeks to obtain a more accurate documentation of all fish species inhabiting or utilizing the Turners Falls impoundment.

Nexus to Project Operations and Effects

Entrainment of fish and aquatic organisms associated with water withdrawal and hydroelectric operations has been documented to result in injury or death of entrained organisms. Migratory and resident fish pass through the project area directly in front of the pump intakes. These organisms may be entrained and thus exposed to passage though the project pumps and reservoir supply tubes. How far from the intake these species and life stages may be drawn into the intake on a pumping cycle or how susceptible they are to the repeated daily cycles of pumping and discharge, and how these factors vary in relation to habitat and river conditions are unknown. Survival of fish subjected to entrainment on the pumping cycle is unknown, but regardless of whether fish survive the pumping process, they are lost to the Connecticut River system. Depending on the species, life stages, and numbers entrained, this loss could impact the ecosystem productivity of the Turners Falls pool and may hinder restoration goals for diadromous fishes.

Previous entrainment studies have been conducted at the project. Those studies, which were done 20 years ago, documented entrainment of American shad and Atlantic salmon at the project, including over 13 million yolk sac and post-yolk sac larvae of American shad. This level of entrainment is cause for concern, not only due to the resultant loss of potential adult returns, but for the important role early life history phases and juveniles play in their ecological contributions to the river system (e.g., trophic interactions).

No entrainment studies for other species of fish have been conducted at the project. The unknown extent of other riverine species ichthyoplankton entrained by the NFMPS requires evaluation. Studies conducted in 1969 and 1970 at the Muddy Run Pumped Storage Station documented significant entrainment of eggs and larval fish. In June and July of 1970, 5.3 million eggs and 56.6 million larvae were entrained (Snyder 1975). Muddy Run and NFMPS are of a similar size and both use a river as the lower reservoir. It is anticipated that a considerable number of eggs and larvae will be entrained by the NFMPS.

Since the previous studies were conducted, operations at the NFMPS facility have changed (e.g., the project increased the efficiency of its turbines, and raised the pumping capacity from 12,000 cfs up to 15,000 cfs), as have river conditions (e.g., Vermont Yankee has increased its thermal discharge and the Vernon Project has increased its station capacity). Further, the PAD indicates that FirstLight will evaluate the feasibility of utilizing an additional 3,009 acre-feet of storage capacity to generate an additional 1,990 MWhs (this represents a 23% increase over existing storage and stored generation levels). While not specified in the PAD, increasing storage and generation would mean longer periods of both pumping and generation at NFMPS. In addition, anticipated improvements in fish passage at the Turners Falls Project will result in increased juvenile production above the NFMPS. These factors, individually or cumulatively, could increase the potential for entrainment at NFMPS station.

Methodology Consistent with Accepted Practice

Previous studies used varying methodologies for determining entrainment. The 1990 study concluded that hydroacoustic monitoring at the intake was a viable method for determining entrainment of later life stages, but does not allow for identification of the species being entrained. While trap netting was ineffective at collecting fish near the intake, gill netting and boat shocking did capture some fish. Both may prove to be viable sampling methods; however it is likely that additional testing and gear refinement will be necessary.

The 1992 study used nets at the pump discharge location into the upper reservoir to collect entrained fish. Testing showed that this method was only 10% efficient. Plankton netting in the nearfield area of intake was used to estimate entrainment of ichthyofauna. It is likely that a combination of methods would provide the most reliable results (e.g., hydroacoustic monitoring at the racks during pumpback operations, variable gear sampling in the vicinity of the intake immediately prior to initiation of pumpback operations to determine species composition, and plankton netting in the nearfield area of the intake to obtain information on entrainment of ichthyofauna). As these methodologies have previously been utilized at the site, they are consistent with accepted practice.

Although a previous entrainment study was conducted, it should be repeated, using a modified study design. The 1992 study only collected a total of 330 juvenile shad over a three-month period (resulting in an overall estimate of 37,260 juveniles entrained, after accounting for poor net efficiency); whereas the hydroacoustic study conducted in 1990 estimated nearly 15,000 fish in 15 days (while these fish were not identified, 77 of the 78 fish collected at the intake during the study were juvenile shad). It also should be noted that in the 1992 study, juvenile shad were collected on the first day of sampling, indicating that the sampling did not begin early enough, which would mean the results are an underestimate of the number of juvenile shad that were actually entrained. In 1990, 27,908 adult shad passed the Turners Falls gatehouse, while in 1992 over 60,000 shad passed gatehouse. The fact that the numbers entrained were so variable between study years argues for repeating the study, using a combination of previously-used methodologies.

The study will require deployment of at least five hydroacoustic transducers (one per rack face and one offshore). These transducers would be operated during every pumping cycle from April 15 through May 14 to assess riverine fish entrainment, from May 15 through July 15 for spent adult shad, and from July 16 through November 30 for entrainment of adult silver eels, juvenile American shad, and riverine fishes. Concurrent field sub-sampling at the intake to determine species composition would need to occur.

Sampling for planktonic fish larvae should capture early spring spawning species (white suckers) through later season centrarchid species (bass and sunfish). Active plankton trawl surveys should utilize a sampling design that adequately captures temporal and spatial changes in water pumping cycle (i.e., early start-up is local water, later cycle pumping is drawn in from both upstream and downstream habitat areas).

Level of Effort/Cost, and Why Alternative Studies will not suffice

We know of no other tool that will provide for this type of assessments for all fish species and organisms that may pass through the project. Cost and effort are expected to be high.

The applicant did not propose any studies to meet this need in the PAD.

References

CRASC. 1992. A Management Plan for American Shad in the Connecticut River.

Harza Engineering Company. 1991. Draft Northfield Mountain Pumped Storage Project 1990 Field Sampling Program. February 1991. Northeast Utilities Service Company, Berlin, CT.

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MassDEP
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Executive Office of Energy & Environmental Affairs

Department of Environmental Protection

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TIMOTHY P. MURRAY
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RICHARD K. SULLIVAN JR.
Secretary

KENNETH L. KIMMELL
Commissioner

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E., Room 1A
Washington, D.C. 20426

March 1, 2013

RE: Study Requests for FERC Hydroelectric Projects P-1889 Turners Falls and P-2485 Northfield Mt.

Dear Secretary Bose,

The Massachusetts Department of Environmental Protection (the Department) is the state resource agency responsible for issuing Section 401 Water Quality Certificates. The Department has reviewed the Preliminary Application Document (PAD) for the Turners Falls (P-1889) and Northfield Mountain (P-2485) Hydroelectric Projects prepared by FirstLight Power Resources and appreciates this opportunity to comment on this PAD and to request additional studies.

The Department has two comments to offer:

1. The MassDEP relies on the recommendations by the Massachusetts Division of Fisheries and Wildlife (the Division) regarding requirements needed to support the Connecticut River's designation as a habitat for fish, other aquatic life, and wildlife including for their reproduction, migration, growth and other critical functions. The Department concurs with the recommendations made by the Division to the Federal Energy Regulatory Commission.
2. The PAD needs to reference the Total Maximum Daily Load Analysis to Achieve Water Quality Standards for Dissolved Oxygen in Long Island Sound prepared by the New York State Department of Environmental Conservation and the Connecticut Department of Environmental Protection (December 2000). Nutrients associated with sediment transport contribute to low dissolved oxygen in Long Island Sound.

The Department requests two studies be conducted:

1. Sediment Transport Study. Results of the sediment transport study request should provide information sufficient to enable staff to understand current and proposed effects of water level fluctuations and the relation to sediment transport in the Connecticut River. Staff should be able to identify techniques that could be used to mitigate the effects of project operations or other mitigation techniques that could be developed to reduce sediment transport within the impoundment and downriver.
2. Water Quality Study. Results of water quality testing will provide a more complete understanding of the seasonal conditions occurring in this section of the river, useful from both a Water Quality Standards and fisheries perspective.

Thank you for this opportunity to comment.

Sincerely,

Robert Kubit, P.E.

FirstLight Study Request: Northfield Mountain/Turners Falls Operations Impact on Sediment Transport

Goals and Objectives

The goals of the study are twofold: (1) Assess management measures available to minimize sediment transport through the Turners Falls Canal and from the Upper Reservoir at Northfield Mountain during and after maintenance drawdowns; and (2) Conduct a focused investigation of bank instability in the Turners Falls Pool ("TFP") where given a causative relationship between the presence of fine grained soils susceptible to instability by anthropogenic fluctuation of pore water, and observed pool surface elevation changes from power generation unstable banks/slopes exist. The results of the study should provide information sufficient to enable staff to understand current and proposed effects on water level fluctuations, both natural and anthopogenic, and to identify sites where biostabilization techniques or other measures may be beneficial to water quality. The purpose of the study will be to focus attention and resources on that fraction of the banks within the Turners Falls Pool (TFP) which are scientifically established to be susceptible to repeated soil wetting and drying.

The specific objectives of the bank instability study are as follows:

a. Accurately map and scientifically describe that portion of the TFP where active or recent "bank" "erosion" is occurring (maybe as much as 18% of the "banks" in the Pool)---all terms should be precisely defined in any such study, and linked to jurisdictional definitions whenever possible;
b. Note any of the areas of active or recent "bank" "erosion" that have been the locus of prior bank stabilization and identify the method of stabilization implemented at that locus;
c. Within the mapped areas of active or recent "bank" "erosion", establish and designate fixed, recoverable transects;
d. Analyze soils (classification, structure, parent materials, texture, hydric regime, position on landscape, chemistry, and most importantly engineering dynamics such as susceptibility to slope failure) at each transect;
e. Along these same transects, collect cross-section data related to bathymetry and riverine hydrology, most especially as they relate to jurisdiction and water level fluctuation. MassDEP will want to know the precise elevation of the Ordinary High Water Mark, "normal pool elevation", "maximum pool elevation", "minimum pool elevation", maximum and minimum daily range elevations, and perhaps other critical elevations, such as 10- and 100-year floodplain elevations. MassDEP will also need to understand subsurface hydrology at each transect, but above OHWM, in order to account for groundwater influences on soil slumping;
f. Once the initial data is collected and organized, MassDEP will want a soil scientist, perhaps one with a strong engineering background, to rank data points at each transect as to relative susceptibility to bank failure due to repeated wetting and drying. Soil science analyses e.g. "Plasticity Index" and "Erosion Factors", would help guide direction of bank stabilization efforts;
g. Map land use practices that are directly observationally linked to "bank" "erosion" directly beneath and/or proximate to them, and target these areas for employment of best management practices;
h. Superimpose on the 18% of the Pool which comprises the "study area" a "sensitive receptors" overlay, which will map in detail the position of bank-nesting bird species, rare

species occurrences, "vegetated shallows", and other sensitive and agreed to factors that might need to be eliminated as sites for biostabilization, in favor of less sensitive sites.

i. Transects will then need to be periodically revisited and data recollected, for use in determining progression of relative "erosion" at each, the effectiveness of biostabilization at transects where this technique has been employed, and potential differences in soil profiles at different transects to withstand repeated, daily wetting and drying.

j. Determine through accurate, repeatable, scientifically based mapping what fraction of the "banks" of the TFP are susceptible to or experiencing erosion due to repeated wetting and drying of the soil column. In the process, eliminate all other "banks" within the TFP from further study in regards this issue, including areas in which bedrock predominates; soils/substrates are presently stable; or where hardscape stabilization has already been installed.

Resource Management Goals

The Proposed Massachusetts Year 2012 Integrated List of Waters shows the segment from the VT/NH state line to the Turners Falls dam (MA34-01 & MA34-02) as impaired and considered a "Water Requiring a TMDL" due to "Other flow regime alterations", "Alteration in stream-side or littoral vegetative covers" and "PCB in Fish Tissue". In addition, the segment below the Turners Falls dam to the confluence with the Deerfield River (MA34-03) is also shown as impaired by these causes as well as total suspended solids.

In order to meet the objectives of the federal Clean Water Act, the Massachusetts Department of Environmental Protection ("MassDEP") adopted the Massachusetts Surface Water Quality Standards, 314 CMR 4.00. The Standards classify each body of water; designate the most sensitive uses to be enhanced, maintained and protected for each class; prescribe minimum water quality criteria required to sustain the designated uses; and contain regulations necessary to achieve the designated uses and maintain existing water quality including, where appropriate, the prohibition of discharges into waters of the Commonwealth.

MassDEP has designated the Connecticut River as a Class B river for its entire length in Massachusetts, 314 CMR 4.06(5). Class B rivers are assigned the designated uses of habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation, 314 CMR 4.05(3)(b). Class B waters must also have consistently good aesthetic value and meet minimum criteria for numerous water quality indicators to achieve compliance with the standards set forth in the regulations. The anti-degradation provisions of 314 CMR 4.04 require protection of all existing and designated uses of water bodies, and maintenance of the level of water quality needed to protect those uses.

The requested studies will assist MassDEP in issuing a Water Quality Certification that complies with the State and Federal Clean Water Acts.

Public Interest

The requestor is a state natural resource agency.

Existing Information

The Pre-Application Document ("PAD") provides a summary of the numerous studies that have been conducted to characterize stream bank conditions of the Turners Falls Impoundment, to understand the causes of erosion, and to identify the most appropriate approaches for bank stabilization.

The *Erosion Control Plan for the Turners Falls Pool of the Connecticut River* (Simons & Associates, Inc. dated June 15, 1999) was completed in order to comply with license articles 19 and 20, and contained a list of 20 priority stream bank stabilization project sites. By the end of the current license, FirstLight believes work at all sites will have been completed, although some require further repair work. The Erosion Control Plan (ECP) approach should be revised to identify and target those sites where facility operation can be directly linked to bank/slope instability on fine grained soils susceptible to repeated pore saturation/dewatering; and has resulted in potential degradation to the "Aquatic Ecosystem" of the TFP in discrete locations, the long-term results of which have not been analyzed. The next Full River Reconnaissance (FRR) is scheduled in 2013 and a proposed QAPP has been submitted to the MassDEP for comment. The Full River Reconnaissance scheduled for 2013 should be conducted using a MassDEP approved QAPP. MassDEP anticipates that the QAPP will specify establishing recoverable transects and standardizing the way the physical features of the LUWW-Bank-Riverfront Area is characterized, and identification of OHW elevation. MassDEP anticipates working with stakeholders to address specific needs and to ensure that all subsequent observations and evaluations are based upon scientifically reproducible geomorphologic criteria that has been established and is free from potential observer bias or prejudice. In this manner all parties will be able to contrast and compare the same data and make more meaningful assessments.

Nexus to Project Operations and Effects

Repetitive water level fluctuations and flow alterations caused by hydroelectric peaking operations are suspected to be a significant contributor to shoreline erosion. The more focused investigation requested above will enable MassDEP to condition future operation of the facility by issuance of a Section 401 Water Quality Certificate toward protecting the designated uses of the river that are most directly impacted by facility power generation; and specific land use activities in close proximity to the banks/slope without allowance for an adequate riparian buffer.

Methodology Consistent with Accepted Practice

MassDEP requests that FirstLight:

- Provide data on the daily water level fluctuation changes from the past five years from stations listed in the PAD, and estimate weekly/daily fluctuations within TFP assuming proposed operations and hydraulic conditions.
- Implement, as outlined in the pending MassDEP approved Quality Assurance Project Plan for the 2013 Full River Reconnaissance, a focused investigation approach in the pool of those remaining sites that are undergoing erosion, sites having fine grained lacrustrine derived soils/parent materials below OHW, sites likely to have slope instability and subsequent erosion due to saturation and dewatering of pore pressure, and sites that experience daily and weekly cycles of changes in elevation of pool water resulting from the Turners Falls Dam, Northfield Mountain or both. The actual daily and weekly river elevation changes, especially those directly related to only power generation, and the corresponding response observed in the soils/slope should be observed.

- Make a comprehensive review of all sites stabilized in the pool to date, with a scope toward comparing pre-stabilization work at previously stabilized sites to comparable site conditions identified in the paragraph above at sites continuing to undergo erosion. Identify the most appropriate techniques for bank stabilization for sites continuing to undergo erosion, given the existing and proposed hydraulic conditions and success of prior stabilization projects at sites with similar conditions, as well as the environmental conditions and associated permitting requirements at each site.
- Evaluate strategies to manage the release of accumulated sediment through Northfield Mountain Project works during upper reservoir drawdown or dewatering activities. FirstLight's evaluation should include the feasibility of the installation of a physical barrier across the bottom of the intake channel designed to prevent the migration of sediment during future drawdowns of the upper reservoir.
- Evaluate practical strategies to manage and minimize sediment released through spillway gates and the log sluice located near the bottom of the forebay adjacent to the Cabot Powerhouse during canal dewatering activities.
- Based upon the information obtained through the bank instability study, propose a list of locations for bank stabilization projects within the TFP, together with a proposed method of stabilization for each identified location and all impediments to the proposed work at each location.

Level of Effort/Cost, and Why Alternative Studies will not Suffice

Numerous erosion studies have already been conducted, however, those studies are insufficient to allow MassDEP to fulfill its statutory obligations. The various studies lack sufficient scope, data and/or quality controls to allow MassDEP to rely on them as they exist or to support an expansion of the scope as a cost effective approach. . This proposed focused approach will enable the stakeholder to reach the stated goals and objectives more efficiently and in a more cost effective manner for FirstLight.

FirstLight Study Request: Water Quality Monitoring

Goals and Objectives

Determine the current water quality of the Connecticut River within the Project area. The results of the study should provide information sufficient to enable staff to understand water quality conditions at the project. The study plan should be developed in consultation with the U.S. Fish and Wildlife Service (FWS) and the Massachusetts Department of Environmental Protection (MADEP).

The specific objectives of this study are as follows:

- Characterize water quality in the Turners Falls impoundment, bypass reach, canal and below the confluence of the bypass reach and canal discharge.
- Evaluate the potential effects of project operation on water quality parameters such as temperature and dissolved oxygen in conjunction with various other water uses.
- Determine the level of contamination in sediment impeded by the Turners Falls dam.
- Collect dissolved oxygen and temperature data during the spring through fall period and under various hydropower operating conditions at the Northfield Mountain Project.

Resource Management Goals

In order to meet the objectives of the federal Clean Water Act, MADEP adopted the Massachusetts Surface Water Quality Standards, 314 CMR 4.00.The Standards classify each body of water; designate the most sensitive uses to be enhanced, maintained and protected for each class; prescribe minimum water quality criteria required to sustain the designated uses; and contain regulations necessary to achieve the designated uses and maintain existing water quality including, where appropriate, the prohibition of discharges into waters of the Commonwealth.

MADEP has designated the Connecticut River as a Class B river for its entire length in Massachusetts, 314 CMR 4.06(5). Class B rivers are assigned the designated uses of habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation, 314 CMR 4.05(3)(b). Class B waters must also have consistently good aesthetic value and meet minimum criteria for numerous water quality indicators to achieve compliance with the standards set forth in the regulations. The anti-degradation provisions of 314CMR4.04 require protection of all existing and designated uses of water bodies, and maintenance of the level of water quality needed to protect those uses.

Public Interest

The requestor is a state natural resource agency.

Existing Information

The PAD provides a summary of existing water quality data. While a number of monitoring efforts have taken place and include sample sites within the project boundary, none of those studies were designed to comprehensively investigate whether all relevant project areas currently meet Class B standards: The Massachusetts DEP’s Connecticut River watershed assessment monitoring occurred in 2003, only had two stations located within the project area (both upstream of the Turners Falls dam) and only collected five to six samples from late April to early October; the Connecticut River Watershed Council’s volunteer monitoring program only had one sample site within the project area (at Barton’s Cove in the Turners

Falls headpond) and while those data are more recent, only three samples were collected in 2007 and only six samples in 2008 (over the course of three to four months each year); and the U.S. Geological Survey's long-term water quality monitoring station located downstream of the Cabot Station tailrace only collects information roughly once per month (and no dissolved oxygen data are provided).

No directed, site-specific surveys have been conducted to determine whether waters within the Project area meet State standards. This information gap needs to be filled so that resource agencies can evaluate properly the potential impact of project operations on water quality.

Nexus to Project Operations and Effects

The project creates a 20-mile-long impoundment where there would naturally be a free-flowing river. It currently operates in a peaking mode, with allowable headpond fluctuations of up to 9 feet, with proposals to continue as such. Portions of the headpond are nearly 100 feet-deep. There is a 2.7 mile-long reach of river bypassed by the Turners Falls power canal with only a nominal seasonal release required (equal to 0.05 cfsm). The below-project flow requirement is equal to 0.20 cfm (1,433 cfs). Water quality can be affected by the operating mode of a hydropower project. Impoundments can stratify, resulting in a near-hypoxic hympolimnion. If the project intake draws off of these deep waters then it could cause low dissolved oxygen levels downstream from the project discharge.

The MADEP requests that the applicant conduct a water quality survey of the impoundment, bypass reach and tailrace reach in order to determine whether state water quality standards are being met under all currently-licensed operating conditions (i.e., during periods of generation and non-generation). Results of the survey would be used, in conjunction with other studies requested herein, to determine an appropriate below-Project flow prescription, bypass reach flow(s), and to recommend an appropriate water level management protocol for the headpond (e.g., limiting impoundment fluctuations to protect water quality).

Operation of upstream hydroelectric projects as well as the Turners Falls Project and Northfield Mountain Project may impact water quality through the use of water for hydropower generation.

Methodology Consistent with Accepted Practice

Turners Falls: Water temperature and DO measurements should be collected from a minimum of six locations: upstream in the impoundment (Route 10 bridge), at a deep location within the impoundment, in the forebay near the intake, in the bypass reach, in the canal near Cabot Station and downstream of the confluence of the Cabot Station discharge and the bypass reach but upstream of the confluence with the Deerfield River. In order to ensure that data are collected during a time of important biological thresholds and anticipated "worst case" conditions for dissolved oxygen (low flow, high temperature, antecedent of any significant rainfall event), we recommend deploying continuous data loggers at all six locations, with biweekly vertical profiles taken at the deep impoundment location from April 1 through November 15. Results should include date, time of sampling, sunrise time, GPS location, generation status (estimated flow through canal and bypass reach), precipitation data, water temperature, DO concentration and percent saturation. In addition, impoundment sediment adjacent to the Turners Falls dam should be analyzed for metals and polychlorinated biphenyls.

A proposed water quality sampling plan is to be submitted to MADEP for approval prior to sampling. A section on quality assurance and quality control must be included.

If river flow and temperature conditions are representative of an "average" or "low" water year, then one year of data collection should be sufficient to perform the study. If conditions are not representative (i.e., a "wet" or cool year) then a second year of data collection may be necessary.

Northfield Mountain: The water quality study will include monthly dissolved oxygen and temperature profiles within the Northfield Mountain Upper Reservoir. It is anticipated that the study will be conducted from approximately June 15 through September 30.

Level of Effort/Cost, and Why Alternative Studies will not suffice

Cost would depend on the specific methodology chosen. If continuous data loggers are installed at all six locations and biweekly vertical profiles taken at the deep impoundment location from April 1 through November 15 then the estimated cost of the water quality study is moderate. It is expected to take two technicians approximately one day to deploy the loggers, twelve days to collect the vertical profiles, one day to remove the loggers, one day to download the data, and five days to write the report.

In the PAD, the applicant proposes to assess the effects of the Turners Falls and NFMPS project operations on dissolved oxygen and temperature by continuously monitoring DO and temperature at locations within the project areas and gathering vertical profiles within the TF impoundment and NFMPS upper reservoir.

New England Farmers Union

SIX STATES WITH ONE VOICE AT THE NATIONAL TABLE

March 1, 2013

Federal Energy Regulatory Commission
Washington, D.C. 20426

RE: Federal Energy Regulatory Commission (Commission) review of Pre-Application Documents (PAD) submitted by TransCanada Hydro Northeast Inc. (TransCanada) for relicensing the existing Wilder (FERC No. 1892), Bellows Falls (FERC No. 1855), and Vernon (FERC No. 1904) hydroelectric projects, and the single PAD filed by FirstLight Hydro Generating Company (FirstLight) for the Turners Falls (FERC No. 1889) hydroelectric project and the Northfield Mountain Pumped Storage Project (FERC No. 2485) (collectively referred to as the Connecticut River projects)

Thank you for this opportunity to participate in the public scoping process and to provide you with input on the issues that should be analyzed in the above referenced multi-project Environmental Impact Statement.

The New England Farmers Union is a regional chapter of the National Farmers Union. We work to improve the lives and livelihoods of our farmer members in New England. One of our members, Nathan L'Etoile, is co-owner of Four Star Farms in Northfield Massachusetts. For 25 years, Four Star Farms has drawn water for irrigation purposes from the Northfield Mountain Pumped Storage Project area. The farm was recently forced to obtain an expensive permit from private power company, First Light Power Resources. Other farms in the multi-project area draw water from the Connecticut River and could also be negatively impacted by the necessity of spending thousands of dollars on unnecessary permits required by TransCanada or First Light. These costs threaten the viability of farms drawing water from the Connecticut River for agricultural irrigation purposes.

To clarify the respective rights of agricultural landowners and irrigators and to make clear the limits of authority granted to private power generators, we ask that within section "1.3 Statutory and Regulatory Requirements" of the EIS you include:

a. A review of the respective riparian property rights held by agricultural landowners taking water for irrigation under settled state law in each of the three states in the project area;

b. A recognition that FERC licensing authority does not occupy the entire field of water withdrawal rights or pre-empt state water right regimes and that <u>FERC licensees do not have the authority to deny agricultural use withdrawals or require permits beyond those granted by state authority; and</u>

c. A recognition that the riparian rights of agricultural users along the Connecticut River are property rights that may not be taken without just compensation.

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The Environmental Impact Statement should also include:

a. Recognition and supporting data to show that agricultural producers and irrigators in the project areas protect critical watersheds that enhance overall water quality, provide wildlife habitat and recreational uses to multiple stakeholders; and

b. The land use and water quality impacts of conversion from agricultural uses to other types of development and land use.

Thank you for this opportunity to provide input.

Sincerely,

Roger Noonan
President, New England Farmers Union

TROUT UNLIMITED
DEERFIELD RIVER CHAPTER

10 Old Stage Road
Wendell, MA 01379

March 1, 2013

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E., Room 1A
Washington, DC 20426

Turners Falls Project, FERC No. 1889
Northfield Mountain Project, FERC No. 2485
Study Requests of Trout Unlimited

Dear Secretary Bose:

Following are Trout Unlimited's (TU) study requests for the Turners Falls Project and the Northfield Mountain Project.

STUDY REQUESTS

Requested Study No. 1
Shad Population Model for the Connecticut River
FERC No. 1889 & FERC No. 2485

Develop an American shad annual step, mathematical simulation population model for the Connecticut River to quantify how project operations and potential restoration/mitigation measures impact the population of shad in the Connecticut River.

Goals and Objectives

The goal of the model is to assess impacts of both upstream and downstream passage at each of the Connecticut River projects and potential management options for increasing returns to the river.

Specific objectives include:

- Annual projections of returns to the Connecticut River;
- A deterministic and stochastic option for model runs
- Life history inputs of Connecticut River shad
- Understanding the effect of upstream and downstream passage delay at projects

- Calibration of the model with existing data
- Analysis of the sensitivity of model inputs
- Analysis of sensitivity to different levels of up- and downstream passage efficiencies at all projects
- Multiple output formats including a spreadsheet with yearly outputs for each input and output parameter

Resource Management Goals

The requestor is not a public agency. However, we believe the information gathered as a result of this study would further regional resource management goals, and more specifically The Connecticut River Atlantic Salmon Commission's *Management Plan for American Shad in the Connecticut River.*

Public Interest

The Northfield Mountain Project and the Turners Falls Project and other projects in the upper Connecticut River alter flows, impacting aquatic species and communities and specifically American shad movement and spawning. Flow alterations caused by the cumulative effects of all projects in the Connecticut River affect the public's use of the river for recreation. Angling for shad is directly impacted by a reduced population caused by hydroelectric projects on the river.

Existing Information

Since the construction of the first fish lift facility at Holyoke Dam in 1967, American shad have had access to spawning and rearing habitat upstream from Holyoke Dam. A number of improvements to the Holyoke fishway have occurred since that time, but while the numbers of shad lifted at Holyoke have reached as much as 721,764 and the overall shad population to the river exceeded 1.6 million shad in 1992 (CRASC 1992), total shad populations, and numbers of shad passing Holyoke, Turners Falls and Vernon Dam have not met CRASC management goals.

Population and passage numbers past Holyoke have declined substantially from those totals in recent years, with average Holyoke passage numbers since 2000 of 229,876. Whole river population estimates have shown that approximately half of the returning population of shad passing upstream of Holyoke. Recent returns to Holyoke are far below management goals. Average passage efficiency of shad at Turners Falls (Gatehouse counts) and Vernon since 2000 has been 3.1 and 20.4 % respectively. These too are well below the CRASC management goals.

Safe, timely and effective up- and downstream passage along with successful spawning and juvenile production are necessary to help achieve shad management goals for the Connecticut River.

Project Nexus

Existing project operations and fish ladder efficiencies have a direct effect on shad populations in the Connecticut River. Poor upstream passage efficiencies and delays restrict river access to returning shad. Fish unable to reach upriver spawning grounds may not spawn or have reduced fitness or survival of young. Poor downstream passage survival and downstream passage delays affect outmigration and consequently repeat spawning, an important ecological aspect of the iteroparous Connecticut River shad population (Limberg et al. 2003).

TU is concerned that poor passage efficiencies and delays at projects may be limiting access to upstream reaches of the river, altering spawning behavior, decreasing outmigration survival and contributing to the failure of the Connecticut River shad population to meet management targets (Castro-Santos and Letcher 2010).

Development of a population model will allow an assessment of individual project impacts on the population as well as the cumulative impacts of multiple projects. The model will allow managers to direct their efforts in the most efficient manner toward remedying the conditions that most impact the shad population.

Proposed Methodology

Population models are commonly used to assess anthropomorphic and natural impacts and are consistent with accepted practice. A model similar to this request was constructed for the Susquehanna River by and Normandeau Associates Inc. for Exelon (FERC #405, RSP 3.4). The model is constructed in Microsoft Access and would have a ‘dashboard’ entry screen that allows individual entry of the parameters listed below.

Specific parameters that would be included in the model:

- Upstream passage efficiency at Holyoke, Turners Falls (Cabot, Gatehouse and Spillway Ladders), Vernon fishways, and any impacts associated with Northfield Mountain.
- Distribution of shad approaching the Turners Falls project between the Cabot Ladder and the spillway at the dam
- Downstream passage efficiencies at Vernon, Northfield Mountain, Turners Falls, and Holyoke projects for juveniles and adults
- Entrainment at Mount Tom and Vermont Yankee
- Sex ratio of returning adults
- The proportion of virgin female adults returning at 4, 5, 6, and 7 years
- The proportion of repeat spawning females at 5, 6 and 7 years
- Spawning success of females in each reach
- Fecundity
- Percent egg deposition
- Fertilization success
- Larval and juvenile in-river survival
- Calibration factor to account for unknown parameters such as at sea survival
- Options for fry stocking and trucking as enhancement measures
- Start year and model run years
- Start population
- Rates of movement to and between barriers

- Temperature, river discharge, and other variable of influence to migration and other life history events

The model should be adaptable to allow the input of new data and other inputs.

Level of Effort and Cost

Neither First Light nor TransCanada have proposed any study to meet this need. Estimated cost for the study is expected to be low to moderate. As the model describes the impacts of multiple projects and two owners, both project owners would share the cost of model development.

Literature cited:

CRASC (Connecticut River Atlantic Salmon Commission). 1992. A management plan for American shad in the Connecticut River basin. Sunderland, MA

Castro-Santos, T and B. H. Letcher. 2010. Modeling migratory bioenergetics of Connecticut River American shad (*Alosa sapidissima*): implications for the conservation of an iteroparous anadromous fish. Can.J.Fish.Aquat.Sci. 67: 806-830

Limberg, K. E., K. A. Hattala, and A. Kahne. 2003. American shad in its native range. Pages 125-140 in K. E. Limberg and J. R. Waldman, editors. Biodiveristy, status and conservation of the world's shads. American Fisheries Society, Symposium 35, Bethesda, Maryland

Requested Study No. 2
Telemetry Study of Upstream and Downstream Migrating Adult American Shad to Assess Passage Routes, Effectiveness, Delays, and Survival
FERC No. 1889 & FERC No. 2485

Goals and Objectives

Assess behavior, approach routes, passage success, survival, and delay by adult American shad as they encounter the projects during both upstream and downstream migrations, under permitted project operations conditions, proposed operational conditions, and study treatment operational conditions at First Light Power's Turners Falls and Northfield Mountain Pumped Storage projects and TransCanada's Vernon Project. There are multiple fishways and issues related to both upstream and downstream passage success at the projects. Some of these issues at the Turners Falls Project are similar to and/or pertain directly to the Northfield Mountain and Vernon projects. Therefore, it is reasonable to address passage issues at all projects in a similar manner.

Telemetry Study - This requested study requires use of radio telemetry using both radio and Passive Integrated Transponder (PIT) tag types to provide information to address multiple upstream and downstream fish passage issues. The following objectives shall be addressed in these studies:

- Assessment of any migration delays resulting from the presence of the dam and peaking flow operations of the Turners Falls Project;
- Determine route selection and behavior of upstream migrating shad at the Turners Falls Project under various spill flow levels (e.g., movement to the dam, attraction to Cabot Station, attraction to Station 1 discharge, movement between locations, delay, timing, etc.). A plan and schedule for dam spill flow releases will need to be developed that provides sufficient periods of spill flow conditions, and various generating levels from Turners #1 Station coupled with Cabot Station generation flows (e.g., treatments will require multiple days of consistent discharge). Evaluated spill flows should include flows between 2,500 – 6,300 cfs, which relate to bypass flows identified as providing spawning opportunities for shortnose sturgeon in the lower bypass reach at the Rock Dam. (Kieffer and Kynard 2012). Sturgeon spawning and upstream shad passage occur concurrently;
- Assess near field, attraction to and entrance efficiency of the Spillway Ladder by shad reaching the dam spillway, under a range of spill conditions;
- Evaluate the internal efficiency of the Turners Falls Spillway Ladder;
- Continue data collection of Cabot Station Ladder and Gatehouse Ladder efficiency, to include rates of approach to fishway entrances, entry into fishways, and passage through them, under different operational conditions that occur in these areas;
- Evaluate modifications to the Cabot and/or Spillway fishways recommended by the agencies if they are implemented;
- Assess upstream migration from Turners Falls to the Vernon Dam in relation to Northfield Mountain's pumping and generating operations and Vernon Project peaking generation operations. Typical existing and proposed project operation alterations should be evaluated;
- Assess near field, attraction to and entrance efficiency of the Vernon Dam Ladder;
- Assess internal efficiency of the Vernon Dam Ladder;
- Assess upstream passage past Vermont Yankee's thermal discharge (also located on the west bank of the river 0.45 mile upstream of fish ladder exit)
- Assess upstream migration from Vernon Dam in relation to the peaking generation operations of the Bellows Falls Project. Typical existing and proposed project operation alterations should be evaluated;
- Determine post-spawn downstream migration route selection, passage efficiency, delays and survival related to the Vernon Project, including evaluation of the impact of the Vermont Yankee heated water discharge plume on downstream passage route, migrant delay/timing, efficiency and survival;
- Assess impacts of Northfield Mountain operations on up- and downstream adult shad migration, including delays, entrainment, and behavioral changes and migration direction shifts under existing and proposed project operations;
- Determine downstream passage route selection, timing/delay, and survival under varied project operational flows into the power canal and spill flows at Turners Falls Dam;

- Determine downstream passage route selection, timing/delay in the canal, Cabot Station fish bypass facility effectiveness, and survival of Cabot-bypassed adult shad that enter the Turners Falls Canal system;
- Compare rates and or measures of delay, movement and survival etc., among project areas or routes utilized (e.g., spill at dam vs. power canal) under the range of permitted and proposed conditions; and
- Utilize available data sets and further analyze raw data (e.g., 2003- 2012 Conte Lab Studies) where possible to address these questions and inform power analyses and experimental design.

Information to address all of these questions would rely on the tagging of upstream migrating adult shad at Holyoke Dam and releasing them to migrate naturally from Holyoke through the Turners Falls and Vernon projects and back downstream after spawning. Additional tagged individuals would likely need to be released farther upstream (Turners Falls Canal, upstream of Turners Falls Dam, and upstream of Vernon Dam), to ensure that enough tagged individuals encounter project dams on both upstream and downstream migrations, that these individuals are exposed to a sufficient range of turbine and operational conditions to test for project effects, and to provide adequate samples sizes for statistically valid data analyses to address the many objectives listed. This study will require two years of field data collection to attempt to account for inter-annual variability in river discharge and water temperatures.

<u>Evaluation of Past Study Data</u>- In addition to collection and analysis of new telemetry data, substantial data has already been collected at Turners Falls from multiple years of passage assessments conducted for First Light by U.S. Geological Survey's Conte Anadromous Fish Research Center (Conte Lab) researchers and there are also data from the 2011 and 2012 full river study conducted by the Conte Lab that address Turners Falls, Northfield Mountain and Vernon project migration and passage questions that have not yet been analyzed. These data include several million records each year from more than 30 radio telemetry receivers deployed between Middletown, CT and Vernon Dam. This data will provide substantial information free from the field data collection costs and therefore should be analyzed as part of this study. This data analysis should be completed in 2013 to help inform the design of subsequent field studies.

<u>Evaluation of Methods to Get Shad Past Cabot Station for Spillway Passage at the Turners Falls Dam</u> – The poor passage efficiency of the Cabot Ladder, the first and most used fishway encountered by shad arriving at the Turners Falls Project, and at the entrance to the Gatehouse Ladder, which all Cabot fishway-passed fish must use, has resulted in very poor overall shad passage efficiency at the project. An alternative to passing fish at the Cabot Station is to install a fish lift at the dam that would put fish directly into the Turners Falls pool, thereby eliminating problems with the Cabot Fishways, and the Gatehouse Fishway entrance and the variable passage efficiency of the Gatehouse Fishways. For this to be effective, attraction of shad to the Cabot Station discharge and associated delays would need to be overcome. It is possible that spillway flow releases coupled with behavioral measures at Cabot Station that dissuade shad from

that tailrace could achieve this end. In order to assess the possibilities, we recommend the following study:

1. A literature search and desk-top assessment of the possible behavioral measures that could be effective in getting shad to pass Cabot Station tailrace and continue upstream to the dam.
2. Based on results of the desk-top assessment, possible evaluation of behavioral measures that are likely to be effective.
3. Field evaluation of the effect of different levels of spill at the dam that would induce fish to move past the Cabot Station into the bypass reach and up to the dam (as noted in objectives).

Besides passage success and delays at passage facilities, these studies would assess the impacts of project operations on migration passage delay, route, timing, injury, mortality, and passage structure attraction, retention, and success. Of particular interest will be fish behavior during periods when flow releases from the project increase from the required minimum flows to peak generation flows and when flows subside from peak generation flows to minimum flows and the operation of NMPS in pumping and generation modes.

Resource Management Goals

The requestor is not a public agency. However, we believe the information gathered as a result of this study would further regional resource management goals, and more specifically The Connecticut River Atlantic Salmon Commission's *Management Plan for American Shad in the Connecticut River*.

Public Interest

The Northfield Mountain Project and the Turners Falls Project and other projects in the upper Connecticut River alter flows, impacting aquatic species and communities and specifically American shad movement and spawning. Flow alterations caused by the cumulative effects of all projects in the Connecticut River affect the public's use of the river for recreation. Angling for shad is directly impacted by a reduced population caused by hydroelectric projects on the river.

Existing Information

Passage of adult shad at the Turners Falls fishway complex has been the subject of intense study by the Conte Lab since before 1999. These studies have clearly demonstrated that passage through the existing fishways at Cabot and Spillway is poor (<10% in many years). Passage through the Gatehouse fishway is better, but still rarely exceeds 80%, despite the short length of this ladder. In addition to poor passage for fish entering the ladders, shad that ascend the Cabot Fishway experience extensive delays before entry into the Gatehouse Fishway. Shad that ascend Spillway frequently fall back into the canal and are also subject to these upstream delays. A new entrance to the Gatehouse Fishway installed in 2007 led to dramatic improvements in passage out of the canal (from 5% to over 50% in 2011), but passage still falls well short of management goals. In addition, shad spend considerable time (up to several weeks) attempting to pass. These delays likely influence spawning success and survival. Adult shad, unable to pass Gatehouse, experience similar delays in downstream passage, even after they have stopped trying to pass Gatehouse. Without spill, all outmigrating shad that have passed Gatehouse must enter the canal at the Gatehouse and may be subject to delays exiting the canal.

During the course of these studies a very large dataset has been compiled that could yield useful information for further improving passage of shad out of the canal in both the upstream and downstream directions. A unique feature of these data is a 2-dimensional array covering the canal just downstream of Gatehouse, documenting fine scale movements and occupancy of this zone. These data should be combined with computational fluid dynamics (CFD) and real-time hydraulic data to determine how canal hydraulics influence the ability of shad to locate and enter the fishway, and to identify modifications that are likely to lead to improvements in approach and entry rates. A separate CFD modeling study is requested that includes modeling of the Gatehouse Fishway entrance are at the head of the power canal.

In addition, whole-river shad telemetry studies performed in 2011 and 2012 will likely provide useful information and should be analyzed. These data should allow quantification of delay below Turners Falls, and could help guide studies requested above. Preliminary analyses of data through 2011 have been made available to FirstLight and the resource agencies (Castro-Santos and Haro 2005; Castro-Santos and Haro 2010).

The whole-river studies have also shown that, at least in 2011, most shad that pass Turners Falls rapidly progress upstream to Vernon Dam where extensive delays also occur. Data from the 2012 study were not available at this time, but Dr. Castro-Santos stated similar patterns were noted in the data between the years on the topic of upstream delay (personal communication, Dr. Theodore Castro-Santos). Similarly, concerns relative to the downstream passage of spent shad also remain relative to delays, with existing unpublished USGS telemetry data sets suggesting this is an issue within the Turners Falls canal.

Since the first year of operation of the Turners Falls upstream fishways (1980), the percent passage of American shad annually passed upstream of Turners Falls Dam compared to the number passed at the Holyoke Fish Lift has averaged 3.6% (1980-2012 data). The highest values for this metric has not exceed 11% and are well below the noted CRASC Management Plan target range for this objective noted earlier as 40-60% on a five year running average.

Since the first year of operation of the Vernon Dam upstream fish ladder (1981), the percent passage of American shad annually passed at Vernon compared to the number passed upstream of Turners Falls Dam (Gatehouse counts) has averaged 39.4%, ranging from 0.42% to 116.4% (> 100% due to counting error at one or both facilities, unknown).

Project Nexus

Existing project operations (peaking power generation) and limited bypass flows have a direct impact on instream flow and zones of passage (migration corridors). Project flow releases affect passage route selection, entry into fishways, and create delays to upstream migration. Inefficient downstream bypasses can result in migration delays and increased turbine passage. Mortality of adult shad passing through these turbines is expected to be high (Bell and Kynard 1985), additional stresses associated with passage and delay may cause mortality as shad are unable to return to salt water in a timely manner. The project's upstream and downstream passage facilities need to be designed and operated to provide timely and effective upstream and downstream fish passage to meet restoration goals of passage to upstream habitat and maximize post-spawn survival. These factors are all critically important to the success of restoration efforts.

Proposed Methodology

Use of radio including passive-integrated transponder (PIT) telemetry is widely accepted as the best method to assess fish migratory behavior and passage success and has been used extensively to assess migration and passage issues at Turners Falls as well as other Connecticut River projects. These studies include one conducted in 2011 and 2012 by the U.S. Fish and Wildlife Service and U.S. Geological Survey's Conte Anadromous Fish Research Center, which has provided substantial information related to some of the issues identified here. The requested study will build and expand on the information collected over the past two years.

The study design must specify sample sizes, tag configurations and receiver configurations, to ensure that rates of entry and exit to the tailraces, fishways, downstream bypasses, and the bypassed reach can be calculated with sufficient precision to determine effectiveness of flow and ensonification treatments (separate Study Request). For project assessments at Turners Falls (e.g., Cabot, Spillway and Gatehouse ladder attraction and entry, route selection, operational effects), double tagged (radio and PIT) shad will be required for release from Holyoke Dam. Additional shad must be released directly into the Turners Falls Canal to support assessment of the various operational and structural conditions in effect, to be modified in this period, and proposed conditions within the Turners Falls power canal relative to entrances to the Gatehouse fishway. A related request on CFD modeling in the Cabot Station tailrace, the upper power canal near Gatehouse, and in the area around the entrance of the Spillway Ladder will address related project operational effects that will also address identified objectives in this telemetry request. Shad captured at Holyoke and tagged and release upstream of Turners Falls Dam, or tagged out of Gatehouse Ladder, would help to ensure an adequate sample size for evaluations in the vicinity of NMPS and to the Vernon Dam and the ability to address identified study objectives in those project areas. Additional tagged shad are expected to be required for release upstream of the Vernon Dam, which should ensure adequate sample for a separate study request, where shad spawn upstream of Vernon Dam as well as ensuring there is an adequate number of outmigrating spent adults to address related study objectives for adult outmigrants. The required number of tagged fish to address study objectives may be adjusted accordingly from area to area depending on target numbers (i.e., best information on resultant viable tagged fish and power analyses to detect effects) to account for typical passage rates, survival rates, and handling effects as examples.

Existing information on captured, handled, tagged fish performance (e.g., percent that drop back, unsuitable for tracking) and factors such as timing of tagging and potentially transport, must all be carefully considered to ensure an adequate sample size of healthy (e.g., viable to characterize behavior, survival, etc.) tagged fish is available to address the many questions identified in this request (as supported by a statistical power analysis). Additionally, ensuring adequate downstream adult fish sample sizes (to address project effect questions above) requires close consideration as expected losses of healthy tagged fish during upstream passage, natural mortality rates, and tagging related effects, are expected to reduce sample sizes on downstream passage objectives/questions as the season progresses. The use of single PIT tagged fish can help improve sample sizes, but will be of limited use to answer some of the passage questions we have identified.

Due to environmental variability, two years of study work will be necessary. A large array of stationary monitoring stations (radio and PIT) will be needed to address the issues identified among the project areas. A sufficient level of radio receiver and PIT reader coverage will be required, to provide an appropriate level of resolution, for data analyses, to answer these questions on project operational effects. The study will provide information on a variety of structural and operational aspects of fish migration, relative to route selection, timing, survival, and up and downstream passage attraction, retention, delay, efficiency, survival as some examples at three projects (Turners Falls, NMPS, and Vernon). The use of video monitoring may also be utilized for specific study areas such as the Spillway Ladder, to provide additional information on shad entrance activity, with the understanding of some data limitations associated with this approach (fish identification, water visibility). This study will be coordinated with the proposed study request to evaluate ensonification as a shad behavioral deterrent at the Cabot Station tailrace which will be an additional treatment of the telemetry study.

In addition to the tagging studies, use of video monitoring of the Spillway Fishway would provide additional overall data on Spillway Fishway efficiency as all shad attempting to pass could be monitored versus just those shad that have been tagged.

Level of Effort and Cost

The requested study is extensive and will require a substantial effort and cost to capture, PIT tag, and radio tag a sufficient number of shad at Holyoke to release at upstream locations. We are not aware of any other study technique that would provide project specific fish behavior and migration information to adequately assess existing project operations and provide insight in possible alternative operations and measures needed to address observed negative impacts to fish migration success. Cost for the entire multi-project tagging, tracking and data analysis are expected to range from $400,000 to $500,000 based on past Turners Falls' studies and the 2011 and 2012 shad telemetry studies. Video monitoring of the Spillway fishway would add a modest cost to this study.

Due to the fact tagged shad will move throughout the larger five project area, to varying degrees, there will be expected cost savings (e.g., radio tags) to both owner/operators, provided cooperation in study planning and implementation occurs.

Literature Cited

Atlantic States Marine Fisheries Commission. 2010. Amendment #3 to the interstate fishery management plan for shad and river herring (American shad management). Washington, D.C.

Bell, C. E. and B. Kynard. 1985. Mortality of adult American shad passing through a 17-megawatt Kaplan turbine at a low-head hydro-electric dam. North American Journal of Fisheries Management, 5:33-38.

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Requested Study No. 3
Impact of Project Operations on Shad Spawning, Spawning Habitat, and Egg Deposition in the Project Areas of the Turners Falls, Northfield Mountain Pumped Storage and Vernon Project Areas and downstream from Bellow Falls Dam
FERC No. 1889 & FERC No. 2485

Conduct a field study of spawning by American shad in the Connecticut River mainstem downstream of Turners Falls Dam, in the Turners Falls Dam impoundment, in the Vernon Dam Project area, and downstream of Bellows Falls Dam to determine if project operations (including operations of the Northfield Mountain Pump Storage) negatively impact shad spawning behavior, spawning habitat use, areal extent and quality of those spawning areas, and spawning activity in terms of egg deposition in those areas.

Goals and Objectives

Determine if project operations (under the permitted and proposed operational ranges) affect American shad spawning site use and availability, spawning habitat quantity and quality, and spawning activity in the river reaches downstream from Cabot Station and in the project bypass reach of Turners Falls Dam, in the Turners Falls Dam impoundment and in relation to Northfield Mountain Pump Storage operations, downstream and upstream of the Vernon Dam, and in the project area downstream of Bellows Falls Dam. The following objectives will address this request:

- Determine areas utilized by American shad for spawning by conducting night-time visual observation of spawning activity, identify and define areas geospatially, and obtain data on physical habitat conditions effected by project operations (e.g., water depth, velocity, discharge, substrate, exposure and inundation of habitats);

- Determine project operation effects on observed spawning activity, under a range of permitted or proposed project operation conditions;
- Quantify effects (e.g., water velocity, depths, inundation, exposure of habitats) of project operation on identified spawning areas for a range of conditions, over the complete period of spawning activity;
- Quantify spawning activity as measured by night-time spawning/splash surveys and egg collection in areas of spawning activity, and downstream of these areas, to further determine project operation effects (location extent of exposure from changing water levels and flows and on associated habitats from project operations).

If it is determined that the Project operations are adversely affecting the spawning activity of American shad and impacting spawning area habitat, identify operational regimes that will reduce and minimize impacts spawning habitat and spawning success within the project area. This study will require two years of field data to capture inter-annual variability to river discharge and water temperatures and to allow for evaluation of alternative flow regimes if year one studies determine that the present peaking regime negatively affects spawning.

Resource Management Goals

The requestor is not a public agency. However, we believe the information gathered as a result of this study would further regional resource management goals, and more specifically The Connecticut River Atlantic Salmon Commission's *Management Plan for American Shad in the Connecticut River.*

Public Interest

The Northfield Mountain Project and the Turners Falls Project and other projects in the upper Connecticut River alter flows, impacting aquatic species and communities and specifically American shad movement and spawning. Flow alterations caused by the cumulative effects of all projects in the Connecticut River affect the public's use of the river for recreation. Angling for shad is directly impacted by a reduced population caused by hydroelectric projects on the river.

Existing Information

Since the construction of the first fish lift facility at Holyoke Dam in 1967, American shad have had access to spawning and rearing habitat upstream from Holyoke Dam. A number of improvements to the Holyoke fishway have occurred since that time, but while the numbers of shad lifted at Holyoke have reached as much as 721,764 and the overall shad population to the river exceeded 1.6 million shad in 1992 (CRASC 1992), total shad population, and numbers of shad passing Turners Falls and Vernon Dam have not met CRASC management plan objectives. Population number and passage numbers past Holyoke have declined substantially from those totals in recent years, with average Holyoke passage numbers over the last 10 years of 211,850. Since historically approximately half of the returning population of shad to the river passed upstream of Holyoke, recent returns are far below management goals. Effective upstream and downstream passage and successful in-river spawning and juvenile production are necessary to help achieve shad management goals for the Connecticut River.

American shad broadcast spawn in congregations over shallow flats and rocky or sandy substrates (Davis et al, 1970, Mansuetti and Kolb 1953), at depths less than 10 feet and often far shallower with spawning fish swimming vigorously near the surface in a closely packed circle (Marcy 1972, Mackenzie et al 1985). Fertilized eggs drift downstream until hatching (Mackenzie et al 1985).

American shad are known to spawn downstream from the Turners Falls Project. Layzer (1974) identified 6 spawning sites from an area below the mouth of the Deerfield River (river mile 191.9) to river mile 161.7 below the Mill River in Hatfield, MA. Kuzmeskus (1977) verified 16 different spawning sites ranging from downstream of the Cabot tailrace to just upstream of the Holyoke dam (river mile 87.1). The only parameter that all spawning sites had in common was current (Kuzmeskus 1977). TU is not aware of any more recent studies that document whether these 16 sites are still viable spawning locations for shad. We are not aware of any studies that have determined American shad spawning habitat or spawning sites upstream of Vernon Dam to Bellows Fall Dam (historic extent of upstream range).

First Light Power conducted studies in the late spring and summer of 2012, examined habitat conditions downstream of the Turners Falls Dam. The study documented that in low flow conditions, Cabot Station project operations produced fluctuations in water level elevations that can range over 4 feet in magnitude (daily operation) at the USGS Montague Gage Station, to lower values of 2 to 3 feet at the Route 116 Bridge, Sunderland, MA (PAD). Similar short-term, limited monitoring in the upper Turners Falls Dam impoundment identified water level changes due to project operations that d cyclically varied several feet on a sub-daily frequency.

Project Nexus

American shad are known to spawn at five locations downstream from the Turners Falls Project from an area below the mouth of the Deerfield River (river mile 191.9) and ten other locations downstream to river mile 161.7 below the Mill River in Hatfield (Layzer 1974, Kuzmeskus 1977).

Shad spawning is likely influenced by river flow, which fluctuates greatly due to the project's peaking mode of operation. These fluctuations may impact shad spawning activity by altering current velocities and water depth at the spawning sites. Effects on spawning behavior could include suspension of spawning activity, poor fertilization, flushing of eggs into unsuitable habitat due to higher peaking discharges, eggs dropping out into unsuitable substrate and being covered by sediment deposition and/or eggs becoming stranded on dewatered shoal areas as peak flows subside.

While a number of shad spawning and egg deposition studies were conducted in the 1970s, that research was aimed at assessing the potential impact of developing a nuclear power station in the Montague Plains section of the Connecticut River. TU is not aware of any studies being conducted specifically designed to determine if a relationship between spawning behavior, habitat use, and egg deposition and project operations effects of the Turners Falls, Northfield Mountain Pump Storage and Vernon projects and downstream of Bellows Falls Dam..

TU is concerned that peaking operations may be altering spawning behavior and contributing to the failure of the Connecticut River shad population to meet management targets.

Proposed Methodology

The first year of study should examine a sample of known spawning areas downstream of the Turners Falls Dam project, to determine operation effects on shad spawning behavior, activity, and success. In areas upstream of Turners Falls Dam to the Bellow Falls Dam tailrace, the study should identify areas utilized for spawning by American shad. In the second year, should results from year one determine project operations affected spawning activity, access to habitat, or success, downstream of Turners Falls Dam, then an identical more detailed assessment (identified objectives) should be conducted in spawning areas upstream of Turners Falls Dam to the Bellows Falls Dam tailwater. Measures to reduce or eliminate any documented project operation impacts should be explored and evaluated in year two, downstream of Turners Falls Dam.

The impacts to spawning behavior would best be studied by night-time observations of actual in-river spawning behavior (Ross et al. 1993). Project discharge increases or decreases during actual observed spawning activity will provide empirical evidence of change in behaviors. The observational methodology should follow the protocol specified in Layzer (1974) and/or as described in Ross et al. (1993). The analysis should utilize the observational field data in conjunction with operational data from the projects (station generation and spill on a sub-hourly basis). To assess the impacts of changes in generation flows, the study should include scheduled changes in project operation to ensure that routine generation changes that occur during the nighttime spawning period affect downstream spawning habitats selected for study while shad are spawning. Stier and Crance (1985) provide optimal water velocities during spawning to range between 1 to 3 ft/sec.

In areas used for spawning, the characteristics of those areas (e.g., location, depth, flow, substrate) should be recorded. The effect of project operations (discharge, water velocity, inundation and exposure) should be assessed. Drift nets will be used to collect eggs to quantify egg production before and after flow changes at the spawning site.

In the reaches above the Turners Falls dam, night time observations of splashing associated with shad spawning should be done in each reach as sufficient numbers of shad are passed above each dam. Observations should be done regularly until the end of the spawning season. The use of radio-tagged adult shad from a separate Study Request will aid in this effort. An estimate of the total area used for spawning and an index of spawning activity should be recorded for each site.

These methods are consistent with previous studies and in the Connecticut River accepted practice.

Level of Effort and Cost

Neither First Light or TransCanada propose any studies to meet this need. Estimated cost for the study is expected to be moderate (up to $40,000) for each owner, with the majority of costs associated with fieldwork labor.

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Stier, D. J. and J. H. Crance. 1985. Habitat suitability index models and instream flow suitability curves: American shad. U. S. Fish and Wildlife Service Biological Report No. 82(10.88),Washington, D.C.

Requested Study No. 4
Evaluation of Timing of Downstream Migratory Movements of American Eels on the Mainstem Connecticut River
FERC No. 1889 & FERC No. 2485

Goals and Objectives

The goal of this study is to better understand migration timing of adult, silver-phase American eels as it relates to environmental factors and operations of mainstem hydropower projects on the Connecticut River.

The objectives of this study are:

1. Quantify and characterize the general migratory timing and presence of adult, silver-phase American eels in the Connecticut River relative to environmental factors and operations of mainstem river hydroelectric projects

Resource Management Goals

The requestor is not a public agency. However, we believe the information gathered as a result of this study would further regional resource management goals, and more specifically The Atlantic States Marine Fisheries Commission's management plans for American eel:

1. Interstate Fishery Management Plan for American Eel. April 2000. Atlantic States Marine Fisheries Commission.
2. Addendum II to the Fishery Management Plan for American Eel. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

In addition, the Connecticut River Atlantic Salmon Commission (CRASC) developed A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin, 2005 whose implementation would be enhanced by the results of this study.

Public Interest

The Northfield Mountain Project and the Turners Falls Project and other projects in the upper Connecticut River alter flows, impacting aquatic species and communities and specifically American eel movement and habitat use. Flow alterations and barriers at hydroelectric projects thereby affect a public fishery resource.

Existing Information

Data on timing of downstream migratory movements and rates of American eels in the mainstem Connecticut River are sparse and relatively incomplete. Preliminary data on presence of "eel-sized" acoustic targets have been collected (Haro et al. 1998) within the Turners Falls Project's Cabot Station forebay that were somewhat confirmed by video monitoring at the Cabot Station downstream fish bypass; however, these were short-term studies, with acoustic monitoring only performed from 17 September to 5 October and video monitoring only conducted between 18 September to 22 October.

Some daily monitoring of the downstream bypass at the Holyoke Dam (canal louver array) was performed in 2004 and 2005 (Kleinschmidt, Inc. 2005, 2006, Normandeau Associates 2007); these studies also were of relatively short duration (spanning from October 5 to November 10 in 2004 and September 9 to November 11 in 2005) and the sampler was only operated at night.

To date, no other directed studies of eel migratory movements have been conducted at any location on the Connecticut River mainstem. This information gap needs to be filled, as it relates directly to when downstream passage and protection measures need to be operated.

We also note that within the past seven years, the U.S. Fish and Wildlife Service has received two petitions to list the American eel under the Endangered Species Act. The first petition was received on November 18, 2004. On July 6, 2005 the Service issued a substantial 90-day finding on the petition and initiated a 12-month status review that concluded on February 2, 2007 with a finding that listing was not warranted. The second petition was filed on April 30, 2010 by the Council for Endangered Species Act Reliability (CESAR). On September 29, 2011 the Service issued a substantial 90-day finding and initiated a 12-month status review. The Service is still accepting new American eel information for the ongoing status review. The Service also is currently in settlement negotiations with CESAR on their legal complaint that the Service failed to complete the 12-month finding within the statutory timeframe. Although the date for completion of the Service's 12-month finding on the latest petition is uncertain, it is likely that it will be made prior to any new licenses are issued for the projects.

Project Nexus

The timing of downstream migration of adult eels is poorly defined for the Connecticut River; therefore the general effects of hydroelectric project operations on eel survival to the ocean are unknown. Although separate study requests have been submitted to address project-specific downstream passage route selection, delays, and mortality of eels, general characteristics of river flow and environmental conditions may have significant relationships with project operation and eel migratory success and survival. For example, eels may tend to move immediately before or during periods of significant precipitation (or consequently river flow); times at which projects may be generating at maximum capacity or spilling, which may (or may not) present a higher passage risk to eels. Conversely, periods of low flow may be associated with a significant proportion of total river flow passing through turbine units, which present additional (or different) passage risk to eels. If discrete conditions which promote eel downstream migration are known, it may be possible to take actions with respect to project operations which reduce or minimize passage risk; i.e., operation of a bypass, reduction of intake approach velocities, directed spillage through a “safe” route, etc. These studies should provide baseline information on river-specific downstream migration to predict when silver-phase eels are expected to be migrating in the mainstem Connecticut River, from which project operations could be modified to minimize passage risks.

The studies are proposed for a single or multiple sites; the results will be relevant to all sites on the Connecticut River mainstem.

Proposed Methodology

Quantification of downstream movements of American eels in river systems requires systematic sampling of migrants throughout the migratory season. This can be accomplished with traditional active trapping methods; i.e., fyke or stow net sampling, weirs, or eel racks, but these methods are technically challenging on larger mainstem rivers, due to the scale of flows that need to be sampled, difficulties in operation throughout all flow conditions, and high debris loading during fall flows. Passive monitoring of migrant eels using hydroacoustic methods offers an alternative to active trapping. However, passive monitoring requires verification of potential acoustic targets with some level of active (collection) or visual (traditional optical or acoustic video) sampling.

Two potential locations offer opportunities to conduct simultaneous passive and active sampling: the Cabot Station (Turners Falls project) canal/forebay and the Holyoke Dam forebay and canal louver/bypass system. Each location possesses a route of downstream passage which conducts a significant proportion of river flow (Cabot canal and Holyoke forebay or canal), and each has a proximal bypass equipped with a sampler so that fish can be concentrated/collected from the passage route and identified to species. Project operations do influence the relative proportion of flow (and thus numbers of downstream migrant eels) in each passage route, so numbers of eels sampled in each route represent only a proportion of the total number of eels migrating downstream within the entire river. Because the absolute proportion of eels using a specific route at any one time is unknown, numbers of eels quantified within a route must serve as a relative index of the degree of migratory movement.

This study shall quantify eel movements in either one, or preferably both, locations for two consecutive years (since environmental conditions strongly influence migratory timing of eels, which can vary significantly from year to year; Haro 2003). Eels will be quantified using methods similar to Haro et al. (1999), by continuously monitoring a fixed location at the projects with hydroacoustics. Because eels tend to concentrate in areas of dominant flow (Brown et al. 2009, EPRI 2001), the zone to be monitored should pass a dominant proportion of project flow throughout most periods of operation (i.e., forebay intake area). Hydroacoustic monitoring shall encompass the entire potential migratory season, beginning in mid-August and ending in mid-December, and shall operate 24 hours per day. Data will be recorded for later processing and archiving.

Systematic active quantification of eels at downstream bypass samplers shall be performed simultaneously with passive hydroacoustic monitoring, to verify presence of eels and relative abundance of eel-sized hydroacoustic targets from the hydroacoustic data. Although daily operation of the bypass sampler could be performed, a more comprehensive technique is to monitor eels entering the bypass with an acoustic camera (i.e. DIDSON, BlueView, etc.). The acoustic camera will afford positive visual identification of eels as they enter the bypass, which is a concentration point for migrating eels. Acoustic camera monitoring will also allow monitoring to be performed 24 hours a day, and will be relatively unaffected by water turbidity (which influences effectiveness of traditional optical video monitoring). The acoustic camera system will be operated during the same time period as acoustic monitoring, and images will be recorded for later processing and archiving.

Data analyses of hydroacoustic, acoustic camera, bypass sampling, and environmental/ operational data will follow standard methodology.

Project operation (flows, levels, gate openings, number of units operating and operation level) and environmental conditions (river flow, temperature, turbidity, air temperature, precipitation) will be monitored regularly (hourly measurements if possible) throughout the duration of the studies.

These methodologies are consistent with common and accepted practice.

Level of Effort and Cost

The level of cost and effort for the downstream migrant eel migratory timing study would be moderate, given the level of cost for instrumentation, deployment, and data review/analysis. Cost is estimated at $50,000 per year for the study.

The applicant did not propose any studies to meet this need in the PAD.

Literature cited:

Brown, L.S. 2005. Characterizing the downstream passage behavior of silver phase American eels at a small hydroelectric facility. M.Sc. Thesis, Department of Natural Resource Conservation, University of Massachusetts, Amherst, Massachusetts. 110 pp.

Brown, L., A. Haro, and T. Castro-Santos. 2009. Three-dimensional movement of silver-phase American eels in the forebay of a small hydroelectric facility. Pages 277-291in: J. Casselman et al. editors. Eels at the Edge: Science, Status, and Conservation Concerns. American Fisheries Society, Bethesda, MD.

EPRI (Electric Power Research Institute). 2001. Review and documentation of research and technologies on passage and protection of downstream migrating catadromous eels at hydroelectric facilities. EPRI Technical Report No. 1000730, Palo Alto, California 270 pp.

Haro, A. 2003. Downstream migration of silver-phase anguillid eels. Pages 215-222 in: Aida, K., K. Tsukamoto, and K. Yamauchi, eds. Eel Biology. Springer, Tokyo.

Haro, A., D. Degan, J. Horne, B. Kulik, and J. Boubée. 1999. An investigation of the feasibility of employing hydroacoustic monitoring as a means to detect the presence and movement of large, adult eels (Genus *Anguilla*). S. O. Conte Anadromous Fish Research Center Internal Report No. 99-01. Turners Falls, Massachusetts. 36 pp.

Kleinschmidt, Inc. 2005. Factors influencing the timing of emigration of silver-phase American Eels, *Anguilla rostrata*, in the Connecticut River at Holyoke MA. Submitted to the City of Holyoke Holyoke Gas and Electric Department. 27 pp.

Kleinschmidt, Inc. 2006. Holyoke Project (FERC No. 2004) silver-phased American eel flow priority plan. Submitted to the City of Holyoke Holyoke Gas and Electric Department. 51 pp.

Normandeau Associates, Inc. 2007. American eel emigration approach and downstream passage routes at the Holyoke Project, 2006. Submitted to the City of Holyoke Holyoke Gas and Electric Department. Final report. Normandeau Associates, Inc., Westmoreland, New Hampshire. 81 pp.

Requested Study No. 5
Downstream American Eel Passage Assessment at Turners Falls and Northfield Mountain
FERC No. 1889 & FERC No. 2485

Goals and Objectives

The goal of this study is to determine the impact of two hydroelectric projects on the outmigration of silver eels in the Connecticut River. Entrainment of eels at the Northfield Mountain Pumped Storage Station (NFMPS) removes eels from the river, effectively extirpating them from the population. Entrainment at the conventional turbines at Station 1 and Cabot Station of the Turners Falls Project can result in mortality or injury. It is important to understand the passage routes at each project and the potential for mortality to assess alternative management options to increase survival.

The objectives of this study are:

1. Quantify the movement rates (including delays) and relative proportion of eels passing via various routes at the projects; i.e. for NFMPS, the proportion entrained into the intake; for Turners Falls Dam, the proportion entrained into the power canal and spilled via bascule and taintor gates; for the Cabot Canal, proportion of fish passing via spillways, turbines, and the downstream bypass.
2. Evaluate instantaneous and latent mortality and injury of eels passed via the Turners Falls Dam routes, including bascule and taintor gates, spillways, turbines, and the downstream bypass.

Resource Management Goals

The requestor is not a public agency. However, we believe the information gathered as a result of this study would further regional resource management goals, and more specifically The Atlantic States Marine Fisheries Commission’s management plans for American eel:

1. Interstate Fishery Management Plan for American Eel. April 2000. Atlantic States Marine Fisheries Commission.
2. Addendum II to the Fishery Management Plan for American Eel. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

In addition, the Connecticut River Atlantic Salmon Commission (CRASC) developed A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin, 2005 whose implementation would be enhanced by the results of this study.

Public Interest

The Northfield Mountain Project and the Turners Falls Project and other projects in the upper Connecticut River alter flows, impacting aquatic species and communities and specifically American eel movement and habitat use. Flow alterations and barriers at hydroelectric projects thereby affect a public fishery resource.

Existing Information

The PAD contains information on the biology, life history, and regulatory status of American eel. It also discusses 2-D and 3-D telemetry studies that were conducted at Cabot Station in 1996, 1997, 2002 and 2003. Results of those studies indicate that a significant proportion of eels entering the Cabot forebay become entrained (90% in 2002, 100% in 2003; Brown 2005, Brown et al. 2009). The PAD notes that the study done in 2003 determined that 15 of the 29 test eels were detected at the Hadley Falls Station. However, that study was not designed to assess turbine mortality.

To date, no directed studies of eel mortality at Cabot Station or eel entrainment or mortality at either Station 1 or the NFMPS facility have been conducted. These information gaps need to be filled so resource agencies can assess the relative and cumulative impact of project operations on outmigrating eels and develop adequate passage and protection measures to meet management goals and objectives.

We also note that within the past seven years, the U.S. Fish and Wildlife Service has received two petitions to list the American eel under the Endangered Species Act. The first petition was received on November 18, 2004. On July 6, 2005 the Service issued a substantial 90-day finding on the petition and initiated a 12-month status review that concluded on February 2, 2007 with a finding that listing was not warranted. The second petition was filed on April 30, 2010 by the Council for Endangered Species Act Reliability (CESAR). On September 29, 2011 the Service issued a substantial 90-day finding and initiated a 12-month status review. The Service is still accepting new American eel information for the ongoing status review. The Service also is currently in settlement negotiations with CESAR on their legal complaint that the Service failed to complete the 12-month finding within the statutory timeframe. Although the date for completion of the Service's 12-month finding on the latest petition is uncertain, it is likely that it will be made prior to any new licenses are issued for the projects.

Project Nexus

The Turners Falls Project operates as a peaking facility, except during periods when inflow exceeds the hydraulic capacity of Cabot Station and Station 1. Silver eels outmigrate during the mid- summer through late fall, a time of year when flows are generally near the maximum operating capacity of the stations. Therefore, the project would be expected to spill infrequently during the silver eel outmigration beyond the nominal amount required in the bypass reach.

Racks at Cabot Station, Station 1, and NFMPS facility are not designed to protect eels from entrainment. At Cabot, the racks have one-inch clear spacing on the top 11-feet, with five-inch clear spacing on the bottom 20 feet of racks. The approach velocity at the racks is approximately 2.0 feet per second at maximum hydraulic capacity. At Station 1, the racks have 2.6-inch clear spacing and an approach velocity of 1.2 feet per second. Eels can readily pass through a 2.6-inch clear space. NFMPS has 48-foot-deep trashracks with six-inch clear spacing over the intake and an approach velocity of 3.5 feet per second at full pumping capacity (15,000 cfs).

As mentioned above, previous studies conducted at Cabot Station documented eel entrainment. Cabot Station has existing downstream passage facilities designed for anadromous species, but studies have documented few eels utilizing the surface bypass (likely because Cabot has a relatively deep, wide intake area). Station 1 has no passage and protection facilities. NFMPS has a seasonally-deployed barrier net to minimize entrainment of Atlantic salmon smolts, but it is only operated from April through June 15 annually. While no studies have been conducted at Station 1 or NFMPS facility, the rack spacing is wide enough to allow for entrainment.

Proposed Methodology

In order to understand the movements of outmigrating silver eels as they relate to operations at the Northfield Mountain Pump Storage Facility, Station 1, and Cabot Station, radio telemetry technology should be utilized. Radio telemetry is an accepted technology that has been used for a number of studies associated with hydropower projects, including at the Muddy Run Project (FERC No. 2355).

Studies should be designed to investigate route selection (i.e., entrainment vs. spill) independently from estimation of mortality/injury, because these metrics require different telemetric methodologies. Studies also will likely benefit from data from several seasons (especially route selection studies, which may be more significantly affected by environmental conditions during a given season that mortality/injury studies). It is also envisioned that results from route selection studies can guide design of turbine mortality studies. Therefore, it is proposed, at a minimum, that route selection studies be conducted in multiple years, but mortality/injury studies may be conducted after the first year of route selection studies have been completed.

1. Objective 1: Route Selection
   This study will involve systematic releases of radio-tagged silver phase eels at strategic points above areas of interest, to assess general routes of passage (i.e., via spill, bypass, or turbines). Active downstream migrants should be collected within-basin if possible (i.e., Cabot or Holyoke bypass samplers), but fish sourced from out of basin may be acceptable to meet sample size demands. Experimental fish must meet morphometric (e.g. eye diameter relative to body size) criteria to ensure they are migrant silver phase. Collections should be made within the migratory season (late Aug to mid Oct), and eels should be tagged and released within 7 days of collection.

NFMPS Route Selection Study:
A minimum number of 50 telemetered eels (e.g., 5 separate groups of approximately 10 eels each) will be required to maximize the data return. Eels will be released at least 5 km upstream of the NFMPS project; releases should be timed so that there is a significant probability that migrating eels will encounter NFMPS during the pumping stage. Radio telemetry antennas will be strategically placed to determine times eels are present within the river reach in the vicinity of the NFMPS intakes, within the intakes themselves, and whether they are entrained into the upper reservoir.

Turners Falls Dam Route Selection Study:
A minimum number of 50 telemetered eels (e.g., 5 separate groups of approximately 10 eels each) will be required to maximize the data return. Groups of eels should be released during spill and non-spill periods if possible. Tagged eels will be released at least 3 km upstream of the Turners Falls dam but several km below the intake to NFMPS. Telemetry receivers and antennas will be located above and below the dam to assess passage via the following potential routes: entrainment into power canal; passage via spill over the bascule gates; passage via spill through the taintor gates.

Eels from the NFMPS route study not entrained into the NFMPS intake and migrating to the Turners Falls Dam may be used to supplement (but not serve in lieu of) these release groups.

Turners Falls Project – Canal Route Selection Study:
A minimum number of 50 telemetered eels (e.g., 5 separate groups of approximately 10 eels each) will be required to maximize the data return. Groups of eels should be released during periods of low, moderate, and high generation conditions if possible. Eels will be released in the upper canal (ideally just downstream of the Gatehouse), and allowed to volitionally descend through the canal. Telemetry receivers and antennas will be located within the canal, bypass, channel, and mainstem below Cabot Station to assess passage via the following potential routes: Spillway Fishway attraction water intake (if operational); Station 1 turbines; Cabot Station spillway; Cabot Station bypass; Cabot Station turbines

Eels from the NFMPS and Turners Falls Dam Route Studies not entrained into the NFMPS intake and migrating into the Turners Falls Canal may be used to supplement (but not serve in lieu of) these release groups.

Mobile tracking (i.e., via boat) in river reaches between release sites and several km downstream of Cabot Station will be performed at regular intervals during and after releases to confirm routes and fates of passed fish, or fish lost to follow-up.

Movement rates (time between release and passage) of eels passing the projects by various routes will also be quantified.

The route selection portion of this study should occur in both study years.

2. Objective 2: Spill, Bypass, and Turbine Mortality/Injury Studies
Spill, bypass, and turbine mortality will be assessed using a radio-telemetric balloon tag method. A minimum number of 50 tagged eels (e.g., 5 separate groups of approximately 10 eels each) will be required at each location (dam bascule gate, dam taintor gate, Cabot Station spillway, Cabot Station bypass, Station 1 and Cabot Station) to maximize the data return. Turbine mortality studies are not required at NFMPS because it is assumed that all entrained fish (including eels) are lost to the Connecticut River system.

For spill mortality sites (dam bascule gate, dam taintor gate, Cabot spillway, Cabot Station bypass), tagged eels will be injected or released into spill flow at points where water velocity exceeds 10 ft/sec, to minimize the possibility of eels swimming upstream into the headpond or canal. Passed balloon-tagged eels will be recovered below areas of spill and held for 48 hours in isolated tanks for observation of injury and latent mortality; unrecovered balloon-tagged eels will be censored from the data.

For turbine mortality sites (Station 1 and Cabot Station), tagged eels will be injected into intakes of units operating at or near full generation at points where intake water velocity exceeds 10 ft/sec, to minimize the possibility of eels swimming back upstream through the intakes. Passed balloon-tagged eels will be recovered in the tailrace and held for 48 hours in isolated tanks for observation of injury and latent mortality; unrecovered balloon-tagged eels will be censored from the data.

Mobile tracking (i.e., via boat) in river reaches between release sites and several km downstream of Cabot Station will be performed at regular intervals after releases to confirm routes and fates of passed fish, or fish lost to follow-up.

The turbine mortality component of the study should occur in Study Year 2.

Data analyses of route selection and turbine mortality (instantaneous and latent) will follow standard methodology.

Project operation (flows, levels, gate openings, number of units operating and operation level) and environmental conditions (river flow, temperature, turbidity, air temperature, precipitation) will be monitored regularly (hourly measurements if possible) throughout the duration of the studies.

These methodologies are consistent with accepted practice.

Level of Effort and Cost

The level of cost and effort for the downstream eel passage study would be moderate to high; silver eels would need to be collected, tagged, and released in several locations over the course of the migration season. Antennas and receivers would need to be installed at the intakes to all stations as well as at the Turners Falls dam spillway and Cabot Station bypass, and monitored regularly. Data would need to be retrieved periodically, then analyzed. A multi-site route selection study conducted by the USGS Conte Lab on the Shetucket River in Connecticut cost approximately $75,000 for the first year of study. Cost are estimated at $100,000 per year for the Route Selection studies and $75,000 per year for the Spill, Bypass, and Turbine Mortality/Injury Studies.

In the PAD, the applicant has identified the need to assess issues related to downstream passage for American eels at the project, but indicates that it intends to rely on information from previously conducted studies and ongoing studies. TU is not aware of any previously conducted or ongoing studies related to downstream eel passage.

Literature cited:

Brown, L.S. 2005. Characterizing the downstream passage behavior of silver phase American eels at a small hydroelectric facility. M.Sc. Thesis, Department of Natural Resource Conservation, University of Massachusetts, Amherst, Massachusetts. 110 pp.

Brown, L., A. Haro, and T. Castro-Santos. 2009. Three-dimensional movement of silver-phase American eels in the forebay of a small hydroelectric facility. Pages 277-291in: J. Casselman et al. editors. Eels at the Edge: Science, Status, and Conservation Concerns. American Fisheries Society, Bethesda, MD.

EPRI (Electric Power Research Institute). 2001. Review and documentation of research and technologies on passage and protection of downstream migrating catadromous eels at hydroelectric facilities. EPRI Technical Report No. 1000730, Palo Alto, California 270 pp.

Requested Study No. 6
Model flows in the Northfield Mountain Pumped Storage Project discharge tailrace and Connecticut River 1 kilometer upstream and downstream of the discharge using two-dimensional Computational Fluid Dynamics (CFD) model techniques
FERC No. 2485

Goals and Objectives

The goal of this study is to determine the potential impacts (both project-specific and cumulative) of the Northfield Mountain Pump Storage Project operations (pumping and generating) on the zone of passage for migratory fish near the Northfield Mountain turbine discharge/pump intake, on natural flow regimes in the area of the Connecticut River immediately upstream and downstream of the project, on the potential for entrainment during pumping operations, on the potential for creating flow reversals in Connecticut River during pumping cycles that may confuse migratory fish attempting to pass the project, and on bank erosion on both sides of the river in the vicinity of the tailrace.

Specific objectives of the study include:

- Develop a 2-dimensional CFD modeling capability for the area of the Northfield Mountain discharge and tailrace, along with the full width of the Connecticut River 1km upstream and 1 km downstream of the discharge.

- Model flow characteristics upstream and downstream of the project under existing project operations (pumping and generating) and at several representative river flow levels, as well as proposed operations such as those proposed in section 3.4.4 of the PAD, and any other modifications under consideration, to assess potential impacts to fish and wildlife resources, recreational use, agricultural resources, and historical resources.

- Assess velocities at and in proximity to the Northfield Mountain intake/discharge structure, when pumping or generating and their potential to interfere with fish migration.

- Assess the potential for velocity barriers in the mainstem river resulting from pumping and generation flows at the project, alone or in combination with generation flows from the upstream Vernon Project.

- Assess potential for Northfield Mountain project operations to create undesirable attraction flows to the intake/discharge that may result in entrainment or delay of migratory fish.

- Assess the potential of a mainstem instream local flow reversal associated with pumping operations to impact migrating fish. The Connecticut River in the area of the Northfield Mountain tailrace has been said to flow upstream potentially confusing migratory fish keying in to flow as a directional aid to upstream or downstream migration, causing delay and additional "fish" energy expense and possible entrainment.

- Model and then evaluate flow characteristics under alternative project operations with potential measures to avoid, minimize, or mitigate impacts to fish and wildlife resources.

- Assess the potential for unnatural flows and eddies in the main-stem associated with pumping or generation at the Northfield Mountain Project to impact bank erosion and recreational use.

Resource Management Goals

The requestor is not a public agency. However, we believe the information gathered as a result of this study would further regional resource management goals, and more specifically The Atlantic States Marine Fisheries Commission's management plans for American eel:

1. Interstate Fishery Management Plan for American Eel. April 2000. Atlantic States Marine Fisheries Commission.
2. Addendum II to the Fishery Management Plan for American Eel. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

In addition, the Connecticut River Atlantic Salmon Commission (CRASC) developed A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin, 2005 whose implementation would be enhanced by the results of this study.

Public Interest

The Northfield Mountain Project alters flows during pumping and generation cycles, impacting riverine and migratory aquatic species and communities most directly through entrainment during the pumping phase of operations. Fish that are entrained are for all intents and purposes extirpated from the river. Angling for shad is directly impacted by a reduced population caused by entrainment at the Northfield Project. Flow alterations and barriers at hydroelectric projects affect a public fishery resource.

Existing Information

No project specific information exists that will allow for a comprehensive assessment of existing project operations (pumping and generating flows) on Connecticut River flows and on fish and aquatic organisms in the project area upstream and downstream of the project in the Connecticut River. Preliminary results from an ongoing study of radio-tagged American shad by the USFWS and USGS Conte lab indictate that shad are exposed to the intakes and some individuals spend substantial amounts of time in the vicinity of the intakes. The PAD does not contain any information or tool that will allow for predictions of impacts of alternative project operations, or potential mitigation measures to protect or enhance aquatic fish and wildlife resources.

As part of Field (2007; see appendix 4), a "Connecticut River Hydraulic Analysis – Vernon Dam to Turners Falls Dam" was completed by Woodlot Alternatives in July 2007. For this analysis, a 2-dimensional flow model was developed for the entire Turners Falls impoundment. This study was geared towards looking at shear stresses from high-flow events, and did not focus in detail around the tailrace or examine how pumping and generation may affect flows in the vicinity of the tailrace under a variety of flows.

As a result of the hydraulic analysis, Field (2007) on page 20 states that "While erosion does occur where high flow velocities and shear stresses approach near the bank, significant amounts of erosion also occur where flow velocitieis near the bank are low." No specific examination was done in the report on the ±1 km area near the tailrace and existing erosion sites. Banks immediately upstream and downstream and across river have all required bank stabilization projects over the last 15 years, in some cases needing several repairs.

Project Nexus

Existing project operations have a direct impact on instream flow and aquatic habitat in the pump/discharge area of the Connecticut River. The PAD in section 3.2.2 says that the velocity at the trash racks when operating at full capacity is 20,000 cfs and maximum pumping conditions are 15,200 cfs. Annual flow duration curves shown for below the Vernon Dam submitted in the PAD section 4.3.1.2 (for years 1944-1973; recent and near project flows are not available; see p. 459) indicate that river flows are ≤ 20,000 cfs more than 85% of the time. Flows released from the project must therefore influence flow patterns and velocities in the Connecticut River, particularly at flows below some unknown threshold level.

Recreational users of the Connecticut River in the Turners Falls impoundment have anecdotally described flow reversals in the mainstem river. Discharges from the project could potentially be larger than river flows or at least act like a major tributary to the Connecticut River. Project flows may influence the availability and extent of upstream and downstream migration zones, or may confuse fish and delay migration. Project flows may also impact stream banks in ways that natural river flow (or flows affected by upstream hydropower facilities) does not, and may also impact recreational use of the river.

Proposed Methodology

CFD modeling is consistent with generally accepted practice, and has been used to assess proposed modifications to the Holyoke Dam fish passage facilities, upstream of the intakes and downstream of the dam, as well as at hydroelectric projects on the Susquehanna River to assess existing and proposed project operations, and develop mitigation measures for fish and wildlife resources.

Level of Effort and Cost

This study will require a detailed elevation map of the study area upstream and downstream of the Northfield Mountain project. Information already exists in historic construction files for the project, the hydraulic analysis included in Appendix 4 of Field (2007), and possibly in conjunction with work done after the 2010 maintenance procedures that resulted a portion of the river being dredged after a large sediment dump) that are in the possession of the applicant. Additional elevation data will likely need to be collected in the field using standard survey techniques. Elevation data will then need to be entered into a CFD modeling program. The CFD computer program will need to simulate existing project operations that include all potential variations of pumping and generating, and static operation. No project specific instream flow analysis tool has been developed for the Northfield Mountain project that will allow for assessment of existing operations and alternative operational impacts on instream flow and aquatic habitat for fish and wildlife resources. The computer model, once built, can be used to simulate flow conditions in the vicinity of the project during migratory fish passage and can be used together with behavior studies (i.e., telemetry studies and entrainment studies requested herein) to assess the impacts of varying project operations or potential mitigation operations and measures on fish migration and aquatic habitat. We know of no other tool that will provide for these types of assessments. Cost is expected to be moderate to high.

Requested Study No. 7
Entrainment of Migratory and Riverine Fish from the Connecticut River into the Northfield Mountain Pump Storage Project.
FERC No. 2485

Goals and Objectives

The goal of the study is to determine the impact of Northfield Mountain Pump Storage Project (NFMPS) during the pumping cycle on entrainment of juvenile American shad, adult shad, adult American eel, and riverine fish, including early life stages.

The objective of the study is to quantify the number of resident and migratory fishes entrained at the NFMPS intake on an annual basis in order to evaluate potential impacts to riverine fish populations in the Turners Falls pool and diadormous fish migrants moving through the project area. This will be accomplished through a combination of hydroacoustic monitoring and netting using various gear types to quantify and identify species of different life stages.

Resource Management Goals

The requestor is not a public agency. However, we believe the information gathered as a result of this study would further regional resource management goals and more specifically The Connecticut River Atlantic Salmon Commission's *Management Plan for American Shad in the Connecticut River* and their Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basinas well as the Atlantic States Marine Fisheries Commission's management plans for American eel.

Public Interest

The Northfield Mountain Project alters flows during pumping and generation cycles, impacting riverine and migratory aquatic species and communities most directly through entrainment during the pumping phase of operations. Fish that are entrained are for all intents and purposes extirpated from the river. Angling for shad is directly impacted by a reduced population caused by entrainment at the Northfield Project. Flow alterations and barriers at hydroelectric projects affect a public fishery resource.

Existing Information

Limited project-specific information exists regarding entrainment of fish and aquatic organisms at the NFMPS. As part of a Memorandum of Agreement between then-owner Northeast Utilities Service Company (NUSCO) and regulatory agencies (including the

Service), NUSCO conducted studies to determine the impact of NFMPS on anadromous fishes, including Atlantic salmon, American shad, and blueback herring. Results of a pilot study conducted in the fall of 1990 indicated that trap netting at the intake was ineffective at collecting fish. Gill netting and boat-shocking did result in collection of some juvenile shad, but further refinement in both methods was recommended to improve effectiveness. A total of 78 fish were collected at the intake (77 of which were American shad) by gill netting and 11 shad were collected by boat electrofishing. Hydoacoustic monitoring was deemed an effective method for monitoring entrained fish during pumpback operation. Hydroacoustic sampling over a two-week period (September 12-27, 1990) produced hourly entrainment estimates that cumulatively equaled 14,816 fish.

Based on the results of the pilot study, NUSCO developed a two-year plan to quantitatively determine the number of shad and salmon entrained at NFMPS station. In 1992, an entrainment study targeting juvenile American shad life stages was conducted in the lower (mainstem river) and upper reservoirs of NMPS. The study used several gear types to quantify egg through juvenile shad densities in different areas. Entrained juveniles were sampled using an upper reservoir net. Pumping operations were modified to only run three (77% of sample time) and sometimes two (23% of sample time) of the station's four units during the study and effort was limited to a total of 80 hours over a period spanning 9 August through 27 October (80 days). An estimated total of 1,175,900 shad eggs, 2,744,000 yolk-sac larvae, 10,525,600 post yolk-sac larvae, and 37,260 juveniles were reported entrained.

There are no reliable data on the timing, magnitude and duration of entrainment of larval riverine fishes in the NFMPS area. Unlike anadromous shad and river herring, , riverine species occurrence and susceptibility relative to space and time exposure windows to NFMPS pumping, are undocumented. The complete lack of any long-term fish population monitoring data for riverine species in the Turners Falls impoundment leaves questions unanswered on the types and extent of impacts to these populations that may be linked to the near daily cycling of river water up and down through the NFMPS operations system. As a starting point, it is necessary to obtain baseline data on project operation impacts for all species potentially impacted by NFMPS. An additional study request seeks to obtain a more accurate documentation of all fish species inhabiting or utilizing the Turners Falls impoundment.

Project Nexus

Entrainment of fish and aquatic organisms associated with water withdrawal and hydroelectric operations has been documented to result in injury or death of entrained organisms. Migratory and resident fish pass through the project area directly in front of the pump intakes. These organisms may be entrained and thus exposed to passage though the project pumps and reservoir supply tubes. How far from the intake these species and life stages may be drawn into the intake on a pumping cycle or how susceptible they are to the repeated daily cycles of pumping and discharge, and how these factors vary in relation to habitat and river conditions are unknown. Survival of fish subjected to entrainment on the pumping cycle is unknown, but regardless of whether fish survive the pumping process, they are lost to the Connecticut River system. Depending on the species, life stages, and numbers entrained, this loss could impact the ecosystem productivity of the Turners Falls pool and may hinder restoration goals for diadromous fishes.

Previous entrainment studies have been conducted at the project. Those studies, which were done 20 years ago, documented entrainment of American shad and Atlantic salmon at the project, including over 13 million yolk sac and post-yolk sac larvae of American shad. This level of entrainment is cause for concern, not only due to the resultant loss of potential adult returns, but for the important role early life history phases and juveniles play in their ecological contributions to the river system (e.g., trophic interactions).

No entrainment studies for other species of fish have been conducted at the project. The unknown extent of other riverine species ichthyoplankton entrained by the NFMPS requires evaluation. Studies conducted in 1969 and 1970 at the Muddy Run Pumped Storage Station documented significant entrainment of eggs and larval fish. In June and July of 1970, 5.3 million eggs and 56.6 million larvae were entrained (Snyder 1975). Muddy Run and NFMPS are of a similar size and both use a river as the lower reservoir. It is anticipated that a considerable number of eggs and larvae will be entrained by the NFMPS.

Since the previous studies were conducted, operations at the NFMPS facility have changed (e.g., the project increased the efficiency of its turbines, and raised the pumping capacity from 12,000 cfs up to 15,000 cfs), as have river conditions (e.g., Vermont Yankee has increased its thermal discharge and the Vernon Project has increased its station capacity). Further, the PAD indicates that FirstLight will evaluate the feasibility of utilizing an additional 3,009 acre-feet of storage capacity to generate an additional 1,990 MWhs (this represents a 23% increase over existing storage and stored generation levels). While not specified in the PAD, increasing storage and generation would mean longer periods of both pumping and generation at NFMPS. In addition, anticipated improvements in fish passage at the Turners Falls Project will result in increased juvenile production above the NFMPS. These factors, individually or cumulatively, could increase the potential for entrainment at NFMPS station.

Proposed Methodology

Previous studies used varying methodologies for determining entrainment. The 1990 study concluded that hydroacoustic monitoring at the intake was a viable method for determining entrainment of later life stages, but does not allow for identification of the species being entrained. While trap netting was ineffective at collecting fish near the intake, gill netting and boat shocking did capture some fish. Both may prove to be viable sampling methods; however it is likely that additional testing and gear refinement will be necessary.

The 1992 study used nets at the pump discharge location into the upper reservoir to collect entrained fish. Testing showed that this method was only 10% efficient. Plankton netting in the nearfield area of intake was used to estimate entrainment of ichthyofauna. It is likely that a combination of methods would provide the most reliable results (e.g., hydroacoustic monitoring at the racks during pumpback operations, variable gear sampling in the vicinity of the intake immediately prior to initiation of pumpback operations to determine species composition, and plankton netting in the nearfield area of the intake to obtain information on entrainment of ichthyofauna). As these methodologies have previously been utilized at the site, they are consistent with accepted practice.

Although a previous entrainment study was conducted, TU believes it should be repeated, using a modified study design. The 1992 study only collected a total of 330 juvenile shad over a three-month period (resulting in an overall estimate of 37,260 juveniles entrained, after accounting for poor net efficiency); whereas the hydroacoustic study conducted in 1990 estimated nearly 15,000 fish in 15 days (while these fish were not identified, 77 of the 78 fish collected at the intake during the study were juvenile shad). It also should be noted that in the 1992 study, juvenile shad were collected on the first day of sampling, indicating that the sampling did not begin early enough, which would mean the results are an underestimate of the number of juvenile shad that were actually entrained. In 1990, 27,908 adult shad passed the Turners Falls gatehouse, while in 1992 over 60,000 shad passed gatehouse. The fact that the numbers entrained were so variable between study years argues for repeating the study, using a combination of previously-used methodologies.

The study will require deployment of at least five hydroacoustic transducers (one per rack face and one offshore). These transducers would be operated during every pumping cycle from April 15 through May 14 to assess riverine fish entrainment, from May 15 through July 15 for spent adult shad, and from July 16 through November 30 for entrainment of adult silver eels, juvenile American shad, and riverine fishes. Concurrent field sub-sampling at the intake to determine species composition would need to occur.

Sampling for planktonic fish larvae should capture early spring spawning species (white suckers) through later season centrarchid species (bass and sunfish). Active plankton trawl surveys should utilize a sampling design that adequately captures temporal and spatial changes in water pumping cycle (i.e., early start-up is local water, later cycle pumping is drawn in from both upstream and downstream habitat areas).

These methodologies are consistent with accepted practice.

Level of Effort and Cost

We know of no other tool that will provide for this type of assessments for all fish species and organisms that may pass through the project. Cost and effort are expected to be high.

The applicant did not propose any studies to meet this need in the PAD.

Literature cited:

CRASC. 1992. A Management Plan for American Shad in the Connecticut River.

Harza Engineering Company. 1991. Draft Northfield Mountain Pumped Storage Project 1990 Field Sampling Program. February 1991. Northeast Utilities Service Company, Berlin, CT.

Lawler, Matusky and Skelly Engineers (LMS). 1993. Northfield Mountain Pumped-Storage Facility – 1992 American Shad Studies. February 1993. Northeast Utilities Service Company, Berlin, CT.

Memorandum of Agreement NUSCO. July 1990.

Snyder, D.E. 1975. Passage of fish eggs and young through a pumped storage generation station. J. Fish Res. Board Canada. 32: 1259-1266.

Requested Study No. 8
Upstream American Eel Passage Assessment at Turners Falls
FERC No. 1889

Goals and Objectives

This study has two objectives:

1. Conduct systematic surveys of eel presence/abundance at Cabot Station discharge, Station #1 discharge, canal discharges, and Turners Falls Dam to identify areas of concentration of eels staging in pools or attempting to ascend wetted structures that would potentially establish the most effective locations to place upstream eel passage facilities.
2. Collect eels with temporary trap/pass devices from areas identified from surveys as potential locations of eel concentration to assess whether eels can be collected/passed in substantial numbers, and whether locations are viable sites for permanent eel trap/pass structures.

Resource Management Goals

The requestor is not a public agency. However, we believe the information gathered as a result of this study would further regional resource management goals, and more specifically The Atlantic States Marine Fisheries Commission's management plans for American eel:

1. Interstate Fishery Management Plan for American Eel. April 2000. Atlantic States Marine Fisheries Commission.
2. Addendum II to the Fishery Management Plan for American Eel. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

In addition, the Connecticut River Atlantic Salmon Commission (CRASC) developed A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin, 2005 whose implementation would be enhanced by the results of this study.

Public Interest
The Turners Falls Project and other projects in the upper Connecticut River alter flows, impacting aquatic species and communities and specifically American eel movement and habitat use. Flow alterations and barriers at hydroelectric projects thereby affect a public fishery resource.

Existing Information
The PAD contains no information relative to areas where eels seeking to move upstream concentrate downstream of the dam, or annual numbers of eels attempting to ascend past Turners Falls Dam. While eels have been known to ascend the Cabot Station ladder (A. Haro, U.S. Geological Survey, pers. comm.), its efficiency is unknown, and it is only operated during the American shad passage season (from April 1 through July 15). Eels are currently able to pass the Turners Falls Dam complex (as evidenced by documented presence of eels upstream), but the total number of eels attempting to pass Turners Falls and the proportion successfully passing the project is unknown (but suspected to be low). The downstream Holyoke Project has operated upstream eel passage facilities since 2004. Last year these facilities passed over 40,000 juvenile eels. While there is rearing habitat in between the Holyoke and Turners Falls dams, some eels will attempt to continue upstream, and passage needs to be provided so these fish can access historical habitat.

These information gaps need to be filled so resource agencies can determine the best locations to site upstream eel passage facilities and assess whether operating the existing anadromous ladders would be an effective mechanism to move juvenile eels upstream past the project.

We also note that within the past seven years, the U.S. Fish and Wildlife Service has received two petitions to list the American eel under the Endangered Species Act. The first petition was received on November 18, 2004. On July 6, 2005 the Service issued a substantial 90-day finding on the petition and initiated a 12-month status review that concluded on February 2, 2007 with a finding that listing was not warranted. The second petition was filed on April 30, 2010 by the Council for Endangered Species Act Reliability (CESAR). On September 29, 2011 the Service issued a substantial 90-day finding and initiated a 12-month status review. The Service is still accepting new American eel information for the ongoing status review. The Service also is currently in settlement negotiations with CESAR on their legal complaint that the Service failed to complete the 12-month finding within the statutory timeframe. Although the date for completion of the Service's 12-month finding on the latest petition is uncertain, it is likely that it will be made prior to any new licenses are issued for the projects.

Project Nexus
The project generates hydropower on the head created by the Turners Falls dam. This dam creates a barrier to upstream migrating eels. While some eels are able to pass dams, some are not, and the passability of a given dam depends on factors such as its height, hydraulics, presence of climbable surfaces, presence of predators, risk of exposure to heat or drying while climbing a dam, etc. The Turners Falls dam is high (35 feet above bedrock), and the majority of the dam face is dry during most of the upstream eel passage

season. Design of the dam is not currently amenable to passage of eels by climbing. While flow is released to the bypass reach via a bascule gate (typically the one closest to the gatehouse), this would not facilitate eel passage, as bascule gates open outward and downward (i.e., requiring the eels to essentially swim nearly upside down to get over the gate). As mentioned earlier, the existing anadromous passage facilities are not designed to pass eels, and even if some eels are able to ascend the ladders, they may incur delays (in attraction or passage rates), be size-selective (e.g. velocity barrier for small eels presented by ~8 ft/sec flow through weirs and orifices), present a potential predation risk (predators in or near the fishways), and are not operated throughout the upstream eel passage season.

Proposed Methodology

1. Objective 1: Systematic Surveys
   Surveys of eel presence and relative abundance should be conducted at regular intervals throughout the eel upstream migratory season (~1 May to ~15 October, or when river temperatures exceed 10 C). Surveys should consist of visual inspection and trapping in likely areas where eels may concentrate as they attempt to climb structures wetted by significant spill or leakage flow in the Turners Falls dam complex area. These locations include: Cabot Station downstream bypass outfall, Cabot Station spillway (including attraction water stilling basin), Cabot Fishway (dewatered state), USGS Conte Lab flume outfall, Number One Station outfall, various small turbine and process water outfalls from the Cabot Canal, Spillway Fishway attraction water stilling basin, and leakage points along the downstream face of Turners Falls Dam (bascule and taintor gates). Methods should include visual surveys (on foot, from a boat, or snorkeling) and trapping using small mesh (< 1/8" clear opening) baited eel pots. Visual surveys should be performed once per week, at night, preferentially during precipitation events. Trap sets should be performed once per week, with an overnight soak time. Recorded data should include location, observation of eels (presence, absence, relative numbers, relative sizes, behaviors, time/date of observation), and survey method.

2. Objective 2: Trap/Pass Collections
   Areas identified from Systematic Surveys as having significant number of eels present should be targeted as potential areas for permanent eel trap/passes, and should be initially assessed using temporary/portable trap passes. At a minimum (regardless of survey results), temporary trap passes should be installed at the following locations: Cabot Fishway attraction flow stilling basin (during dewatered fishway period), Number One Station outfall, and Spillway Fishway attraction flow stilling basin (during watered and dewatered fishway period), as these locations may be supplemented with additional attraction flow and have high potential for being concentration points for upstream migrant eels. Temporary trap/passes should be purpose-designed and built for each location, and operated throughout the eel upstream migratory season (~1May to 15 October, or when river temperatures exceed 10 C). Ramp-type traps with supplementary attraction flow are preferred temporary trap/pass designs. Traps should operate daily, with catches quantified every 2-3 days. Recorded data

should include location, trapping interval, absolute numbers of eels trapped, relative eel sizes, and hydraulic and environmental conditions during the trapping period.

All collected eels from surveys should be released at their point of capture; those eels collected from trap/pass collections should be transported to and released above the dam in the Turners Falls Pool.

These methodologies are consistent with accepted practice.

Level of Effort and Cost

The level of cost and effort for the survey component of the study would be low; a minimal number of personnel may be able to conduct the weekly surveys. The trap/pass component would require low to moderate cost (estimated at $40,000) and effort.

In the PAD, the applicant has identified the need to assess issues related to upstream passage for American eels at the project, but indicates that it intends to rely on information from previously conducted studies and ongoing studies. TU is not aware of any previously conducted or ongoing studies related to upstream eel passage.

Requested Study No. 9
Impacts of Turners Falls Canal Drawdown on Fish Migration and Aquatic Organism Populations
FERC No. 1889

Conduct a study to quantify impacts of the annual Turners Falls Canal drawdown on emigrating and resident fishes, freshwater mussels, odonates, and mudpuppies in the canal.

Goals and Objectives

Quantitatively assess the effects of the Turners Falls Canal drawdown on diadromous fishes and other aquatic organisms known to be present in the canal during the annual drawdown.
Objectives of this study request include:

1. Determine whether juvenile shad and American eel abundance in the canal increases leading up to the time of its closure, due to delays in downstream passage (e.g., is fish accumulation occurring?)
2. Determine level of mortality for juvenile sea lamprey from exposure of burrow habitats;
3. Conduct surveys to determine aquatic organisms (fishes, freshwater mussels, odonates, and mudpuppies) present in the canal during the drawdown, their densities, status (stranded, dead, alive), and locations (mapping to document habitat, substrate type, wetted , at complete drawdown);
4. Evaluate measures to minimize aquatic organism population impacts of the canal drawdown.

Other submitted Study Requests compliment or directly relate to this project activity and assessing project effects, including the resultant effects of all river flow being passed over the Turners Falls Dam as spill (e.g., downstream juvenile shad study request and American eel movement and survival request).

Resource Management Goals

The requestor is not a public agency. However, we believe the information gathered as a result of this study would further regional resource management goals, and more specifically The Atlantic States Marine Fisheries Commission's management plans for American eel:

1. Interstate Fishery Management Plan for American Eel. April 2000. Atlantic States Marine Fisheries Commission.
2. Addendum II to the Fishery Management Plan for American Eel. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

In addition, the Connecticut River Atlantic Salmon Commission (CRASC) developed A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin, 2005 whose implementation would be enhanced by the results of this study.

Public Interest

The Turners Falls Project during drawdown dewaters the power canal, impacting aquatic species and communities. Multiple aquatic species die as a result of dewatering. These deaths affect a public aquatic and fishery resource.

Existing Information

Existing information in the PAD does not provide data on the population size or survival rates of juvenile American shad, American eels, or juvenile sea lamprey located in the power canal during the de-watering process. The power canal is dewatered in early September of each year for over a one week period to perform facility maintenance, inspections, and repairs including substantial silt removal and bank repairs. Historically, the canal drawdown occurred in July, but approximately five years ago it was moved to September, where it has occurred annually since then, with the exception of 2010. The agencies were informed in a letter by FLP that the shift to September was at the request of the Independent System Operator –New England (ISO-NE) to avoid peak load months of June through August. Studies conducted by the previous operator, Northeast Utilities Service Company (NUSCO), to assess downstream clupeid survival and use (1991 and 1994 studies at Cabot Station) support the contention that juvenile shad out-migration is occurring within the current drawdown time frame. There are no data to suggest that out-migration would occur earlier than 1 August, but likely does begin in the month of August (O'Donnell and Letcher 2008). Based on these data, CRASC altered its Fish Passage Notification Letter for Downstream Passage Operations for juvenile shad and herring to require the Cabot Station downstream bypass to begin operating.on 15 August in 2010 and then moved the date to 1 August in 2011

It is unknown, whether the power canal may, through potential mechanism(s) of delay due to its configuration or operation, cause out-migrating juvenile shad to accumulate in the canal. This information gap leads to concerns that migrant numbers may be elevated beyond simple extrapolations of surface area comparison in the canal to main stem habitat. In the PAD, FLP indicates that the Cabot Station forebay in the vicinity of the intake has a maximum depth of 60 feet, while the existing near-surface downstream bypass structure at the Cabot Station is designed to operate only within a depth of six feet of the surface. As a result, the downstream bypass only operates effectively for a short period during the drawdown period (timing of this is unknown). The only points of egress, once the bypass becomes unavailable, are through the turbines at Cabot as well as at Station 1, and eventually at the Keith Street gate located well upstream from the Cabot Staion intakes. It is unknown what the survival rates are for these passage routes, what proportion of fish are using each route, what number may become stranded and their survival rates, and how many fish are subjected to this situation. The related Study Requests on downstream juvenile shad outmigration and American eel outmigration outline objectives that would address some of these information gaps.

There is also a paucity of information relative to the disposition of fish moving downstream in the impoundment during the canal drawdown. Once the Turners Falls Gatehouse closes its gates, all inflow passes over the dam; a situation unique to this brief one week annual time period. Survival rates for outmigrating juvenile American shad and adult American eel moving past the project during the period of spill are not known.

Lastly, there exists an information gap regarding the fate of juvenile sea-lamprey (known as ammocetes) that reside in the soft substrate materials located in much of the lower or downstream end of the canal (personal communication, Boyd Kynard). In previous drawdowns, thousands to tens of thousands of dessicated ammocetes have been observed (Matt O'Donnell, personal communication, USGS Conte Lab). However, the distribution and abundance of ammocetes in the canal as well as mortality rates for ammocetes during the drawdown period has not been quantitatively determined.

Project Nexus

Previous studies at Cabot Station have documented that juvenile American shad and American eel migrate through the project area during the canal drawdown period. During normal operations (where canal water level elevations are stable), downstream migrants are able to utilize the Cabot bypass facility; however, as the canal water level is drawn down, the bypass is no longer available, and the only routes of egress are through the turbines at Cabot Station and Station 1, unless the Cabot Station spill gates are utilized (the spill gates have a canal depth limitation of approximately 16 feet). Turbine entrainment at hydropower projects has been shown to cause injury and mortality to fishes.

The annual canal drawdown was formerly conducted in July. In response to ISO-NE's request that FL conduct the drawdown outside of the June through August period, FL moved the drawdown to a period of time when diadromous fishes are known to be moving through the project area.

Once the canal has been drawn down, isolated shallow pools are left standing until the canal is refilled. During this period, fish (including lamprey ammocetes), amphibians, and benthic invertebrates are prone to dessication, predation or other sources of mortality or impact.

Proposed Methodology

The methods presented here are consistent with the study requests addressing downstream juvenile American shad passage and downstream American eel passage, with an emphasis on addressing survival and movement immediately prior to and during the canal draw down. Hydroacoustic monitoring immediately upstream of the Turners Falls Gatehouse, as well as upstream of opened dam gates for spill, will provide data on the timing, frequency and magnitude of natural wild juvenile shad movement into these areas, particularly the power canal. The abundance of juvenile shad moving into the canal can be derived and compared with similar data obtained with hydroacoustic equipment monitoring upstream of the Cabot Station intake and bypass, for comparisons. Juvenile shad will be PIT tagged, released, and monitored in the canal, for movements, timing and location including Station 1 canal and forebay. PIT tagged fish will be detected at the Cabot Bypass Sluice sampler. Juvenile fish should be specifically targeted for release immediately prior to drawdown to assess survival and movement in and through the canal. Surveys of sea lamprey ammocetes should be conducted by a stratified sampling design based upon substrate.

Lamprey density surveys, immediately after drawdown and in a subsequent later survey, may derive rates of change in observed densities and their status (live, moribund, dead); appropriate methods would need to be discussed. Surveys of remaining ponded water should be conducted immediately following drawdown and at later intervals (mid- week and end of week) to compare species occurrence and densities (relative abundance) which will be used to develop catch-curve analyses that can inform rates of mortality to the observed populations.

Assessments of freshwater mussels should also be conducted to quantify drawdown impacts. As with lamprey, the assessment can be based on sampling identified habitats in a stratified, random design, over the three time periods noted (initial drawdown, mid week, and end of week), tracking changes in densities and status of observed individuals among areas. Sub-sampling, with sufficient repeated measures to determine variability and acceptable level of precision of data will inform the required sampling intensity that will be needed. This sampling intensity will be determined as the study occurs and may vary among identified species. Comparisons among the three time periods for measures of density and status will inform the evaluation of project effects for juvenile shad, sea lamprey ammocetes, freshwater mussels, odonates, and mudpuppies

The canal drawdown mitigation assessment involves evaluating alternative drawdown protocols to minimize impacts to resident and migratory fish, mussels and amphibians inhabiting the canal. Alternatives should include: (1) moving the drawdown to a time of year outside of migration seasons; (2) keeping or moving the timing of the drawdown, but utilize technologies to keep the majority of the canal wetted during the drawdown (e.g., portadams in the forebay immediately upstream of the trashracks and at other canal intakes in need of maintenance); and (3) in combination with alternative #2, assess whether other existing infrastructure within the forebay could be used to pass fish safely out of the canal (e.g., low level outlets, deep gates, side spillway boards, etc.). The assessment should compare the merits and drawbacks of each alternative and provide an order of magnitude cost estimate for implementation.

These methodologies are consistent with accepted practice.

Level of Effort and Cost

This Study Request has many elements that overlap directly with a larger scale downstream juvenile American shad passage and downstream American eel passage study requests. With equipment costs principally covered in those requests, many components of what has already been proposed will be used in this study. However this request does include some specific elements not specified in the other two larger requests. The study cost and effort are expected to be low to moderate. Some additional radio tags and balloon tags with additive days of field work to accurately assess impacts specific to the drawdown period will be required. Surveys for identified aquatic organisms will take several days during the drawdown period as well.

The canal drawdown mitigation assessment should require a low to moderate level of effort and cost. One staff person would evaluate alternative drawdown protocols. This should take less than one week to complete.

The applicant did not propose any studies to meet this need in the PAD.

***Literature Cited*:**

O'Donnell, M and B. H. Letcher. 2008. Size and age distributions of juvenile Connecticut River American shad above Hadley Falls: influence on outmigration representation and timing. River Research Applications #24: 929-940.

Requested Study No. 10
Three-dimensional Computational Fluid Dynamics (CFD) Modeling in the Vicinity of Fishway Entrances and Powerhouse Forebays
FERC No. 1889

Goals and Objectives

The goal of this study is to determine the flow field conditions that exist in and around the fishway entrances, and upstream of both Turners Falls powerhouses (Station 1 and Cabot). The information from this request is meant to be coupled with data from the telemetry study such that a comprehensive understanding of fish behavior is developed. The objective of this study is to develop a series of maps that show color contour maps of velocity magnitude at discharges that have been agreed upon by the resource agencies and the licensee. With respect to upstream passage, the results will show approach velocities and orientation within the approach zone of the fish that may create a response in fish. This information can be coupled with telemetry data (from the requested shad telemetry study) and passage counts to understand which conditions are optimal for guiding migrating fish to the fishway entrances and for stimulating fishway entry. With respect to downstream migration, the results will show velocities and orientations in front of each powerhouse. At Cabot Station, the results will indicate to what degree, if any, flow directs downstream migrating fish towards the surface bypass weir. At Station 1, we will have an improved understanding of the magnitude of velocity in front of the turbine intakes.

Resource Management Goals

The management goals of this study request are to obtain information that will help assist in designing effective up- and downstream fishways for migrating species and to reduce impingement, entrainment and delay for downstream migrating fish. The requestor is not a public agency. However, we believe the information gathered as a result of this study would further regional resource management goals and more specifically The Connecticut River Atlantic Salmon Commission's *Management Plan for American Shad in the Connecticut River* and their Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basinas well as the Atlantic States Marine Fisheries Commission's management plans for American eel.

Public Interest

The Turners Falls Project poor upstream fish passage efficiency has been documented. The inability of American shad to pass the project affects a public fishery resource and angling for shad.

Existing Information

To date, no CFD modeled data exist in front of either fish ladder, nor do they exist in front of either powerhouse. Some preliminary modeling has been done downstream of the Gatehouse, but changes to the gatehouse entrances would require updated modeling . It is our understanding that the licensee has worked with the firm Alden to develop a CFD model of the upper power canal and that elevation survey data from the power canal also are available. Detailed 2-dimensional movement data on shad are available from observations made between 2003 to 2005 and 2010 to 2012. By coupling and analyzing these two data sets, flow and fish movement, we believe this will have substantial benefits to our management efforts.

When designing upstream passage structures, a site assessment is critical. The development of these models gives resource agencies and other stakeholders valuable information into the hydraulic cues which may elicit a response from upstream migrants. For downstream passage, the U.S. Fish and Wildlife Service has approach velocity guidelines; the output from these models would inform the resource agencies under what conditions appropriate approach velocities are being met and when they are being exceeded.

Project Nexus

The Turners Fall Project has direct impacts to upstream and downstream migrating shad and eel. .

With respect to upstream migration, the auxiliary water system (AWS) plays a critical role in determining whether or not fish are attracted to the entrance. The results from this study would allow us to assess how well the AWS is performing and under what conditions it attracts the most fish.

With respect to downstream migration, as a general rule, fish tend to follow the flow. If flow fields are directing fish towards the turbine intakes, the results from this study will indicate that. The development of a CFD model under existing conditions also informs the design of future modifications. The development of a CFD model could be used to improve the survivability of downstream migrating shad and eel.

Proposed Methodology

A 3-dimensional CFD model has become and increasing common standard of analysis at hydro-electric projects around the nation. Within the Northeast region, we have seen these types of models developed at the Holyoke (P-2004), Brunswick (P-2284), Shawmut (P-2322), Milford (P-2534) and Orono (P-2710). We would expect to engage with the licensee in terms of determining the appropriate area and flows to be modeled. We expect that the spatial extent of the model at each study site will vary. Given the large number of ways that output from these models can be presented and the near infinite number of flows that could potentially be modeled, we would expect to consult with the licensee to reach agreed upon modeling efforts and scenarios to be examined.

Level of Effort and Cost

The cost of developing, running and testing a CFD model can vary tremendously; one large variable is determining the cost is based on the amount of existing bathymetric data the applicant currently has access to. We roughly estimate the cost of each CFD model could run as high as $50,000 assuming no bathymetric data currently exists. Proactive communication with resource agencies will reduce the cost and iterative effort. Given the above mentioned projects where this level of effort has occurred for other projects that have proposed to amend their license for various reasons, we see the level of effort as commensurate with the other projects given that the applicant is requesting a renewal of its existing license.

Requested Study No. 11
Determine the Fish Assemblage in the Turners Falls and Northfield Mountain Pumped Storage Project-Affected Areas

Goals and Objectives

The goal of this request is to determine the occurrence, distribution, and relative abundance of fish species present in the Project affected areas of the Turners Falls and Northfield Mountain Project Areas, which potentially includes Species of Greatest Conservation Need (SGCN) for Massachusetts, New Hampshire, and Vermont.

Specific objectives include:
1) Document fish species occurrence, distribution and abundance within the project affected area along spatial and temporal gradients.

2) Compare historical records of fish species occurrence in the project affected area to results of this study.

Resource Management Goals

The requestor is not a public agency. However, we believe the information gathered as a result of this study would further regional resource management goals of protecting and conserving aquatic species and their habitats. Riverine fish species are an important component of the river's ecology and are the basis for the sport fishery.

Determining species occurrence, distribution, and abundance will better clarify what species occur in the project area both spatially and temporally, relative to habitats which may be affected by project operations of the Turners Falls or Northfield Mountain Pump Storage projects. This information will better inform other results from other study requests that will be examining project operation effects on various aquatic habitats, water quality and other related concerns such as entrainment concerns at Northfield Mountain. This information will be used to make recommendations and provide full consideration for all species, including those that might not otherwise be known to occur in the project-affected area and impacts that may affect their population status through direct or indirect effects of the projects.

Public Interest

Riverine fish represent an important ecological role as well as recreational and angling opportunities. A full assessment of species composition will benefit a public resource with better information for management.

Existing Information

A thorough and comprehensive assessment of the fish assemblage present in the project-affected areas of the Turners Falls and NFMPS projects is lacking. The PAD for these projects sites notes resident fish surveys conducted by the State of Massachusetts in the early to mid 1970s and a limited 2008 sampling effort by Midwest Biodiversity Inst. (contracted by EPA). The PAD identifies a total of 22 fish species in the project area which omits, as an example of its limited information basis, northern pike, tessellated darter, burbot, eastern silvery minnow, and channel catfish (Ken Sprankle, USFWS, and

Jessie Leddick, MADFW, personal communication). It is unknown how many other species may inhabit or utilize aquatic habitats in the projects area, potentially including species of greatest conservation need.

The most relevant recent fish survey study related to the project affected areas is a Connecticut River electrofishing survey conducted in 2008 (Yoder et al., 2009). While some sampling was conducted in both project areas during the 2008 survey, this survey did not have the same goals and objectives as those outlined above. Due to the design of the study limitations in geographic/habitat type coverage both spatially and temporally, and the use of a single gear type, limits the use of these data and that synthesized data may not be a full representation of species occurrence in the project affected areas. It follows that since information is limited regarding the composition of the fish community and their use of habitats in the project-affected area, project impacts on fish species are also unknown.

Project Nexus

Project operations have the potential to directly impact fish species life history requirements, biological interactions, and habitat quantity and quality. For example, headpond and tailwater water level fluctuations could dewater important spawning areas, or affect habitat availability, thus limiting productivity of fish species by direct impacts to their spawning success or indirectly by limiting the spawning success of forage fish species. Accordingly, a thorough understanding of the current fish assemblage structure and associated metrics are needed in order to examine any potential project-related impacts. A Study Request to examine project effects on aquatic habitats, as well as impacts to spawning habitats (e.g., sea lamprey and black bass) has been submitted and will compliment this request.

Proposed Methodology

An accepted and robust field sampling design (e.g., as described in Pollock et al. 2002 or MacKenzie et al. 2006) and accepted methods for collecting fish species likely to be present in the project-affected areas (Bonar et al. 2009) should be used to conduct field surveys. Randomly sampling multiple habitat types using a multi-gear approach will be required to ensure that all fish species present are sampled. The spatial scope of the study will be from the headwaters of the Turners Falls pool downstream to Sunderland, Massachusetts, and will omit the upper reservoir of Northfield Mountain Pump Storage Project. Sampling should occur at each selected site across multiple seasons (spring, summer, and fall). Digital photographs should be taken to avoid misidentification of certain species such as Cyprinids.

The sampling design should include replicate samples for estimation of species detection probability. Sample replicates may be gathered temporally, using different methods, by independent observers, or by randomly sampled spatial replicates (MacKenzie et al. 2006). For each replicate sample, data that may be important for describing variation in species occurrence and presence/absence should be collected and recorded, such as gear type, mesohabitat type, depth, velocity, flow, water temperature, substrate, time of day, day of year, presence of cover, proportion of vegetation cover, size of individuals collected (juveniles may select different habitat), and/or other factors as determined by a qualified biologist. Species detection, occurrence, and/or abundance and related habitat measures on these parameters should be estimated using methods as described by Kery et al. (2005), MacKenzie et al. (2006), Wenger and Freeman (2008), or Zipkin et al. (2010).

This will be a one year study provided river discharge conditions fall within 25th to 75th percentile for weekly averages. Based upon this study's results, and the additional information obtained on requests to survey aquatic habitats and littoral zone fish spawning, an additional study may be required if evidence of project operation affects on population status or habitat for identified species.

Level of Effort/Cost

The cost of the study will be moderate to high as seasonal sampling with several types of gear will be required. However, cost will also be partially dependent on the number of sites sampled, the number of sample replicates, and the extent of the covariate data that are measured, all which may be flexible. Based on first year study results, a second year of sampling or specific studies examining impacts of project operations on specific fish species may be needed and requested. Provided the collected data are of high quality, analysis and synthesis should take approximately 10-20 days. FirstLight did not propose any studies specifically addressing this issue.

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Requested Study No. 12
Model River Flows and Water Levels Upstream and Downstream from the Turners Falls Project Dam Generating Stations and Integration of Project Modeling with Upstream and Downstream Project Operations
FERC No. 1889 and FERC No. 2485

Develop a river flow model(s) that are designed to evaluate the hydrologic changes to the river caused by the physical presence and operation of the Turners Falls Hydroelectric Project and the interrelationships between the operation of all five hydroelectric projects up for relicensing (i.e., P-1889 Turners Falls Hydroelectric Project, P-2485 Northfield Mountain Pumped Storage, P-1904 Vernon Hydroelectric Project, P-1855 Bellows Hydroelectric Project, P-1892 Wilder Hydroelectric Project) and river inflows. The flow studies should assess the following topics:

1. Conduct quantitative hydrologic modeling of the hydrologic influences and interactions that exist between the water surface elevations of the Turners Falls Project impoundment and discharges from the Turners Falls Dam and generating facilities and the upstream and downstream hydroelectric projects. Data inputs to and outputs from the model(s) should include:
   a. Withdrawals from the Turners Falls impoundment by the Northfield Mountain Pumped Storage Project, FERC No. 2485,
   b. Discharges to the Turners Falls impoundment by the Northfield Mountain Pumped Storage Project,
   c. Discharges into the Turners Falls impoundment from the Vernon Project, FERC No. 1904 and other sources.
   d. Existing and potential discharges from the Turners Falls Project generating facilities and spill flows.
   e. Existing and potential water level fluctuation restrictions (maximum and minimum pond levels) of the Turners Falls impoundment and downstream flows from the project
   f. Existing and potential required minimum flows and/or other operation requirements at each of the four upstream projects.
   g. Minimum discharge flows ranging between 2,500 and 6,300 cfs in the bypass reach from April 15th through June 22nd to support spawning, rearing, and outmigration of shortnose sturgeon at Rock Dam.

2. Document how the existing and potential outflow characteristics from the four upstream projects affect the operation of the Turners Falls Project including downstream flow releases and Turners Falls impoundment levels.

3. Assess how the operation of the existing Turners Falls Project and upstream projects affect Holyoke Project (P-2004) operations including:
    a. How Turners Falls Project flow fluctuations affect Holyoke impoundment water levels, with emphasis on the influence on the water levels on listed Puritan tiger beetle habitat at Rainbow Beach in Northampton, MA. and assess what changes would be needed in Turners Falls operations to stabilize water levels at Rainbow Beach.
    b. How Turners Falls Project operations affect Holyoke Project discharges and what changes in Turners Falls operations would be needed to reduce fluctuations in the discharges from the Holyoke Project.
4. To the extent predictable and practical, incorporate the potential effects of climate change on project operations over the course of the license.

Goals and Objectives

Determine the extent of alteration of river hydrology caused by operation of the project and the interactions between upstream project operations, Turners Falls operations and downstream operations at the Holyoke Project. The models will provide necessary information on what changes can be made to each of the five project's flow releases and/or water levels restrictions, and how those changes affect downstream resources.

Specifically, for the Turners Falls Project continuous minimum discharge flows in the Turners Falls bypass reach need to be no less than 2,500 cfs during shortnose sturgeon spawning, rearing, and outmigration (April 15th – June 22nd). Incorporating these parameters into the model will inform what changes, if any, need to be made to operations of upstream projects to accommodate such flows.

As other specific modifications of the operations of each of the projects are identified based on results of other requested studies, these desired conditions will need to be input into the models to assess how each change affects that project and other project operations and the implications of those changes on other resources and/or the ability to achieve desired operational changes at other projects.

Resource Management Goals

The requestor is not a public agency. However, we believe the information gathered as a result of this study would further regional resource management goals of protecting and conserving aquatic species (including the federally endangered shortnose sturgeon) and their habitats. Specifically:

- Protect, enhance, or restore, diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.

- Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
- Minimize current and potential negative project operation effects on water quality and aquatic habitat.
- Ensure that project operations are not likely to jeopardize the continued existence of shortnose sturgeon.
- Avoid or minimize the current negative effect of project operations on shortnose sturgeon spawning and rearing within the Montague spawning area (i.e. Rock Dam and Cabot Station spawning sites and associated early life stage rearing areas).

Public Interest

Migratory and riverine fish have an important ecological role as well as recreational and angling opportunities. A full assessment of the impacts of hydrogenation will benefit a public resource with better information for management of flows to protect these resources as well as the federally endangered shortnose sturgeon.

Existing Information

Available information in the PAD does not indicate how project operations have altered downstream hydrology, which may affect resident and migratory fish, macroinvertebrates, rare, threatened, and endangered species, aquatic plants and other biota and natural processes in the Connecticut River from below the Vernon Dam downstream to the Holyoke Dam.

Information in the PAD also does not reflect data analyzed in Kynard et al. 2012, which identifies minimum discharge thresholds for shortnose sturgeon spawning and rearing at the Rock Dam spawning site. Spawning success was observed at Rock Dam when discharge was between 2,500 cfs and 22,000 cfs during the spawning period (April 27–May 22nd) (Kynard et al. 2012, chapter 3). In 1995 at the Cabot spawning area, the greatest level of spawning and spawning success occurred (i.e., 21 late stage females present, 342 ELS captured, spawning period was 17 days) even though no spawning was detected at Rock Dam (Kynard et al. 2012, chapter 3). Discharges in 1995 at Rock Dam had dropped below 2,500 cfs by March 26th (Kynard et al. 2012, chapter 3), showing that even though 1995 saw the largest number of pre-spawning adults, none spawned at Rock Dam. This may indicate the need to have adequate flow well in advanced of spawning. Discharge reductions at the Rock Dam site that occurred during spawning caused females to leave the spawning cite and not return even if flow increased to acceptable levels later during the spawning period. Researchers observed that substrate did not change during fluctuating flows and thus cessation of spawning is likely due to velocities falling below the range preferred by females. Given the current flow dynamics at Rock Dam, spawning does not occur most years (Kynard et al. 2012, chapter 3). These data represent the best available scientific information and indicates that the current minimum flow thresholds at the project are not adequate for the protection of endangered shortnose sturgeon. All modeling efforts described above must incorporate the identified minimum flow and temporal parameters.

Project Nexus

The Turners Falls Project is currently operated with a seasonally-varying minimum bypass flow (400 cfs from 5/1 through 7/15, then 120 cfs through the winter until river temperature rises to ≥ 7°C) and year-round minimum flow below the projects of 1,433 cfs. The project operates as a daily peaking project, often with large, rapid, daily flow fluctuations between the minimum and project capacity (15,928 cfs) and fluctuations in headpond elevation (175' to 186' MSL). These changes affect biotic habitat and biota upstream and downstream of the project. Project operations and potential changes to operations to mitigate impacts are influenced by inflows and operations of upstream peaking projects and the Northfield Mountain Pumped Storage Project operations and potential changes in operations of each project could affect the ability to achieve desired operational changes at other projects. Results of river flow analyses will be used to develop flow-related license requirements and/or other mitigation measures.

Proposed Methodology

River hydrology statistics and modeling are commonly employed at hydroelectric projects to assess implications of project operations on the river environment.

Level of Effort and Cost

Level of effort and cost of model development are expected to be moderate but to be valuable in developing license conditions, the model(s) will need to be run under various scenarios throughout the relicensing process to assess the implications of changes to the operations of each project on other projects and other resources. Therefore, ongoing consultation and re-running of the model(s) are likely to be needed throughout the relicensing process. The modeling exercise will also require coordination and cooperation between First Light and the upstream licensee to assure that the model inputs and outputs can be accurately related.

We would anticipate that the expected level of effort and anticipated costs will be moderate and comparable to that experienced on similar FERC relicensing projects of this size.

Requested Study No. 13
In-stream Flow Habitat Assessment Downstream of Cabot Station
FERC No. 1889

Conduct an instream flow habitat study to assess the impacts of the range of the proposed project discharges on the wetted area and optimal habitat for key species. The study should include non-steady flow approaches to assess effects of within-day flow fluctuations due to peaking power operations on target fish species and benthic invertebrate communities. Target fish species include: federally endangered shortnose sturgeon, American shad, fallfish, and white sucker

Goals and Objectives

The goal of this study is to determine an appropriate flow regime that will protect and enhance the aquatic resources from the Cabot tailrace of the Turners Falls Project downstream to the Rt. 116 bridge in Sunderland, MA. Specifically, the objective of the study is to conduct an instream flow habitat study to assess the impacts of a range if flows on the wetted area and optimal habitat for key species, including the impacts of hydropeaking flow fluctuations on the quantity and location of aquatic habitat.

The study should include non-steady flow approaches to assess effects of within-day flow fluctuations due to peaking power operations on target fish species and benthic invertebrate communities. Target fish species include: federally endangered shortnose sturgeon, American shad, fallfish, white sucker and walleye.

For shortnose sturgeon, the flow study will need to evaluate bottom velocities in shortnose sturgeon spawning and rearing areas during discharge conditions normally observed from April 15th to June 22nd. Protection of shortnose sturgeon spawning will necessitate establishment of discharges that create bottom velocities suitable for shortnose sturgeon spawning and rearing over a sustained period of time and avoid dramatically fluctuating flows. To protect shortnose sturgeon rearing, adequate discharge without dramatic flow fluctuations are needed to ensure the rearing shoals are wetted and velocities are sufficiently protective for early life stage (ELS) rearing.

Field verification will be necessary to confirm the flow modeling results that identify the flows needed to provide sustained bottom velocities for spawning also maintain flows, depths, and water release regime adequate for spawning and rearing. Velocity and depth data should be collected under each potential operation scenarios such that actual velocity, depth, and flow conditions occurring across the entire spawning and rearing areas including wetted shoals.

Resource Management Goals

The requestor is not a public agency. However, we believe the information gathered as a result of this study would further regional resource management goals of protecting and conserving aquatic species (including the federally endangered shortnose sturgeon) and their habitats. Specifically:

- Protect, enhance, or restore, diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
- Provide an instream flow regime that meets the life history requirements of resident and migratory fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
- Minimize current and potential negative project operation effects on water quality and aquatic habitat.
- Avoid or minimize the current negative effect of project operations on shortnose sturgeon spawning and rearing at the Cabot Station spawning and rearing site.

Public Interest

Migratory and riverine fish have an important ecological role as well as recreational and angling opportunities. A full assessment of the impacts of hydrogenation will benefit a public resource with better information for management of flows to protect these resources as well as the federally endangered shortnose sturgeon.

Existing Information

Presently FirstLight is required to release 1,433 cfs below the Project. Information included in the PAD does not provide a detailed description of how this minimum flow was established and TU is not aware of any previously conducted studies that evaluated the adequacy of this minimum flow in protecting aquatic resources in the 10+ miles of riverine habitat below the Cabot Station. Therefore, in order to fill this important information gap, an empirical study is needed to provide information on the relationship between flow and habitat in the Connecticut River downstream of the Cabot tailrace. Results will be used by the the agencies and stakeholders to determine an appropriate flow recommendation.

Kynard et al. (2012, chapter 3) examined the effects of water manipulation at the Turners Falls project on shortnose sturgeon spawning over the course of 17 years. This body of data represents the best available scientific information which does not support 1,433 cfs as an adequate minimum flow to support successful shortnose sturgeon spawning at Cabot Station. Peaking operations at Cabot Station cause discharge fluctuations to rapidly change bottom velocities from 0.4 m/s to 1/3 m/s over 30 minutes (Kynard et al. 2012, chapter 3). Shortnose sturgeon have not evolved to adapt to such artificial rapid changes in velocities and therefore continue to spawn during fluctuations even though conditions may be unsuitable and likely result in high egg mortality. During the 10 years when spawning succeeded at Cabot Station, discharge flow decreased to less than 35, 460 cfs by April 29th. The lowest discharge level observed while females remained on the spawning site was 4,700 cfs. Spawning behavior was not monitored during Cabot Station discharges at or below 3,500 cfs, so it is unclear what the minimum flow threshold is for spawning at Cabot Station. When peaking generation discharges cease during naturally low flow years, the tailrace shoals, likely used by shortnose ELS for rearing, were exposed (observed during years ’95, ’98-99, ’04) and may have resulted in larvae mortality due to stranding and exposure (Kynard et al 2012, chapter 3). Researchers observed that shoal exposure began when river flow below Cabot Station dropped below 7,062 cfs (Kynard and Kieffer 2007). Thus, total flow at Cabot, which may include flow from the Turners Falls Dam or Station 1, must be at least 7,062 cfs to both support adequate bottom velocities and prevent shoal exposure.

Furthermore, the emergency water control gates at Cabot Station that are used to sluice trash from the canal and balance canal flows spill large amounts of water. These large spill events create a plume of turbid turbulent flow, which caused some females to leave the area. These spill events scour bottom sediments which are then carried downstream over the spawning and rearing shoals where an entire year class of early life stages may be destroyed (Kynard et al. 2012, chapter 3). Information included in the PAD does not address adequate flows for shortnose sturgeon spawning and rearing. Results of the requested modeling will be used by the the agencies and stakeholders to determine an appropriate flow recommendation.

Researchers have also looked at suitable depth and velocity habitat for spawning (Kynard and Kieffer 1996, Kynard et al. 2012, chapter 3). Spawning sites are characterized by moderate river flows with average bottom velocities between 0.4 and 0.8 m/s (Hall et al. 1991, Kieffer and Kynard 1996, NMFS 1998). Water depth at the spawning site appears to be a less important habitat feature than substrate type and flow. A recent study by Kynard et al. (2012, chapter 6) demonstrated that females in an artificial stream will readily accept a shallow water depth of 0.6 m, with a rubble bottom, and 0.3–1.2 m/s bottom velocity. In addition, although eggs and embryos can likely tolerate very low depths, researchers measuring water depths between Turners Falls Dam and Cabot Station in order to recommend minimum flows suitable for an escape route for shortnose sturgeon trapped in the Turners Falls Dam Plunge Pool used a minimum depth of 1.5 x adult body depth. Because adults spawning in an artificial spawning channel frequently positioned themselves on top of one another (Kynard et al. 2012 Chapter 6), a minimum depth to facilitate spawning within the known Cabot Station spawning area is 3.0 body depths, or 38 inches.

Project Nexus

The Project is currently operated with a minimum flow release that was not based on biological criteria or field study. Further, the project generates power in a peaking mode resulting in significant with-in day flow fluctuations between the minimum and project capacity on hourly or daily basis. The large and rapid changes in flow releases from hydropower dams are known to cause adverse effects on habitat and biota downstream of the project. There are more than ten miles of free-flowing river below the project's discharge that are impacted by peaking operations at Cabot Station. This section of the Connecticut River contains habitat that supports native riverine species, including important spawning and rearing habitat for migratory fish such as American shad and federally endangered shortnose sturgeon. Shortnose sturgeon larval migrants initially become bottom dwellers and transition from living off of yolk sacs to orally feeding, which is a critical stage in their life history. While the existing license does require a continuous flow of 1,433 cfs below the project (0.20 cubic feet per second flow per square mile of drainage area - cfsm), that is equal to only 40% of the Aquatic Base Flow. this flow does not sufficiently protect the aquatic resources, including endangered species, in this substantial reach of river, especially in the context of the magnitude, frequency, and duration of changes in habitat that likely occur between minimum and generation flows.

Results of the flow study will be used by the the agencies and stakeholders to determine an appropriate flow recommendation that will protect and/or enhance the aquatic resources below the Project.

Proposed Methodology

In-stream flow habitat assessments are commonly employed in developing plant operational regimes that will reduce impacts or enhance habitat conditions downstream of hydroelectric projects.

TU requests a flow study be conducted at the Project. Given the length of the river reach (10+ miles) impacted by project operations, we believe a study methodology that utilizes an IFIM approach is appropriate for this site. This same protocol was used during the relicensing of the Housatonic River Project (FERC No. 2576), and has been accepted by the Commission in other licensing proceedings.

At a minimum, the study design should involve collecting wetted perimeter, depth, velocity, and substrate data along transects located in the reach of river below Cabot Station. The measurements should be taken over a range of test flows. This information then should be synthesized to quantify habitat suitability (using mutually agreed upon HSI curves) of each test flow for target species identified by the fisheries agencies. Habitat modeling using standard PHABSIM 1 dimensional modeling is acceptable for the river channel downstream from the railroad bridge below the mouth of the Deerfield River. The area from the Cabot Station discharge to the railroad bridge should be modeled using 2 dimensional 2D modeling to better characterize flows and velocities in this complex channel area.

The types of data collected with this study should be sufficient to perform a dual-flow analysis and habitat time series or similar approaches that will permit assessment of how quality and location of habitat for target species changes over a range of flows between existing minimum flow and maximum project generation flows.

These methodologies are consistent with accepted practice.

Level of Effort and Cost

Field work for instream flow studies can be reasonably extensive but will depend on consultation with the applicant on study methodology and on-site decisions on locations for data collection and the number of collection locations. Post-fieldwork data analysis would be a moderate cost and effort. We anticipate that the level of effort and costs will be moderate and comparable to that experienced on similar FERC relicensing projects of this size.

Requested Study No. 14
In-stream Flow Habitat Assessment of the Turners Falls Bypassed Reach
FERC No. 1889

Goals and Objectives

The goal of this study is to determine an appropriate flow regime that will protect and enhance the aquatic resources in the bypassed reach between Turners Falls Dam and the Cabot Station discharge. Specifically, the objective of the study is to conduct an instream flow habitat study to assess the impacts of the range of the proposed project discharges on the wetted area and optimal habitat for key species.

Target fish species include: federally endangered shortnose sturgeon, American shad, fallfish, white sucker, freshwater mussels and benthic macroinvertebrates.

Resource Management Goals

The requestor is not a public agency. However, we believe the information gathered as a result of this study would further regional resource management goals of protecting and conserving aquatic species (including the federally endangered shortnose sturgeon) and their habitats. Specifically:

- Protect, enhance, or restore, diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
- Provide an instream flow regime that meets the life history requirements of resident and migratory fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
- Minimize current and potential negative project operation effects on water quality and aquatic habitat.
- Avoid or minimize the current negative effect of project operations on shortnose sturgeon spawning and rearing at the Cabot Station spawning and rearing site.

Public Interest

Migratory and riverine fish have an important ecological role as well as recreational and angling opportunities. A full assessment of the impacts of hydrogenation will benefit a public resource with better information for management of flows to protect these resources as well as the federally endangered shortnose sturgeon.

Existing Information

The Turners Falls Project bypasses a 2.7 mile-long section of the Connecticut River. Presently the only required spill releases from the Turners Falls dam to the bypassed reach are 400 cfs from May 1 through July 15 and 120 cfs from July 16 until the river temperature reaches 7°C.

In addition to these flows provided at the Turners Falls Dam, the bypassed reach receives flow from one small tributary (the Fall River, drainage area of 34.2 square miles), which enters the mainstem approximately 0.16 miles below the dam. The bypassed reach also receives the discharge from Station 1, when it is generating (typically when there is flow in excess of Cabot Station's needs). This discharge enters the bypassed reach approximately 0.9 miles below the dam.

Available information in the PAD does not indicate how project operations have altered downstream hydrology, habitat quantity and quality, and water quality, which may affect resident and migratory fish, macroinvertebrates, listed species, aquatic plants and other biota and natural processes in the Connecticut River from below the Turners Falls Dam downstream to the Cabot Station discharge. The PAD also provides no detailed description of the physical or biological characteristics of the bypassed reach.

Limited information exists on the adequacy of the existing bypass flow regime to protect water quality and aquatic life. However, there is existing information (not included in the PAD) relative to minimum flows necessary for shortnose sturgeon spawning and rearing at the Rock Dam spawning site (Kynard et al. 2012). Spawning success was observed at Rock Dam when discharge was between 2,500 cfs and 22,000 cfs during the spawning period of April 27th through May 22 (Kynard et al. 2012, chapter 3). In 1995 at the Cabot spawning area, the greatest level of spawning and spawning success occurred (i.e., 21 late stage females present, 342 ELS captured, and the longest spawning period of 17 days) even though no spawning was detected at Rock Dam (Kynard et al. 2012, chapter 3). Discharges in 1995 at Rock dam had dropped below 2,500 cfs by March 26th (Kynard et al. 2012, chapter 3), which may indicate the need to have mitigated flow well in advance of spawning. Flow reductions at the Rock Dam site that occurred during spawning caused females to leave the spawning site and not return even if flow later increased to acceptable levels. Researchers observed that the rubble substrates remained dominant during fluctuating flows and cessation of spawning is likely due to velocities falling outside the range preferred by females. Given the current flow dynamics at Rock Dam, spawning does not occur most years (Kynard et al. 2012, chapter 3). These data represent the best available scientific information and does not support current minimum flow thresholds at the project.

An empirical study is needed to provide information on the relationship between flow and habitat in the bypassed reach for the the agencies and stakeholders to use in determining a flow recommendation.

Project Nexus

The Project includes a 2.7 mile-long bypassed reach. The Turners Falls Project is currently operated with a seasonally-varying minimum bypass flow (200 cfs starting on May 1, increasing to 400 cfs when fish passage starts through to July 15, then reduced down to 120 cfs until river temperature drops below 7°C). The 400 cfs release is primarily to facilitate upstream movement of anadromous migrants to the spillway fish ladder at Turners Falls Dam and the 120 cfs was intended to provide protection to shortnose sturgeon by maintaining a wetted habitat 1.5 times the maximum adult body depth through connections between pools within the bypassed reach. Neither of the currently required flows were based on quantitative, rigorous scientific studies.

This section of the Connecticut River contains habitat that supports native riverine species, including important spawning and rearing habitat for the federally endangered shortnose sturgeon. While the existing license does require seasonally-varying flow releases from the Turners Falls dam, we do not believe these flows sufficiently protect the aquatic resources, including endangered species, inhabiting the bypassed reach.

Results of the flow study will be used by the the agencies and stakeholders to determine an appropriate flow recommendation that will protect and/or enhance the aquatic resources in the bypassed reach for the duration of any new license issued by the Commission.

Proposed Methodology

TU requests a bypass flow study be conducted at the Project. Bypass flow habitat assessments are commonly employed in developing flow release protocols that will reduce impacts or enhance habitat conditions in reaches of river bypassed by hydroelectric projects.

Given the size of the bypassed reach (2.7 miles long) and the important resources known to inhabit the reach (i.e., federally endangered shortnose sturgeon and diadromous fishes), we believe a study methodology that utilizes an IFIM approach is appropriate for this site. This same protocol was used during the relicensing of the Housatonic River Project (FERC No. 2576), and has been accepted by the Commission in other licensing proceedings.

At a minimum, the study design should involve collecting wetted perimeter, depth, velocity, and substrate data within a range of discharge levels along transects located in the reach of river between the dam and the Cabot Station discharge. The measurements should be taken over a range of test flows up to 6,300 cfs or over a sufficient range of flows to model flows up to 6,300 cfs. This information then should be synthesized to quantify habitat suitability (using mutually agreed upon HSI curves) of each test flow for target species/life stages identified by the fisheries agencies. Habitat modeling using standard PHABSIM 1 dimensional modeling is acceptable for the bypassed reach from the area downstream of the spillway where the river channel constricts to Rawsons Island upstream from the Rock Dam. The area from Rawson Island to the Cabot station discharge should be modeled using 2 dimensional 2D modeling to better characterize flows and velocities in this complex channel area. Likewise, we recommend 2D modeling in the spillway area and mouth of the Falls River to the point where the channel constricts given this complex area with numerous potential flow discharge locations.

The flow study should incorporate the identified minimum flow and temporal parameters for shortnose sturgeon discussed in the Background and Existing Information section of this request.

The methodologies are consistent with accepted practice.

Level of Effort and Cost

Field work for flow studies can be reasonably extensive but will depend on consultation with the applicant on study methodology and on-site decisions on locations for data collection and the number of collection locations. Post-fieldwork data analysis would be a moderate cost and effort. Field work associated with this study could be done in conjunction with the project instream flow study request. We anticipate that the level of effort and costs will be comparable to that experienced on similar FERC relicensing projects (e.g., the Glendale Project, FERC No. 2801).

Requested Study No. 15
Impact of Project Operations on Downstream Migration of Juvenile American Shad
FERC No. 1889

Conduct a field study of juvenile American shad outmigration in the Turners Falls impoundment and the power canal and at Turners Falls Dam,t, Station #1, and Cabot Station to determine if project operations negatively impact juvenile American shad survival and production.

Goals and Objectives

Determine if project operations affect juvenile American shad outmigration survival, recruitment, and production. The following objectives will address this request:

- Assess project operations effects of NMPS and Turners Falls Dam on the timing, orientation, routes, migration rates, and survival of juvenile shad;
- Determine the proportion of juvenile shad that select the Gatehouse into the power canal versus the dam spill gates as a downstream passage route, under varied operational conditions, including a range of spill conditions up to full spill;
- Determine if there are any delays with downstream movement related to either spill via dam gates or through the Gatehouse and within the impoundment due to operations (i.e., NMPS pumping and generation);
- Determine survival rates for juvenile spilled over/through dam gates, under varied operation conditions, including up to full spill during the annual fall power canal outage period;
- Determine the juvenile downstream passage timing and route selection in the power canal to: Station 1; Cabot Station; and the Cabot Station log sluice bypass, and assess delays associated with each of these locations and with project operations (e.g., stockpiling in the canal);
- Based upon year 1 study results on route selection, determine the survival rate for juvenile shad entrained into Station 1; and
- Determine the survival rates for juvenile shad entrained into Cabot Station units;

If it is determined that the Project operations are adversely affecting juvenile shad survival, migration timing, or other deleterious population effects , identify operational solutions or other passage measures that will reduce and minimize these impacts within the project area. This study will require two years of field data to capture inter-annual variability of river discharge, water temperatures, and variability in the timing and abundance of juvenile production and their outmigration timing, which may relate to spring, summer, and fall conditions. This study will compliment the NMPS Fish Entrainment Study Request which includes assessment of impacts to juvenile shad.

Resource Management Goals

The requestor is not a public agency. However, we believe the information gathered as a result of this study would further regional resource management goals, and more specifically The Connecticut River Atlantic Salmon Commission's *Management Plan for American Shad in the Connecticut River*.

Public Interest

The Turners Falls Project alters flows, impacting aquatic species and communities and specifically juvenile American shad outmigration. Mortality and delay of outmigrating juveniles affect the public's use of the river for recreation. Angling for shad is directly impacted by a reduced population caused by hydroelectric projects on the river.

Existing Information

Since the construction of the Turners Falls Dam upstream fishways in 1980, American shad have had access to spawning and rearing habitat upstream of Turners Dam. A number of modifications to the Turners Falls fishways have occurred since that time, with the numbers of adult shad passed at Gatehouse Ladder (into Turners Falls Dam impoundment) reaching as much 60,089 in 1992 when a record 721,764 shad passed upstream of Holyoke Dam. However, since 1980 an average of only 3.6 % of the adult shad passed upstream of Holyoke Dam subsequently have passed upstream of Turners Falls Dam, and this value has never exceeded 11%. This value is well below the CRASC 1992 Shad Plan objective of 40-60% passage from the previous dam. In addition, population number and passage numbers past Holyoke have declined substantially, with the average Holyoke passage number over the last 10 years being 211,850. Because historic data suggests that approximately half the returning adult shad to the Connecticut River pass the Holyoke Dam, recent adult returns are far below management goals. Effective upstream and downstream passage and successful in-river spawning and juvenile production are necessary to help achieve shad management restoration goals for the Connecticut River, which extends to the Bellows Falls Dam. In 1990, FirstLight's predecessor, Northeast Utilities, CRASC and its member agencies, signed an MOA on downstream fish passage to address both juvenile and adults at the Turners Falls Project and Northfield Mountain Pumped Storage Project.

American shad broadcast spawn with the highest spawning activity occurring in runs and lowest activity in pools and riffle/pools (Ross et al. 1993). Field research by Ross et al. (1993) in the Delaware River further noted that a combination of physical characteristics that seems to be avoided by spawning adults is slow current and greater depth. American shad year-class strength has been shown to depend on parent stock size and environmental conditions during the larval life stages (Creeco and Savoy 1984). Delays in juvenile American shad outmigration may affect survival rates in the transition to the marine environment (Zydlewski et al. 2003). One published study on the Connecticut River, identified that juvenile shad outmigration began when declining autumn temperatures reached 19C and peaked at 16C (O'Leary and Kynard 1986).

Juvenile American shad production has been monitored upstream of the Vernon Dam and immediately downstream of that dam by Vermont Yankee Nuclear as part of an annual monitoring program using both boat electrofishing (since 1991) and beach seining (since 2000). Sampling of juvenile shad was also conducted by a contractor hired by Northeast Utilities in the Turners Falls impoundment in 1992. O'Donnell and Letcher (2008) examined juvenile shad early life history and migration upstream and downstream of Turners Falls Dam. Their study results led to the decision by the agencies to require earlier operation of downstream fishways to protect early season juvenile shad out-migrants (1 September prior to 2010, 15 August in 2010, and since 2011, 1 August).

Downstream juvenile clupeid passage studies at Turners Falls were conducted in the fall of 1991 which included the objectives of determining the percentage of juvenile shad and herring that pass via the bypass log sluice or that were entrained in the Cabot Station turbines and related data (e.g., catch rates) were compared. The 1991 Downstream Clupeid Study did not assess survival rates for juveniles for either of these passage routes. The 1991 study report documented a higher rate entrainment into the project turbines (23.0 fish per minute) versus through the bypass sluice (11.6 fish per minute). It was concluded that only an estimated 54% (average bypass rate, weighted by estimated number bypassed) of the juvenile American shad approaching Cabot Station were bypassed via the log sluice. The range of the percent bypassed varied widely by date, between nearly 0 and 83%, with ‘no clear explanation as to why.” The report did not identify the percentage entrained into the turbines but it can be reasoned to be substantial based on the data presented in the report or assumed as the remaining balance (46%). as there were no spill events reported during this study, and therefore nowhere else for them to pass. It was further noted that entrainment rates for juveniles were consistently greatest for units 1 and 6 (ends), not uniform across all units. Although no concurrent bypass sampling occurred during the first entrainment sampling events, it was noted that “entrainment rates were relatively high during the end of September.” Additional modifications have occurred over time without quantitative evaluation to improve downstream passage attraction and use to the bypass sluice, including lighting systems.

The 1994 Downstream Juvenile Shad Study report assessed juvenile shad survival from passage via the log sluice, reported to be 98%, based on tagged and recaptured fish (held for up to 48 hours). Scale loss (<20%) (22 of treatment fish) compared with scale loss of >20% (5 of treatment fish) was examined and determined to occur in an overall total of 10% of study fish (adjusted by control fish data).

Project Nexus
Adult American shad passed upstream of Turners Falls Dam utilize upstream spawning habitat. Juvenile American shad production occurs in these habitats upstream of Turners Falls Dam on an annual basis. Juvenile American shad require safe and timely downstream passage measures to have the opportunity to contribute to the fishery agencies’ target restoration population size.

TUis not aware of any studies being conducted specifically designed to determine:

- When spill gates are open at the Turners Falls Dam?;
- What proportion of juvenile outmigrant shad take that route of passage?;
- What is the rate of survival under a range of spill and gate configurations?
- What is the timing, duration, and magnitude of juvenile shad outmigrants in summer and fall to the Turners Falls Dam and Gatehouse?

- Are there delays in migration/movement at the dam, Gatehouse, Cabot Station, or Station 1?
- For juveniles that enter the power canal, what proportion subsequently enter the Station 1 power canal?
- As there is no downstream passage facilities at Station #1, and trash rack spacing is 2.6 inches, what is the survival rate of juvenile shad entrained at Station #1?
- What is the rate of movement through the Turners Power Canal, relative to r delay to outmigrant juvenile shad and the potential accumulation of juveniles (e.g., prior to the canal drawdown in September)?
- What proportion of juvenile shad use the downstream sluice bypass versus the Cabot Station turbines under varied operational conditions given that project operations may change (PAD notes possible increase in turbine capacity at Cabot)?
- Based upon earlier facility studies (1991 Downstream Clupeid) a large proportion and number of juvenile shad are entrained into Cabot Station turbines. What are the associated impacts in terms of short-term and longer term survival and injury (i.e., scale loss)?

TU is concerned that project operations may impact juvenile shad outmigration survival and be contributing to the failure of the Connecticut River shad population to meet management targets. In the PAD, proposed modification include; Station 1 may be upgraded with new turbines, Station 1 may be closed, and/or the turbine capacity at Cabot may be increased. It is unclear how these scenarios will affect the questions identified in this request.

Proposed Methodology

The impact to juvenile shad outmigrants by project operations would be best studied by a combination of approaches including hydroacoustic, radio telemetry, and turbine balloon tags. Project discharge over a full range of existing and, to the extent possible, potential future operational conditions at Station 1 and Cabot, at the dam (likely increased bypass reach flows in new license) and in relation to the Gatehouse, should be examined relative to timing, duration, and magnitude of juvenile shad migration to and through these areas, with hydroacoustic equipment for natural/wild fish evaluation. In addition, study fish should be collected and tagged (PIT, radio, other mark, balloon) to also empirically determine rates of survival for fish passed over or through the dam's gates, under varied operations, including up to full spill condition that occurs annually in fall with canal outage period. The understanding of the timing, magnitude, duration of the wild fish outmigration will help inform the design, data/results, and assessment of tagged study fish. The release of tagged or marked fish (radio, PIT) upstream of the Gatehouse induction into the power canal, will provide data on concerns of delay and route selection to Station 1, Cabot Station downstream bypass, Cabot Station spill gates, and Cabot Station turbines. Additional hydroacoustic assessment at Cabot Station forebay will provide information on wild/natural juvenile fish timing, magnitude, and duration to and through this area. Based upon Year 1 study findings relative to the frequency, magnitude, timing of juvenile American shad that end up in the forebay of Station 1, the determination of whether an entrainment survival study at that site is necessary will be made. Release sites for tagged fish will be determined based upon further consultation among the parties.

Radio tagged juvenile shad will be released in areas upstream of the NMPS facility at multiple release locations, to determine operation effects on migration rates, route, orientation, entrainment, and survival, over a full range of permitted and operational conditions.

These methodologies are consistent with common and accepted practice.

Level of Effort and Cost

First Light does not propose any studies to meet this need. Estimated cost for the study is expected to be high, between $200,000 and $300,000, with the majority of costs associated with equipment (hydroacoustic gear, radio tags, radio receivers, and PIT readers) and related fieldwork labor.

Literature Cited:

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Zydlewski, J., S. D. McCormick, and J. G. Kunkel. 2003. Late migration and seawater entry is physiological disadvantageous for American shad juveniles. Journal of Fish Biology #63, 1521-1537.

Trout Unlimited respectfully requests the Commission consider these proposed study requests. We also request that the Commission add the following representative to the official service list for this project:

Donald Pugh
10 Old Stage Rd.
Wendell, MA 01379

Sincerely,

Donald Pugh

March 1, 2013

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E., Room 1A
Washington, DC 20426

RE: Comments on Integrated Licensing Process and Study Request for FERC project numbers P-1904 (Vernon), P-1855 (Bellows Falls), P-1892 (Wilder), 1889 (Turners Falls), No. 2485 (Northfield Mountain).

Dear Secretary Bose:

The Connecticut River Joint Commissions (CRJC) is comprised of New Hampshire's Connecticut River Valley Resource Commission (CRVRC) and Vermont's counterpart, the Connecticut River Watershed Advisory Commission (CRWAC). Each commission was created by its respective state legislature and directed to cooperate to preserve and protect the resources of the Connecticut River and its watershed.

In 1992, the New Hampshire Legislature designated the Connecticut River into the New Hampshire Rivers Management and Protection Program pursuant to NH RSA 483. Upon designation, CRVRC was appointed the local river management advisory committee for the Connecticut River to work with the CRWAC "to consider and comment on any federal, state or local governmental plans to approve, license, fund or construct facilities that would alter the resource values and characteristics for which the river or segment is designated."

The Connecticut River possesses a variety of significant federal, state and local resources which qualified it for designation into the Rivers Management and Protection Program. These resources were inventoried in the 1991 nomination document prepared by CRVRC. Aided by bi-state subcommittees of riverfront town representatives, CRJC developed and adopted its Connecticut River Corridor Management Plan in 1997, and published amplified plans for Water Resources and Recreation in 2009. The corridor management plans contain recommendations to protect the multiple uses and resources of the river and its watershed..

CRJC has reviewed the Preliminary Application Documents and Scoping Documents for the relicensing of the following hydropower projects:

- Wilder Dam (Wilder Project No. P-1892)
- Bellows Falls Dam (Bellows Falls Project No. P-1855)
- Vernon Dam (Vernon Project No. P-1904)
- Turners Falls Dam (Turners Falls Project No. 1889), and
- Northfield Mountain Pumped Storage Project (No. 2485).

On the basis of the Legislature's designation, the nomination document, and the three plans cited above, CRJC wishes to provide comment on how the Federal Energy Regulatory Commission's relicensing of these five projects may affect the resources of the Connecticut River and its watershed. This review is included as Attachment A.

Attachment B contains a study request by the Connecticut River Joint Commissions for a watershed-wide stormwater model to:

1. assess the effect of dam operations, under current flow conditions and future conditions when more extreme weather events are anticipated, on public interests; and
2. recommend measures to manage stormwater through dam operations to protect, preserve and enhance public interests.

Sincerely,

Rebecca Brown
President

Attachment A:

Resources of the Connecticut River Watershed and Potential Impacts on these Resources by Relicensing of the Wilder, Bellows Falls, Vernon, Turners Falls and Northfield Mountain Projects

Natural Resources:

The Connecticut River designation documents and subsequent river corridor management plans recognize a number of state and federally-listed rare, threatened and endangered (RTE) species in the Connecticut River and its banks, including the dwarf wedge-mussel and Jesup's milk vetch populations between Wilder Dam and Bellows Falls, the cobblestone tiger beetle, and the round whitefish. The Atlantic salmon restoration project was also recognized. In addition, the Connecticut River is home to numerous exemplary natural communities along the river's edge – floodplain forests, riverside seeps and outcrops (where Jesup's milk vetch grows), calcareous wetlands, and steep, rocky cliffs. The Connecticut River serves as a migratory corridor for waterfowl, hawks and songbirds. The operation of Wilder, Bellows Falls and Vernon Dams causes fluctuating water levels that can cause erosion and degradation of riverside habitat and natural communities, as well as alteration of aquatic habitat, including the mainstem, tributaries and backwaters or "setbacks", on which aquatic species and migratory waterfowl rely.

The Connecticut River designation documents and subsequent river corridor management plans emphasized the valuable open space in each town along the river. This open space includes riverside lands and islands owned by New England Power (now TransCanada), e.g. at Wilder Dam in Hartford and Lebanon, Sumner Falls in Hartland, farmland in Charlestown, Rockingham and Springfield, Upper Meadows and Herrick's Cove in Springfield, setbacks and islands above Vernon Dam in Hinsdale and Vernon.

Managed Resources:

The Connecticut River's water is used in many ways. In addition to the hydropower operations at Wilder, Bellows Falls and Vernon Dams, river water is used by farms for irrigation and by wastewater treatment plants in Lebanon, Charlestown, Hartford, Windsor, Bellows Falls, and Brattleboro. The designation process identified concerns for the adequacy of water quantity, specifically with respect to the demand for new and expanded water withdrawals in the future, in New Hampshire, Vermont and Massachusetts.

Cultural Resources:

Several Archaic and Woodland archeological sites are located on the banks of the Connecticut River and several tributaries – specific mention is made of sites in Hanover, Claremont, West Chesterfield, Hinsdale and sites on terraced banks of Connecticut River in Orford, Plainfield, Charlestown, Walpole and North Walpole. Historic resources on the river include Porter Cemetery in Lyme, Gilman Island in Hanover, site of old mill at Wilder Dam in Hartford, original village site of Lebanon, Mast Camp in Cornish, an historic settlement at the confluence of Blow-me-down Brook in Cornish, Hubbard and Jarvis Islands in Claremont, Fort at No. 4 in Charlestown, and a recreational boat club near Bellows Falls-North Walpole bridge. Also historic ferry crossings are located in Norwich, Hanover, Weathersfield, Claremont, Putney, Westmoreland, Dummerston, Chesterfield, Hinsdale and Vernon.

Current-day community cultural resources include several attractions on the river, including the Montshire Museum in Norwich, Ledyard Canoe Club in Hanover, Lyman Point Park in Hartford, Cornish-Windsor Covered Bridge, Fort at No. 4 in Charlestown, and the fish ladder at Vernon Dam. Bass tournaments and fishing derbies are important cultural events.

Recreational Resources:

The Wilder Dam, Bellows Falls Dam and Vernon Dam impoundments, including the bays and setbacks above Vernon Dam, serve as a warmwater fishery and boating resource. Fishermen access the river primarily by boat, but there are many fishing spots on the banks, as well as ice fishing. Fishermen also fish in free-flowing sections of the river: in the eddy at outwash of Wilder Dam, near 1-89 bridge in Hartford and West Lebanon, and below Bellows Falls and Vernon Dams.

The Wilder Dam impoundment was reported as a very popular boating spot, with the 1991 nomination document noting that boat launch parking lots were full on weekends. There is diversity in the types of boats used in these areas - canoes, fishing boats, party boats, speedboats, plus rowing shells, canoes and kayaks from Ledyard Canoe Club, also tubing, water skiing in wider parts of the river. Below Wilder Dam to Sumner Falls, the river can be very shallow, which limits recreation to mostly canoes, but is still well-used. Sumner Falls offers a portage around the falls, as well as an opportunity for whitewater canoeing and kayaking; below the falls, powerboats and canoes are typical. Between Bellows Falls and Vernon and then below Vernon Dam, there is again diversity in the types of boats used: pleasure boats, jon boats, water ski boats, canoes and rowboats, with canoes and rowboats accessing the shallow back inlets.

The 1992 designation recognized that canoeists engaged in day trips as well as longer trips by staying at different inns along the river. In the years following, the Connecticut River Paddlers' Trail has developed, allowing canoeists to camp at designated sites along the river in New Hampshire and Vermont. The 2009 Recreation Management Plan, part of the Connecticut River Corridor Management Plan recommends that TransCanada maintain their property to continue to provide campsites at Gilman Island, Lower Meadow, Stebbins Island and Wantastiquet/Hinsdale, portage trails around the dams, and public river access at Sumner Falls and Herrick's Cove.

Potential Impacts on Resource Values:

Fluctuating water levels: The fluctuation of water levels due to dam operations may impact instream and riparian biological communities and rare, threatened and endangered (RTE) species through bank erosion, flooding and drought. Dam operations may also alter spawning and feeding habitat upon which aquatic species and migratory waterfowl rely. Furthermore, fluctuating water levels may affect many other uses, from the experience of boaters and fishermen to archaeological, historic and cultural resources on the banks.

The 2009 Water Resources update of the Connecticut River Corridor Management Plan recommends that "dam owners should thoroughly evaluate impacts of impoundment cycling on riverbank erosion as part of relicensing studies, and undertake mitigation as appropriate." CRJC supports requests submitted by resource agencies to study the effect of water level fluctuations on public interests.

Water quantity: The Connecticut River's designation recognized the need for the dams to maintain minimum flows when they are not generating power. Participants in the designation process raised concerns over the allocation of water, specifically with respect to the future. Furthermore, the designation of the river into the Rivers Management and Protection Program statutorily requires the establishment of instream flows to support a variety of public interests (e.g., fisheries, water quality, recreation, power, scenic values, etc).

CRJC is submitting a study request (Attachment B) for a watershed-wide stormwater model that will provide a methodology to optimize dam operations, during existing and projected future flows, to ensure the availability of water for uses that include:

1. maintenance of natural communities including wetlands, flood plains and fish and wildlife habitats;
2. promotion of human uses such as water-based recreation and agriculture, and
3. society's needs for water supply, waste water assimilation, flood control, hydropower generation.

Water quality: The designation recognizes the resource values of aquatic RTE species, the warmwater fishery and recreational uses, which are all dependent on clean water. Dam operations may impact river water quality, especially in the future when more extreme weather events and flows are anticipated. Of particular concern is sediment and pollutant transport, water temperature, dissolved oxygen and turbidity. Therefore, CRJC supports the study requests submitted by state and federal resource agencies that propose to study the effect of dam operations on water quality with respect to these uses and other public interests.

Recreation: The designation recognizes the effect of dam operations on recreational values of the river, specifically fishing for warmwater species and boating of many types. It should be noted that all reaches of the river are used for recreation, both impoundments and free-flowing reaches below the dams. The 2009 Recreation update of the Corridor Management Plan makes several recommendations to maintain recreational opportunities. These include maintaining existing portage trails, campsites and public access points, and improving safety to ensure enjoyable recreational experiences. Specific recommendations to improve safety include providing:

- signage at Sumner Falls,
- notices at boat ramps regarding draw down of the Bellows Falls impoundment, and
- signage that calls attention to boat speed regulations, bank erosion, nuisance aquatics and boater responsibilities.

Recreational uses are largely dependent on water levels controlled by the dams and the management of lands owned by TransCanada. The land holdings provide access points to the river and recreational sites. CRJC supports study requests submitted by state and federal resource agencies that propose to study the effect of dam operations and land management by the licensee on recreational uses, particularly with respect to providing safe experiences for users. CRJC would like to emphasize the fact that the Local River Subcommittees composed of citizen representatives from riverfront communities possess extensive local knowledge of existing recreational uses. Thus, the CRJC recommends that the local river advisory committees be consulted as a resource in the assessment of alternative land management and river flow proposals on recreational uses.

Attachment B:
Study Request for Watershed-wide Stormwater Model

1. *Goals, Objectives and Required Information*

Goals:
(1) Take a cumulative watershed approach to the management of surface water, a public trust resource;
(2) determine the effect on public interests from projected future stormwater flows and the operation of the dams; and
(3) recommend measures to manage stormwater flows through the operation of the dams to protect public interests.

Objectives:
(1) Identify public interests in the watershed that have a nexus to dam operations,
(2) develop an integrated, sharable, and scientifically-rigorous stormwater model for the entire watershed,
(3) assess the cumulative effect of the dams on public interests, and
(4) recommend license conditions to protect, preserve and enhance public interests.

Required Information:
(1) High resolution base maps from LiDAR (Light Detection and Ranging) imagery of the watershed north of the Turners Falls Project (Exhibit 1), with LiDAR data collection recommended at Quality Level 2 as defined by the National Enhanced Elevation Assessment.

Elevation Quality Levels (QL)	Source	Horizontal Resolution Terms			Vertical Accuracy Terms	
		Point Density	Nominal Pulse Spacing (NPS)	DEM Post Spacing	Vertical RMSEz	Equivalent Contour Accuracy
QL 1	LiDAR	8 pts/m^2	0.35 m	1/27 arc-sec ~1 meter	9.25 cm	1-ft
QL 2	LiDAR	2 pts/m^2	0.7 m	1/27 arc-sec ~1 meter	9.25 cm	1-ft
QL 3	LiDAR	1 – 0.25 pts/m^2	1 – 2 m	1/9 arc-sec ~3 meters	≤18.5 cm	2-ft
QL 4	Imagery	0.04 pts/m^2	5 m	1/3 arc-sec ~10 meters	46.3 cm – 139 cm	5 – 15 ft
QL 5	IFSAR	0.04 pts/m^2	5 m	1/3 arc-sec ~10 meters	92.7 cm – 185 cm	10 – 20 ft

(2) land uses and characteristics in the watershed, and
(3) locations and assessments of existing and future public interests (e.g., fish habitats, archaeological and historic resources, actual and potential pollutant releases, farmland, wetlands, recreational locations, flood plains, water withdrawals, etc.).

2. Resource Management Goals

Develop a rigorous stormwater model (model) that incorporates the precise location and elevation of each public interest resource to enable an assessment of the effects of dam operations under a number of different stormwater scenarios. These analyses may be used as the basis for assessing the effect of dam operations, determining *cumulative impacts* and identifying potential *compensatory mitigation measures*.

The model may be used to (1) inform coordinated operations of main stem and tributary dams to regulate normal flows in order to reduce adverse effects and enhance beneficial effects on public interests, (2) predict future low and high water flows, based on a range of precipitation events, and (3) modify dam operations to lessen impacts during extreme precipitation events on specific resources.

Furthermore, the model may be used for emergency planning if, for example, during a severe storm event there is a catastrophic dam breach, the model could be used to predict the extent of downstream flooding.

3. Public Interest Considerations

The Connecticut River Joint Commissions are requesting this study. The public needs to know the effect the dams and their operations have on our natural and human environment, particularly in the decades ahead when precipitation is expected to be more extreme than in prior decades. They also need to know if and how the dams can be operated to benefit public interests in addition to hydropower.

The dams are the most significant factor in regulating stormwater flows in the mainstem of the river. They create detention ponds that collectively extend for more than a hundred miles in length between Vermont and New Hampshire (Exhibit 2). They slow the velocity of the water and promote the deposition of sediment and pollutants. They also play an important role in providing recreational opportunities, desynchronizing flood flows, diluting toxic discharges, and sustaining instream and riparian habitats.

A diversity of water users need access to timely, accurate, reliable data in order to determine anticipated availability of water for the maintenance of natural communities including wetlands, flood plains and fish and wildlife habitats, for the promotion of human uses such as water-based recreation and agriculture, and for society's needs for water supply, waste water assimilation, flood control, hydropower generation, and other uses that can be anticipated over the forty-year time period of the forthcoming licenses.

4. Existing Information and Need for Additional Information

Existing data on the location of resources of concern, while well-intentioned, are too often incomplete or inaccurate. Since instream and riparian uses are closely tied to the frequency, depth and duration of the inundation by the river, stormwater information needs to be modeled and modernized, as precisely as possible, for accurate application.

For example, the dams currently coordinate with the United States Army Corps of Engineers to provide flood control. However, a model needs to be developed that will accurately predict flooding from storm events that are projected to be more frequent and intense than the historical pattern. The Northeast has experienced a greater increase in extreme precipitation over the past few decades than any other region in the United States. Between 1958 and 2010, the Northeast saw a 74% increase in the amount of precipitation falling in very heavy events (http://ncadac.globalchange.gov). Recent flooding events in Vermont and New Hampshire highlight the issue.

Moreover, better elevation data needs to be acquired to more accurately predict the extent of flooding during storm events. The accuracy of the floodwater extent portrayed on Flood Insurance Rate Maps (FIRM) varies with the accuracy of the digital elevation model used to simulate the land surface. During tropical storm Irene areas in our bi-state region were flooded that were not within a mapped flood plain whereas other areas escaped the floods even though they had been depicted clearly within a mapped floodplain. Irene and other storms have highlighted the fluvial erosion risks throughout the watershed, and how management of streams and rivers throughout the watershed have exacerbated those risks. Better understanding stream and river geomorphology, including the extent to which streams and rivers have lost access to their floodplains due to incision, is critical to understanding the hydrology of the watershed, including updated model of low and high flow events. Better elevation data is needed for the entire watershed. A recently published report by the National Academy of Sciences, *Elevation Data for Flood plain Mapping, 2007* highlights the deficiencies of available land surface elevation data.

5. Nexus between Project Operations and Development of License Requirements

Stormwater flows in the river effect nearly every resource under study, from providing white water recreational activities to sustaining flood plain biological communities. The operation of the dams, in which they impound and then release the water, relies entirely on available stormwater. Integrated, accurate information about storm frequency, precipitation intensity, topography and land uses in the watershed is essential to allocate water for specific uses and, at the same time, maintain acceptable water quality standards.

A model with precise elevation data will help us better assess potential effects on all our resources and then develop appropriate mitigation measures for those effects. For example, riverbank erosion, with its attendant loss of land and accumulation of sediment is a costly and prevalent problem on the reaches of the river affected by flow modification from the dams. A refined model will (1) allow a better understanding of the causes and effects of riverbank erosion and (2) assist in identifying measures to mitigate the problem. Mitigation of erosion and other effects should be an important component of eventual dam license provisions.

A rigorous model is essential so that license permit conditions can be developed to protect river resources through coordinated management of the dams. The challenge will be to identify and designate specific uses for each reach of the river and to identify and regulate specific flows in each of these reaches to ensure that designated uses are not degraded, and where feasible can be enhanced as a consequence of the impoundment and release of flows by the dams.

6. Proposed Study Methodology is the Preferred Scientific Practice

The watershed approach to analyzing water flows is the preferred methodology for forecasting flows, and evaluating environmental and economic outcomes based on various dam management scenarios. This approach is being utilized in the Connecticut River Watershed Restoration project that is being undertaken by the Nature Conservancy, United States Army Corps of Engineers New England District Office, University of Massachusetts Amherst, and United States Geological Survey. This study is being performed to help determine how management of large mainstem and tributary dams and water systems can be modified for environmental benefits while maintaining beneficial human uses such as water supply, flood control and hydropower generation.

The use of airborne LiDAR technology is the preferred methodology for the preparation of digital elevation models. Coastal studies, in progress, are using LiDAR imagery to interpret the effect of sea level rise due to climate change are on our coast lines. The Northeast LiDAR Project is a collaboration between a number of agencies to acquire accurate, high-resolution LiDAR data for coastal areas of New York, Connecticut, Rhode Island, Massachusetts, New Hampshire and Maine (www.ma.nrcs.usda.gov/technical/lidar/index.html).

Moreover, scientists at the University of New Hampshire are using LiDAR data to model potential future inundation areas in the Lamprey River watershed based on projections of land use changes and increased precipitation (http://www.unh.edu/news/cj_nr/2012/may/ds16landscape.cfm#ixzz2LuUVDFLF). Furthermore, the New Hampshire Geographic Information System (GIS) Strategic Plan points out that airborne LiDAR technology is recommended as the preferred method for acquiring data of sufficient accuracy and resolution for the assessment and management of water resources (Exhibit 3).

7. Cost of Proposed Study and Relationship to Other Studies

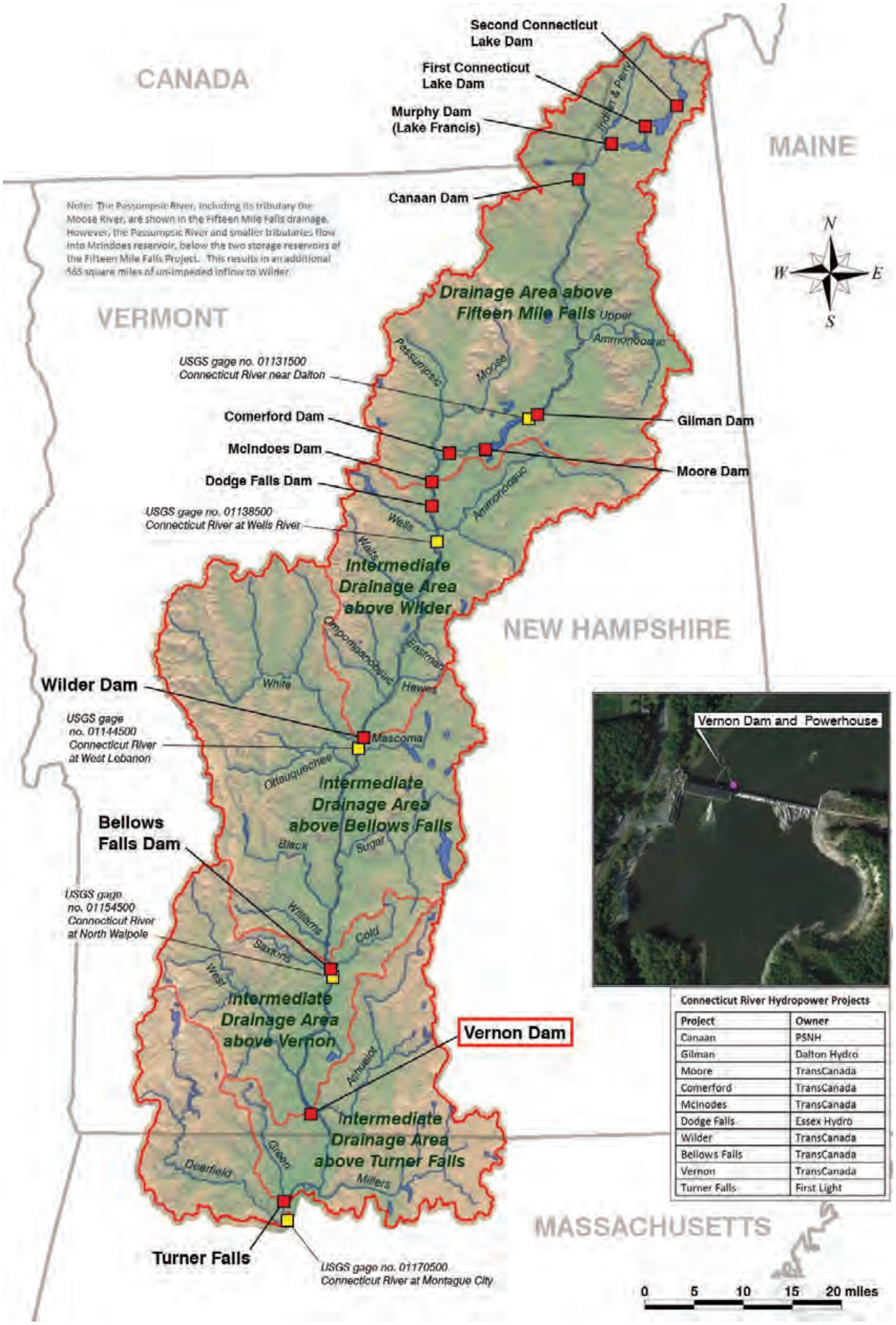
To our knowledge, none of the other proposed studies suggest LiDAR mapping be undertaken and a stormwater model be developed for the entire watershed. Existing hydrological studies lack precise elevation data and are based on historic United States Geological Survey gage data. The historic record will be of limited usefulness in predicting flows under the changed climate regime of the decades subject to the new permit.

The model we propose, utilizing LiDAR, will have much more precise elevation data and will incorporate land uses, topography, cover types and other characteristics within the entire watershed. This will be a refined tool that may be used to better predict the timing and quantity of future flows and to some extent address issues related to water quality (e.g., identify the locations of pollution discharges that could become incorporated in storm flows).

Moreover, we anticipate specific agencies will request the preparation of high-resolution maps and assessments of resources under their jurisdiction. For example, we expect federal and state resource agencies responsible for protecting wetlands will request the delineation and assessment of wetlands bordering the mainstem. We also expect other resource agencies will request bathymetric studies of the river channel to assess instream habitats. Together, these studies and the proposed stormwater model will provide the basis for identifying measures to reduce adverse effects and compensate for unavoidable ones.

Development of the proposed stormwater model utilizing LiDAR data could cost two million dollars or more. Amortized over the life of the permits this puts a yearly cost at about $50,000. Moreover, we strongly argue that the model be shared with cooperating agencies, the LiDAR data be made available, i.e. in the public domain, and the specifications for the LiDAR data collection are adequate for broad uses of the data. As such we might anticipate the cost will also be shared among these agencies which could include National Oceanic and Atmospheric Administration, United States Environmental Protection Agency, United States Fish and Wildlife Service, United States Army Corps of Engineers, Federal Emergency Management Agency, United States Geological Survey, and state resource and transportation agencies and academic institutions in Massachusetts, Vermont and New Hampshire. NH GRANIT, New Hampshire's state GIS clearinghouse, has reviewed and supports this request, and furthermore has the capacity to disseminate and archive the LiDAR data for use by the licensees, the potential funding agencies involved in cost-sharing and the public at-large.

EXHIBITS:
Exhibit 1. Watershed Map.
Exhibit 2. Operations Summary.
Exhibit 3. An Enhanced Statewide Elevation Dataset for New Hampshire: The Case for LiDAR.



Connecticut River Hydropower Projects

Project	Owner
Canaan	PSNH
Gilman	Dalton Hydro
Moore	TransCanada
Comerford	TransCanada
McIndoes	TransCanada
Dodge Falls	Essex Hydro
Wilder	TransCanada
Bellows Falls	TransCanada
Vernon	TransCanada
Turner Falls	First Light

Figure 3.2-1. Project and the upper Connecticut River Basin (Source: EPA, 2012, as modified by TransCanada).

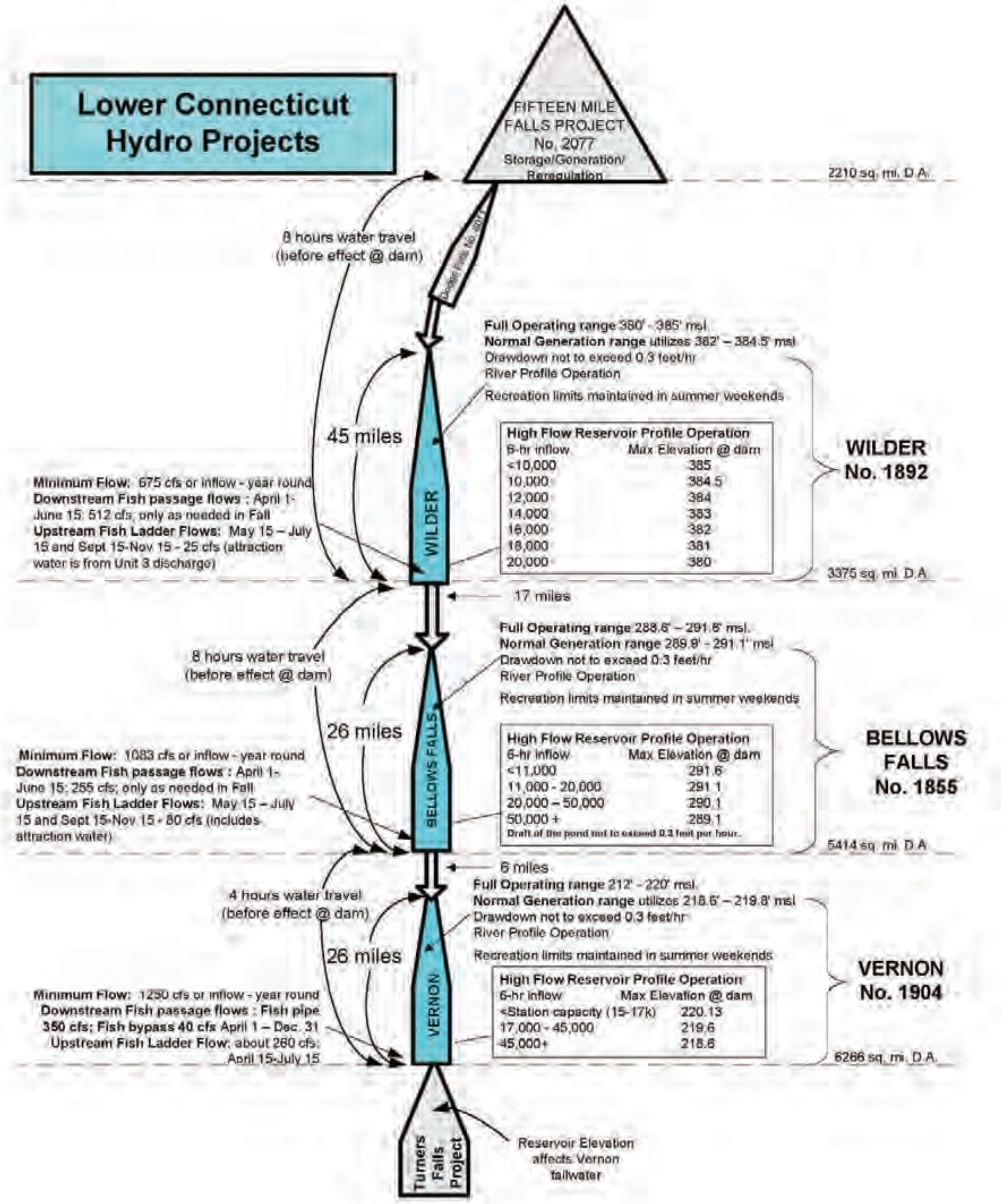
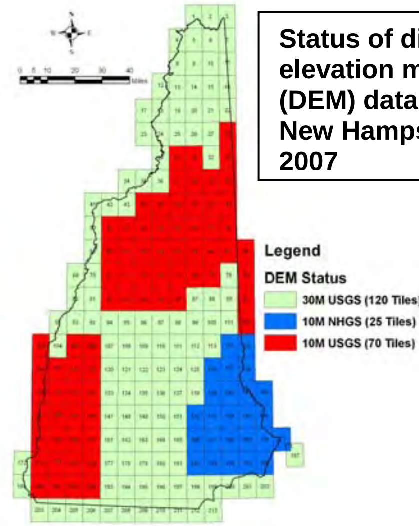


Figure 2.5-1. Connecticut River operations summary.

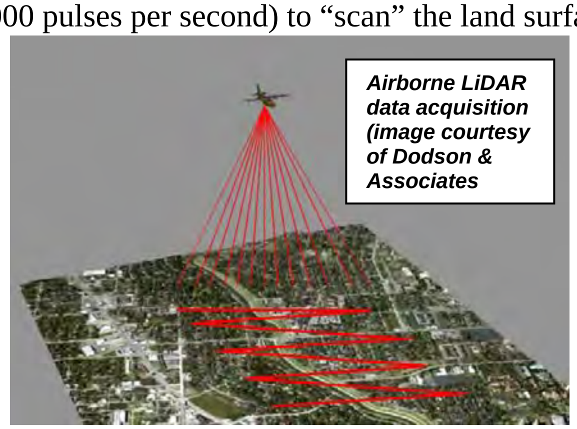
AN ENHANCED STATEWIDE ELEVATION DATASET FOR NEW HAMPSHIRE: THE CASE FOR LIDAR

The NH Geographic Information System (GIS) Strategic Plan identifies the need to develop statewide high-quality topographic data to replace the existing mixed resolution data for NH (statewide 30-meter and partial 10-meter digital elevation models) available as part of the US Geological Survey (USGS) National Elevation Dataset. The cost associated with a project of this scope together with the recognition that a variety of GIS users have the potential to benefit significantly from the availability of an enhanced topographic dataset, suggest that a number of funding partners should be engaged in any development effort. Perhaps the most critical use of these data has been highlighted by recent flooding events in the state. A recently published report by the National Academy of Sciences (*Elevation Data for Floodplain Mapping, 2007*) (http://www.nap.edu/catalog.php?record_id=11829 – Hidden) points out the deficiencies of available land surface elevation data to support modernization of floodplain maps under the National Flood Insurance Program administered by the Federal Emergency Management Agency (FEMA). The report states that "FEMA needs land surface elevation data that are about ten times more accurate than data currently available for most of the nation."

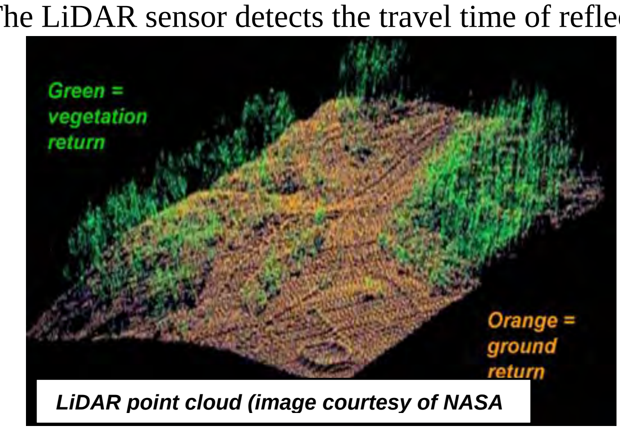


Status of digital elevation model (DEM) data in New Hampshire, 2007

Airborne LiDAR (Light Detection And Ranging) technology is recommended as the preferred method for acquiring data of sufficient accuracy and resolution. This method uses laser pulses (between 5,000 and 50,000 pulses per second) to "scan" the land surface. The LiDAR sensor detects the travel time of reflected



Airborne LiDAR data acquisition (image courtesy of Dodson & Associates



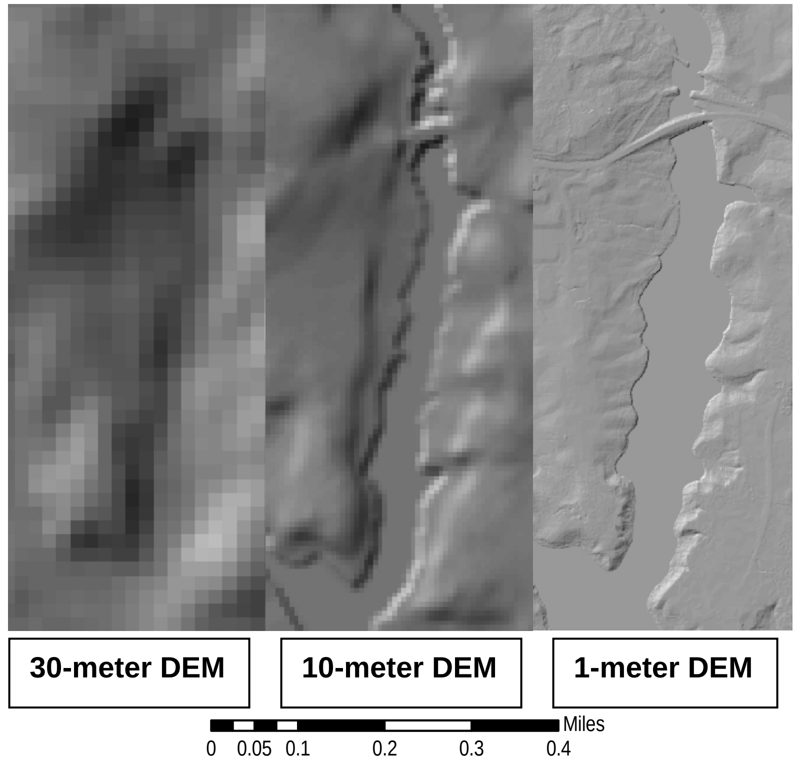
LiDAR point cloud (image courtesy of NASA

energy from each pulse, including a 'first return" for the first reflective surface in its path, but also potentially records multiple returns as the light beam penetrates to different "soft" surfaces at lower levels within a vegetated area. Post-processing of the collected data is then performed to extract a bare earth terrain model, but also can be used to derive vegetation characteristics (such as forest canopy height and density) and/or to extract structural features within the built environment.

As the availability of LiDAR data has increased through statewide initiatives (i.e. North Carolina, New Jersey, Florida, Pennsylvania, New York) and more localized projects, the number and range of demonstrated uses and experimental applications has grown tremendously. A high-resolution bare-earth digital elevation model (DEM) supports the detailed classification of landforms. These data in turn serve as the framework for ecological and habitat assessments used to prioritize land conservation and restoration efforts, but also enable geologic hazards, such as potential landslides, to be mapped. Many of the uses are focused on activities related to the assessment and management of water resources, such as watershed delineation, floodplain mapping, stormwater management, water quantity and quality modeling within watersheds, land cover/ land use mapping, etc. Other potential applications exist in the areas of transportation, forestry, agriculture, and emergency management.

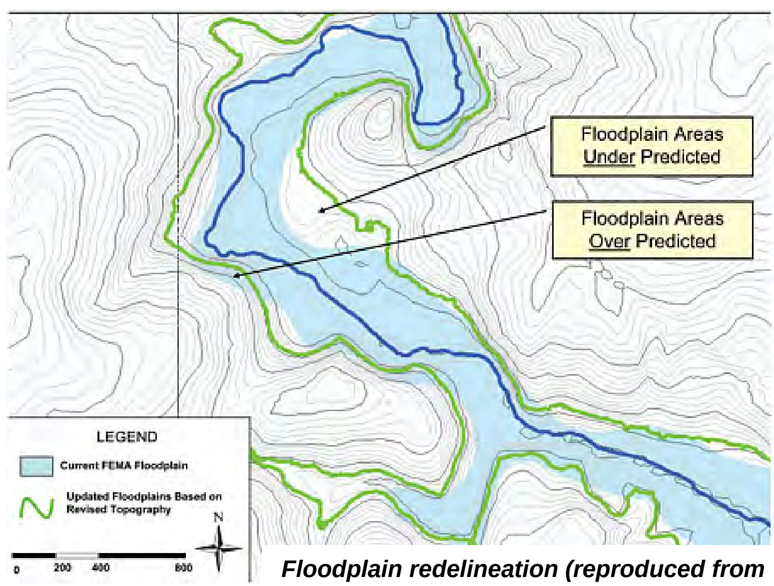
The NH GIS Strategic Plan also identifies a critical need for statewide high resolution orthoimagery, with repeat coverage at some specified time interval in order to enable changes in land use/land cover to be monitored. An accurate digital terrain model (DTM) is required to orthorectify the original aerial photographs so that the resulting imagery can support detailed spatial analyses. Although this process can be performed with elevation data that have been derived photogrammetrically, a DTM created from LiDAR has the potential to support additional applications that benefit from higher resolution elevation data. Therefore, a certain economy could be realized by investing in LiDAR data as an integral part of any program to acquire high resolution orthoimagery. Because of this potential to achieve mutual benefits, advocates for developing one dataset might be enlisted to promote development of the other dataset.

Comparison of terrain models for Fresh Creek, Strafford County, NH: NED 30-meter and 10-meter DEMs versus 1-meter LiDAR



While FEMA clearly is an important stakeholder given the utility of LiDAR for updating and refining flood hazard maps, other significant interests could be served through a cost-sharing data development initiative. The "Elevation for the Nation" (http://lidar.cr.usgs.gov/downloadfile.php?file=Harding_Elev4Nation_2-15-07_small.pdf) initiative recently unveiled by the USGS is evidence of the overall importance and broad applicability of this dataset. This announcement identifies USGS as a prime advocate for a statewide LiDAR project, if not as a potential funding partner. Funding should also be solicited from other entities that would benefit directly from such a project, assuming that data acquisition and processing could be specified and coordinated in order to meet their needs.

The following summary of organizations and some of their related business needs is intended as a starting point for building the necessary partnerships:



Floodplain redelineation (reproduced from the National Academies Press, 2007)

- U.S. Environmental Protection Agency – enhanced terrain data should improve the accuracy of watershed models used to assess total maximum daily loads by better defining flow pathways across the landscape.

- U.S. Forest Service – multiple return data from LiDAR surveys can be used to determine tree canopy height and stand density (or total biomass) and also support fire fuel mapping; bare earth digital terrain models can assist with the layout of road networks for timber harvests.

- Natural Resources Conservation Service – detailed topographic data are useful for high intensity soil surveys and for designing erosion control structures or defining best management practices for minimizing erosion.

- National Oceanic and Atmospheric Administration – storm surge modeling to mitigate flood inundation and coastal erosion hazards; shoreline delineation and monitoring of sea-level rise.

- NH Department of Transportation – design of new roads and stormwater drainage systems; improved estimation of volumes of material involved in cut and fill operations.

- Various state agencies and private non-profit organizations whose mission involves environmental conservation and resource management.

- Private sector telecommunications companies – siting of cell towers to minimize gaps in coverage due to interferences from terrain and trees depend on highly accurate terrain models and forest land cover assessments.

- Private sector wind energy producers – siting of wind turbines to maximize exposure.

NEW HAMPSHIRE DIVISION OF HISTORICAL RESOURCES
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March 1, 2013

Kenneth Hogan
Federal Energy Regulatory Commission
888 First Street NE
Washington, DC 20426
Via email: Kenneth.Hogan@ferc.gov

Re: Wilder P-1892, Vernon P-1904, Bellows Falls P-1885, Turners Falls P-1899, Northfield Mt. Pumped Storage P-2485

Dear Mr. Hogan,

Thank you for the opportunity to comment on TransCanada's Pre Application Documents (PAD) dated 10/30/12 for the above referenced projects and FERC's response, dated 12/21/2012. Comments by the New Hampshire Division of Historical Resource (DHR) are limited, given the preliminary nature of the reports.

The DHR can confirm that it intends to participate fully in the Section 106 consultation with FERC and TransCanada for these projects. FERC's response on 12/21/12 initiates “informal” consultation under Section 106 and also designates TransCanada to carry out “informal” consultation with the State Historic Preservation Offices. Given that informal consultation is not defined in the Section 106 regulations, the DHR would appreciate a greater understanding of its meaning for these projects and how it may differ from official consultation going forward.

Unfortunately, DHR lacks the ability to concur with conclusions and recommendations in the PADs because the source document for the cultural resources discussions has not yet been submitted to our office: the Phase IA Archaeological Reconnaissance Survey Report by Public Archaeological Laboratory. Following the paper submission of this report to our office, the DHR will comment more fully on its contents and future recommendations.

It also appears that archaeological consultants have compiled all historical and archaeological information presented in the project PADs. Please note that going forward with more in-depth identification and evaluation of above-ground historical resources, qualified architectural historians will be needed to confirm these preliminary identification efforts and complete any survey and National Register eligibility submissions.

Again, thank you for the opportunity to comment on the above referenced projects. Please feel free to contact our office if you have any questions.

Sincerely,

Elizabeth H. Muzzey

Elizabeth H. Muzzey
Director and State Historic Preservation Officer

c.c. John Ragonese, TransCanada
Giovanna Peebles, Vermont DHP

VERMONT

Vermont Department of Environmental Conservation
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FILED AND DISTRIBUTED ELECTRONICALLY

March 1, 2013

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

RE: Wilder Hydroelectric Project – FERC No. 1892-026
Bellows Falls Hydroelectric Project – FERC No. 1855-045
Vernon Hydroelectric Project – FERC No. 1904-073
Turners Falls Hydroelectric Project – FERC No. 1889-081
Northfield Mountain Pumped Storage Project – FERC No. 2485-063
Study Requests and Comments on Pre-Application Documents and Scoping Document 1

Dear Secretary Bose:

The Vermont Agency of Natural Resources (Agency) submits the following comments on the Pre-Application Documents (PADs) and Scoping Document 1 (SD1) for the TransCanada (Wilder, Bellows Falls and Vernon) and FirstLight (Turners Falls and Northfield Mountain) projects located on the Connecticut River. In addition, we submit our requests for studies for the five projects.

Study Requests

The Agency is requesting 34 studies that address water quality, fisheries, habitat, threatened and endangered species and other issues. Most of these studies apply to multiple projects. The study requests are compiled in Attachment 1.

The Agency's interest in the FirstLight projects (Turners Falls and Northfield Mountain) merits some explanation. While these two projects are located on the Connecticut River south (downriver) of Vermont, they influence Vermont's aquatic resources. These influences are related to migratory fish species that must move upstream past these projects to reach habitat in Vermont, move from Vermont waters downstream past the projects, or both. Fish such as American shad and American eel use Vermont waters (Connecticut River and its tributaries) as part of their life cycle, and must be able to migrate to these waters from ocean habitats and then return. Other fish species such as walleye, brown trout and other species also move upstream and downstream to meet seasonal habitat needs, such as to find spawning habitat, over-wintering habitat, feeding areas or more favorable temperature conditions. These movements may be localized or may involve miles of travel, but they are very important to production and survival.

Fish moving upstream and downstream past the FirstLight projects must be able to pass safely and effectively, without undue delay. This goal applies to more than just fish passage facilities. It relates as well to store-and-release flow management and intake configurations that minimize impingement and entrainment. It relates to the quality of waters that fish must move through. Additionally, water level fluctuations in the Turners Falls and Northfield Mountain areas can act as barriers to fish movement in and out of tributaries and backwaters in 5.7 miles of the Turners Falls impoundment located between New Hampshire and Vermont. Fish moving within the river system also need suitable habitat appropriate to their life stage, location in the river and time or season of use. Erosion and impoundment fluctuations can damage near-shore habitats often used by fish as spawning and nursery habitat.

The fish community downstream of Vernon is of interest to the Agency since part of this river reach is in Vermont and since fish found there may seek to move upstream past the Vernon dam to access other Vermont waters.

Consequently, the Agency requests that FERC recognize its interest in these projects and require the studies requested of FirstLight in support of the relicensing of its projects.

Comments on Pre-Application Documents and Scoping Document 1

The comments below are referenced to the relevant sections of Scoping Document 1.

Geographic Scope (4.1.2)

The geographic scope in SD1 tentatively identified the mainstem of the Connecticut River from the Wilder Project downstream as having resources that may be cumulatively affected by the hydro projects. The Agency mostly concurs with the geographic scope identified in SD1. The Agency recommends assessment of the cumulative effects on migratory fish species (i.e., American shad, American eel) from the head of the Wilder impoundment to downstream of Turners Falls. This would include the effectiveness of upstream and downstream fish passage and issues related to stream flow and temperature that could cause delays in migrations. The Agency is interested in the effectiveness of fish passage at Turners Falls because of its direct implications on the state resource management goals for these migratory species.

The U.S. Army Corps of Engineers operates seven flood control dams on tributaries that discharge into the Connecticut River in the project areas. The geographic scope of the cumulative effects analysis should also include the effect operation of these dams have on Connecticut River flows.

Geology and Soils (4.2.1) – TransCanada

Surveys conducted by TransCanada in 2011 identified shoreline erosion at a number of locations within the boundaries of the three projects. The SD1 has identified issues and concerns on the effects of the project's operation and maintenance on river bank erosion, including the potential effects on protected species, cultural resources or the structural integrity of adjacent facilities. The Agency concurs with these concerns. However, TransCanada has not proposed any studies specific to geology or soil resources, therefore, the Agency is requesting a study of shoreline erosion (Study Request 1) to determine how project operations contribute to the shoreline erosion and riverbank failure within the impoundment and downstream of each of the projects.

Geology and Soils (4.3.1) – FirstLight

The PAD for the FirstLight projects identified the effects of the Turners Falls Project and Northfield Mountain Project operations on riverbank erosion as a preliminary issue, and information from previously conducted studies and ongoing studies will be utilized to assess the effects of the Turners Falls and Northfield Mountain Projects on riverbank erosion. The SD1 has identified issues and concerns on the effects of project-induced water level fluctuations in the Turners Falls impoundment, on shoreline stability and river bank erosion, particularly where erosion might impact protected plant species, critical wildlife habitat, adjacent structures, recreational facilities and private landowners within the project boundary. Approximately 5.7 miles of the Turners Falls impoundment potentially impacts Vermont's shoreline. However, First Light has not proposed any studies specific to geology or soils resources, therefore, the Agency requests a study (Study Request 1) to determine the potential environmental effects of the presence and operation of the licensed facilities on river bank stability, shoreline habitat, and water quality.

Water Resources (4.2.2) – TransCanada

The PADs states that water quality data suggest that the projects have no significant impact on temperature, dissolved oxygen (DO) or other chemical parameter in the river. However, the data in the PADs indicate that Vermont Water

Quality Standards for dissolved oxygen were not consistently met during monitoring in the summer 2012. Furthermore, there is no comprehensive water quality data specific to the projects and how project operations possibly affect water quality conditions.

TransCanada is proposing to develop a river flow and operation optimization model that will optimize water resources, electrical generation, and provide analytical results and outputs to make determinations or develop alternatives. However, this study will not address issues pertaining to Vermont Water Quality Standards.

The SD1 identifies the effects of current and proposed project operations on water quantity and water quality, particularly on dissolved oxygen and temperature (including cumulative effects from the operation of the Vermont Yankee nuclear power plant) as an issue or concern.

In order to determine if operations at the three projects meet Vermont Water Quality Standards, the Agency proposes Study Request 2. Additionally, we concur with the concerns noted in SD1 regarding cumulative effects of the projects on water resources, and Study Request 3 addresses the effects of potential increases in water temperature from increased travel time through the project impoundments. Additionally, Study Request 4 address concerns about water quantity and timing of river flows as it relates to assessing the effects of the dams on the riverine environment. Study Request 5 addresses how river flows and water temperature could be impacted by climate change, and how project operations and maintenance could be affected during the duration of the new license.

Water Resources (4.3.2) – FirstLight

The PAD identified preliminary issues relating to the effects of Turners Falls and Northfield Mountain operations on dissolved oxygen and temperature. FirstLight has proposed to collect dissolved oxygen and temperature data during the summer period and under various hydropower operating conditions at Vernon, Turners Falls and Northfield Mountain. The SD1 identified the effects of current and proposed project operations on water quantity (including power generation) and the effects of project operations on water quality, particularly on dissolved oxygen and temperature as an issue or concern. The Agency concurs with the identified issues and is requesting a study for the portion of the impoundment adjacent to the Vermont shoreline (Study Request 2).

Aquatic Resources (4.2.3) – TransCanada

The PADs state that that there are numerous dams on the Connecticut River that affect river flow and anadromous fish, and can interrupt habitat connectivity for resident fish. However, existing upstream and downstream passage facilities provide access to habitat for both anadromous and resident fish. Nonetheless, the effectiveness of these passages for passing different species of fish has not been studied.

The PADs also note that hydroelectric generation can cause potential instream and reservoir related adverse effects on fish and aquatic resources, but conclude that normal impoundment operating ranges minimize fluctuations that could affect fish spawning recruitment. TransCanada concludes that, based upon the available information, no immediate resource issues with regard to fish habitat or fish passage are apparent, and that existing upstream and downstream passage facilities provide access to habitat for both anadromous and resident fish. At this time, TransCanada is not proposing studies specific to fish and aquatic resources.

The SD1 identified areas of concern including the potential effects operation and maintenance of the three projects (including fluctuations in water levels and flow releases) on aquatic habitat and resources in the vicinity (e.g., resident and migratory fish populations; fish spawning, rearing, feeding, and overwintering habitats; mussels and macroinvertebrate populations and habitat). Further, entrainment and the project's effects on fish migration through and within project fishways, reservoirs and the downstream riverine corridor was also noted as areas of concern. The Agency generally concurs with the issues and concerns recognized in SD1, and identifies several subjects that warrant further investigation. The Agency also recommends that the effects of project operation and maintenance on aquatic habitat and resources in the project vicinity (e.g. resident and migratory fish populations; fish spawning, rearing, feeding, and overwintering habitats; mussels and macroinvertebrate populations and habitat) be considered cumulatively for the TransCanada projects since together they affect resident and migratory fish populations throughout the mainstem of the river.

Project Operations

The projects impound miles of river that would otherwise be naturally free-flowing. They currently operate in a peaking mode, with allowable impoundment fluctuations of up to 5 feet at Wilder, 3 feet at Bellows Falls, and 8 feet at Vernon, with proposals to continue without change. The Bellows Falls Project bypasses a 3,500 foot-long section of the Connecticut River. Presently this bypass reach only receives flow when inflow exceeds the hydraulic capacity of the Bellow Falls station. In order to determine an appropriate bypass flow regime that will protect and enhance the aquatic resources in the Bellows Falls bypass reach, the Agency is submitting Study Request 6.

The downstream conservation flow requirements for all three projects are equal to 0.20 csm.[1] The PADs did not indicate how these conservation flow requirements were established or what specific ecological resources they are intended to benefit. These conservation flows are inconsistent with both the Agency's *Procedure for Determining Acceptable Minimum Stream Flows*[2] and the U.S. Fish and Wildlife Service Interim Regional Policy for New England Streamflow Recommendations.[3] The Agency is not aware of any previously conducted studies that have evaluated the adequacy of this minimum flow in protecting aquatic resources, nor project effects of daily hydropeaking on riverine habitat.

Therefore, in order to fill this important information gap, the Agency has developed Study Request 7, which will provide information on the relationship between flow and habitat in the Connecticut River downstream of the three projects. Results will be used to develop an appropriate flow regime that will protect and enhance the aquatic resources downstream of each project.

Additionally, hydropeaking operations and the presence of the dams directly affect sediment supply and transport, which in turn can affect channel morphology and the availability of coarse substrate habitat for aquatic biota. Study Request 8 aims to investigate coarse sediment supply and transport as it relates to aquatic benthic habitat (e.g. gravel bars).

American Shad

American shad (*Alosa sapidissima)* spawning is influenced by river flow, which fluctuates greatly due to the projects' peaking mode of operation. Juvenile American shad production occurs in the river reach between Bellows Falls and Vernon dams, which is thought to be the historic upstream limit of the shad migration in the Connecticut River. Juvenile American shad require safe and effective downstream passage measures to have the opportunity to contribute to the restoration target population size. In order to determine if project operations affect juvenile American shad outmigration survival, recruitment, and production the Agency is filing Study Request 9.

Total American shad populations and numbers of shad passing Holyoke, Turners Falls and Vernon Dam have not met Connecticut River Atlantic Salmon Commission (CRASC) management goals. Study Request 10 addresses the need to understand how the projects' operations are affecting the overall American shad population.

Fluctuations in water levels may impact shad spawning activity by altering current velocities and water depth at the spawning sites. Effects on spawning behavior could include suspension of spawning activity, poor fertilization, flushing of eggs into unsuitable habitat due to higher peaking discharges, eggs dropping out into unsuitable substrate and being covered by sediment deposition or eggs becoming stranded on dewatered shoal areas as peak flows subside. In order to determine if project operations affect American shad spawning site use and availability, spawning habitat

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[1] cubic feet per second per square mile
[2] www.anr.state.vt.us/dec/waterq/rivers/docs/rv_flowprocedure.pdf
[3] www.fws.gov/newengland/pdfs/Flowpolicy.pdf

quantity and quality, and spawning success in the river reaches downstream and upstream of the Vernon Dam the agency submits Study Request 11.

As mentioned above, water level and flow velocity fluctuations during the spawning migration of American shad can cause delays, injury, mortality, and passage failure, as evidenced by ongoing research from USGS. The Agency's Study Request 12 addresses the need to assess American shad behavior, approach routes, passage success, survival, and delay as adult shad encounter the projects during both and upstream and downstream migrations.

Resident fish species

A thorough and comprehensive assessment of the fish assemblage present in the project affected areas is lacking. The PADs for the TransCanada Hydroelectric Projects state, "No targeted studies have been conducted to characterize the fish community in relation to the Project." Project operations that result in water levels and stream flow fluctuations have the potential to impact resident fish populations differently depending on the species ecology and habitat requirements. Therefore, in order to determine the assemblage of fish species present in the project affected area the Agency proposes Study Request 13.

Resident spring spawning fish downstream of the hydroelectric projects can potentially be impacted by peaking operations that result in the dewatering of nests or stream flow conditions that displace eggs or larvae, influencing spawning success, and the quality and quantity of spawning habitat. Study Request 14 aims to investigate the potential impacts of project operations on resident spring spawners.

Species of Greatest Conservation Need

The American eel (*Anguilla rostrata*), is a Species of Greatest Conservation Need (SGCN) for New Hampshire and Vermont. The status for conservation need in Vermont is listed as high priority in Vermont's Wildlife Action Plan[4] and the species is listed as "vulnerable" in New Hampshire. As identified in the Vermont action plan, threats to the species include the construction of large dams on rivers which obstruct juvenile fish access to critical rearing habitats, as well as mortality associated with passing through hydroelectric facilities' turbines during their outmigration to sea.

As outlined in Vermont's Wildlife Action Plan, research and monitoring needs for this SGCN include determining its distribution and abundance, as the contribution of eels in northern regions to overall stock is unknown. One of the conservation strategies for this species is to support efforts to enhance access of American eels to Vermont waters by eliminating or minimizing impacts of dams and other obstructions along the Richelieu, St. Lawrence, and Connecticut Rivers.

No targeted eel surveys have been conducted to determine the abundance and distribution of American eels in riverine and lacustrine habitat on the Lower Connecticut River. In order to determine the relative abundance and distribution of American eel in the project areas in both riverine and lacustrine habitat, the Agency submits Study Request 15.

The tessellated darter (*Etheostoma olmstedi*), a New Hampshire SGCN and known host species for the federally-endangered dwarf wedgemussel (*Alasmidonta heterodon*), is known to occur in the project-affected area. Operations at the Wilder, Bellows Falls and Vernon projects alter the natural flow regime and consequently cause changes in the availability of instream habitat on which the tessellated darter and other lotic species depend. Habitat for tessellated darters is directly related to project operations in terms of changes in flow (water depth and velocity, timing, duration, frequency, and rate of change) as well as the interactions of flow with other habitat variables such as substrata, vegetation, and cover. Operations both upstream (changes to the impoundment) and downstream (changes to the flow regime) may impact habitat, and may consequently lead to changes in the distribution, abundance, and behavior of tessellated darters that could in turn potentially impact the federally-endangered dwarf wedgemussel. In order to evaluate the effects of project operations on populations of the tessellated darter, the Agency submits Study Request

[4] Kart, J., R. Regan, S.R. Darling, C. Alexander, K. Cox, M. Ferguson, S. Parren, K. Royar, B. Popp, editors. 2005. Vermont's Wildlife Action Plan. Vermont Fish & Wildlife Department. Waterbury, Vermont. www.vtfishandwildlife.com

16. Results of the study will help determine whether project operations have a substantial impact on populations of tessellated darter, or whether population parameters are consistent with those of other populations in the region. If there is an impact, study results will provide information that will assist the development of recommendations aimed to maintain populations of dwarf wedgemussel.

The sea lamprey (*Petromyzon marinus*), within the Connecticut River drainage, is a Species of Greatest Conservation Need (SGCN) in New Hampshire and Vermont. Project operations and subsequent large and rapid changes in flow releases from the dams have the potential to cause direct adverse effects on spawning habitat and spawning activity downstream of the dams. Study Request 17 aims to investigate potential impacts of operations at Wilder, Bellows Falls and Vernon on sea lamprey spawning success.

As mentioned above, project operations and subsequent large and rapid changes in flow releases from the dams have the potential to negatively impact riverine fish species spawning activities. For example, the project's operations and subsequent water level fluctuations directly affect spawning habitat quality and quantity. Changes in water levels may create conditions where fish eggs are exposed to air (dewatering) or where fish abandon nests containing eggs. The Agency's Study Request 18 aims to evaluate potential impacts of water level fluctuations in the impoundment on nest abandonment, spawning fish displacement and egg dewatering for various riverine species.

Additionally, water level fluctuations in the project areas have the potential to result in barriers to fish movement in and out of tributaries and backwaters. Maintaining connectivity between the mainstem of the Connecticut River and tributaries and backwaters is vital to the fish populations in these systems, because many fish species utilize these areas for spawning, rearing, refuge, and feeding. Study Request 19 addresses the need to determine if water level fluctuations in the project impoundments impact water levels, available fish habitat and water quality in tributaries and backwaters.

Fish passage facilities

The PAD acknowledges that Wilder, Bellows Falls and Vernon dams are among the numerous dams on the Connecticut River that affect diadromous fish and can interrupt habitat connectivity for resident fish. Furthermore, the fish passage facilities located at the dams are designed and operated primarily for Atlantic salmon. The fishways are operated during the spring migration period typically May 15-July 15 and September 15-November 15, and as a result passage for riverine species, as well as other diadromous species is thwarted for most of the year.

The PADs for the three TransCanada projects provide limited information pertaining to trash rack configuration, spacing or approach velocities. The Agency requests more information on trash rack specifications for the Wilder, Bellows Falls, and Vernon projects, specifically details of rack bar spacing at all depths, bar configuration and orientation and approach velocities.

The American eel (*Anguilla rostrata*) is a Vermont and New Hampshire state listed Species of Greatest Conservation Need (SGCN), and is currently being petitioned for federal listing under the Endangered Species Act. The American eel has been documented upstream of all the projects. Although some eels are able to ascend the ladders, they may incur delays (in attraction or passage rates), be size-selective (e.g. velocity barrier for small eels presented by ~8 ft/sec flow through weirs and orifices), increase risk of predation (predators in or near the fishways), or are not operated throughout the upstream eel passage season. The Agency is filing Study Request 20 to determine the timing of silver eel migration downstream. Furthermore, entrainment of the American eel at the conventional turbines at the projects can result in mortality or injury. To determine the impact that the projects have on the outmigration of silver eels in the Connecticut River, the Agency submits Study Request 21. Results will facilitate an understanding of the passage routes of the American eel at the projects and the potential for mortality. Alternative strategies will be explored to increase out migrant survival.

The three projects' upstream fish passage facilities were not designed to pass American eel, and likely to do not provide effective and efficient eel passage. The Agency proposed study (Study Request 22) would examine upstream American eel passage at the Wilder, Bellows Falls and Vernon Projects. Results will be used to determine whether existing operations at the fish ladders would be an effective mechanism to move juvenile eels upstream past the project.

Furthermore the projects propose a risk to resident fish populations moving in the forebay of the projects. To determine the risk of impingement and entrainment to resident fishes moving in the vicinity of the projects the Agency requests a study (Study Request 23). Additionally, in order to determine the adequacy of the existing fish ladders in passing riverine species and determine the appropriate operation period for these fishways to pass riverine and diadromous fish, the Agency proposes Study Request 24.

Aquatic Resources (4.3.3) – FirstLight

The PAD has identified issues relating to the effectiveness of upstream passage for American shad at all three fish passage facilities; the effectiveness of existing upstream passage for American eels; the effectiveness of downstream passage for juvenile and post-spawned adult American shad and out-migrating adult silver eels; the effects of changes in water levels and flows from the Turners Falls Project operation on zone of passage and fish habitat.

First Light is proposing to:

1. Evaluate the need for potential improvements to existing downstream fish passage/protection measures for American shad, and American eel at the Turners Falls Project by utilizing information from previously conducted studies and ongoing studies
2. Evaluate the need for potential improvements to existing upstream fish passage facilities for American shad, and American eel by utilizing information from previously conducted studies and ongoing studies.

The SD1 identified the effects of project operations (including fluctuations in water levels and downstream releases) on aquatic habitat and resources in the projects' vicinity (e.g., resident and migratory fish populations; fish spawning, rearing, feeding, and overwintering habitats; mussels and macroinvertebrate populations and habitat), as well as cumulative effects; the effects of project facilities and operations, (including reservoir fluctuations and generation releases) on fish migration through and within project fishways, reservoirs, and the downstream riverine corridor; the effects of entrainment on fish populations at each project, as well as cumulative effects. The Agency generally concurs with these issues and concerns, and identifies several subjects that warrant further investigation.

American Shad

Adult American shad passed upstream of Turners Falls Dam utilize upstream spawning habitat in Vermont waters. Juvenile American shad production occurs in these habitats upstream of Turners Falls Dam on an annual basis. Juvenile American shad require safe and effective downstream passage measures to have the opportunity to contribute to the restoration target population size. In order to determine if project operations affect juvenile American shad outmigration survival, recruitment, and production the Agency submits Study Request 9.

American shad populations and numbers of shad passing the dams at Holyoke, Turners Falls and Vernon have not met CRASC management goals. To understand how the hydro project operations are affecting the overall American shad population is the subject of the Agency's Study Request 10.

American shad spawning is influenced by river flow, which fluctuates greatly due to the project's peaking operations. These fluctuations may impact shad spawning activity by altering current velocities and water depth at the spawning sites. Effects on spawning behavior could include suspension of spawning activity, poor fertilization, flushing of eggs into unsuitable habitat due to higher peaking discharges, eggs dropping out into unsuitable substrate and being covered by sediment deposition or eggs becoming stranded on dewatered shoal areas as peak flows subside. To determine if project operations affect American shad spawning site selection and availability, spawning habitat quantity and quality, and spawning success in the Turners Falls Dam impoundment the Agency submits Study Request 11.

The fishways at Turners Falls were originally designed and operated primarily for Atlantic salmon. As such, the American shad may be prone to delay, injury, mortality, and passage failure. The proposed study (Study Request 12) would assess behavior, approach routes, passage success, survival, and delay by adult American shad as they encounter the Turners Falls and Northfield Mountain projects during both and upstream and downstream migrations to and from Vermont waters.

Resident fish species

A thorough and comprehensive assessment of the fish assemblage present in the project-affected areas of the Turners Falls and Northfield Mountain projects is lacking. The PAD for these projects notes resident fish surveys conducted by the State of Massachusetts in the early to mid-1970s and a limited 2008 sampling effort by the Midwest Biodiversity Inst. (contracted by EPA). The PAD identifies a total of 22 fish species in the project area but omits several species. For example northern pike, tessellated darter, burbot, eastern silvery minnow, and channel catfish (Ken Sprankle, USFWS, and Jessie Leddick, MADFW, personal communication) are known to occur within the project area. It is unknown how many other species may inhabit or utilize aquatic habitats in the projects area, potentially including species of greatest conservation need. Therefore, in order to determine the assemblage of fish species present in the project affected area the Agency proposes Study Request 13. Vermont's interest in the resident fish population in the Turners Falls impoundment relates to fish passage operations at Vernon dam and maintaining a healthy fishery in 5.7 miles of the impoundment that are Vermont waters.

The Northfield Mountain and Turners Falls project operations and subsequent large and rapid changes in flow releases from the dam have the potential to negatively impact riverine fish species spawning activities. The Agency's Study Request 18 aims to evaluate potential impacts of impoundment fluctuation on nest abandonment, spawning fish displacement and egg dewatering.

Additionally, water level fluctuations associated with operations at Turners Falls and Northfield Mountain have the potential to result in barriers to fish movement in and out of tributaries and backwaters. Study Request 19 is intended to determine if water level fluctuations in the Turners Falls impoundment impact water levels, available fish habitat and water quality in tributaries and backwaters in Vermont waters.

American Eel

The American eel (*Anguilla rostrata*) is a Vermont and New Hampshire state listed Species of Greatest Conservation Need (SGCN), and is currently being petitioned for federal listing under the Endangered Species Act. Information on the timing of downstream migratory movements and rates of American eels in the mainstem Connecticut River is lacking. Preliminary data on presence of "eel-sized" acoustic targets have been collected (Haro et al. 1998) within the Turners Falls Project's Cabot Station forebay that were to some extent confirmed by video monitoring at the Cabot Station downstream fish bypass. However, these were short-term studies, with acoustic monitoring only performed from 17 September to 5 October and video monitoring only conducted from 18 September to 22 October. Some daily monitoring of the downstream bypass at the Holyoke Dam (canal louver array) was performed in 2004 and 2005 (Kleinschmidt, Inc. 2005, 2006; Normandeau Associates 2007). These studies also were of relatively short duration (spanning from October 5 to November 10 in 2004 and September 9 to November 11 in 2005) and the sampler was only operated at night. To date, no other directed studies of eel migratory movements have been conducted at any location on the Connecticut River mainstem. This information gap needs to be filled, as it relates directly to when downstream passage and protection measures need to be operated. The Agency requests a study (Study Request 20) which will better quantify and characterize the general migratory timing and presence of adult, silver-phase American eels in the Connecticut River relative to environmental factors and operations of mainstem river hydroelectric projects.

The PAD contains no information relative to areas where eels seeking to move upstream concentrate downstream of the Turners Falls Dam, or annual numbers of eels attempting to ascend past the dam. While eels have been known to ascend the Cabot Station ladder (A. Haro, U.S. Geological Survey, pers. comm.), its efficiency is unknown, and it is only operated during the American shad passage season (from April 1 through July 15). Eels are currently able to pass the Turners Falls Dam complex (as evidenced by documented presence of eels upstream), but the total number of eels attempting to pass Turners Falls and the proportion successfully passing the project is unknown (but suspected to be low). Furthermore, Turners Falls presently has no provision for eel passage, and the Project's upstream fish passage facilities were not designed to pass the American eel. Therefore, the Agency proposes a study (Study Request 21) which would examine upstream American eel passage at Turners Falls.

Furthermore, entrainment of eels at the Northfield Mountain station removes eels from the river, effectively extirpating them from the population. Entrainment at the conventional turbines at Station 1 and Cabot Station of the Turners Falls Project can result in mortality or injury. It is important to understand the passage routes at each project and the potential for mortality to assess alternative management options to increase survival. In order to determine the impacts the facilities at Northfield Mountain and Turners Falls have on the outmigration of silver eels in the Connecticut River, the Agency submits Study Request 22.

Terrestrial Resources (4.2.4) – TransCanada

The PAD indicates that operations at the three projects may impact species that utilize the edge of the river, but that most wildlife species will not be adversely affected by the normal water level fluctuation. TransCanada has not proposed any studies regarding the effect of water level fluctuation on species utilizing the edge of the river or on any other terrestrial resources.

SD1 identifies the effects of project fluctuations on water levels and flow releases from the projects on riparian, wetland, and littoral vegetation community types and the spread of invasive species as issues or concerns.

Wetland habitat and their ecosystem functions are important for many species and help protect water quality. As indicated in SD1, the frequency, timing, amplitude, and duration of water level fluctuations both upstream and downstream of the project can have an impact on wetland function and promote the spread of invasive species. The Agency's Study Request 25 addresses these concerns.

Aquatic vegetation is crucial fish habitat as the majority of fish in the project areas utilize emergent aquatic vegetation (EAV) and submerged aquatic vegetation (SAV) at some point during their life history. Water level fluctuations in the three impoundments have the potential to negatively impact EAV and SAV. In order to determine project effects to EAV and SAV species distribution and abundance, the Agency is proposing Study Request 26.

Terrestrial Resources (4.3.4) – FirstLight

The PAD identified preliminary issues pertaining to the effects of changes in water levels and flows resulting from operation of the Turners Falls and Northfield Mountain projects on wildlife and botanical habitat and species within the projects' boundaries. FirstLight is proposing to:

1. Perform field verification of National Wetland Inventory mapping in the Turners Falls Project area.
2. Conduct a field survey of wildlife and botanical species/habitat (including rare, threatened, and endangered species and critical habitat) at the Turners Falls impoundment, bypass reach, and downstream of Cabot Station.

The SD1 has identified numerous resource impacts of the Turners Falls and Northfield Mountain projects on terrestrial resources. Many relate to fluctuating water levels and flow releases, while others are caused by project operation and maintenance or project-related recreation.

Aquatic vegetation is crucial fish habitat as the majority of fish in the Turners Falls impoundment utilize emergent aquatic vegetation (EAV) and submerged aquatic vegetation (SAV) at some point during their life history. Fluctuating water levels in the Turners Falls impoundment have the potential to negatively impact EAV and SAV. In order to determine project effects to EAV and SAV species distribution and abundance, the Agency is proposing a study (Study Request 26).

Threatened and Endangered Species (4.2.5) – TransCanada

The PAD identifies several known threatened and endangered species that occur within the lower Connecticut River that are effected by project operations. The SD1 recognizes that water level fluctuations from project operations could affect the federally-endangered dwarf wedgemussel and puritan tiger beetle populations. The SD1 does not list any state-listed species for New Hampshire or Vermont that could be impacted by project operations.

The federally-endangered dwarf wedgemussel (*Alasmidonta heterodon)* is known to occur in the Wilder and Bellows Falls project areas. In order to evaluate the effects of project operations on populations of the dwarf wedgemussel and other state-listed mussels the Agency requests a study (Study Request 27).

The Agency is concerned that the continued operations of the three projects could adversely affect many state-listed species that are known to occur in the vicinity of the project. Several threatened and endangered plant species occur within the three project areas and could be impacted by project operations. Study Request 28 addresses the Agency's concerns relative to threatened and endangered plant species and natural communities within the project area.

Additionally, several species of rare odonates (dragonflies) are found in the three project areas. Water level fluctuation could impact the survival of these species during the aquatic larval stage and during emergence by increasing the risk of predation or dewatering habitat. The Agency requests a study (Study Request 29) to address concerns regarding state-listed odonate species occurring in the vicinity of the project.

The state threatened cobblestone tiger beetle is known to occur within the lower Connecticut River, and the federally endangered puritan tiger beetle historically occurred within the area affected by the three projects. Continued project operation could impact these species and habitat availability. The Agency's Study Request 30 addresses concerns regarding cobblestone and puritan tiger beetles.

The state-listed Fowler's toad (*Bufo fowleri*) is known to have occurred within the project boundaries, predominately using shorelines and river islands that are subject to water level fluctuation from project operations. Habitat for Fowler's toads is dependent on high flow events to deposit fine sediments on shorelines, floodplains, and riverine islands. Alteration of the natural flow regime from project operations potentially can impact habitat availability for toads. Study Request 31 addresses the Agency concern.

Recreation (4.2.6) – TransCanada

The SD1 identifies the adequacy of existing recreation and public use facilities in meeting existing and future regional public use and river access needs, effects of project operations on quality and availability of flow-dependent and water level-dependent recreation opportunities, including boating, and adequacy of structural integrity, physical capacity, and management methods to support recreation use at existing facilities.

The Agency is interested in improving recreational opportunities and access to public waters in the project areas to help meet state and regional recreation management goals. The Agency is requesting a study (Study Request 32) to address the effects of project operations on recreational uses (including boating, angling and ice fishing), user safety and access to boat launches. Further, the adequacy of recreational facilities on project lands to meet current and future needs, how existing facilities may be improved and opportunities for new facilities, including primitive camping sites, should be addressed.

Land Use (4.2.7) – TransCanada

The PADs state that there is limited development in the floodplains and river corridor of the projects, yet the objective of river profile operations at each of the project are to limit the amount of overland flow during high flow events. The SD1 identifies the adequacy of the projects to meet current shoreline management policies and programs. Vermont's policy is to protect and restore river corridors and floodplains to protect public safety and economic investments. Study Request 33 addresses the Agency's concerns about river profile operations and floodplain development.

Aesthetic Resources (4.2.8) – TransCanada

The SD1 did not identify any issues related to aesthetic resources. The Bellows Falls bypass is 3500 feet long and, except for leakage, is dewatered much of the time. The PAD indicates that water is spilled over the dam when river flow exceeds station capacity, but there is no conservation flow requirement for the bypass reach.

Under the Vermont Water Quality Standards for Class B waters, good aesthetic value is a management objective. Vermont's Water Quality Standards provide that waters shall be of a quality that consistently exhibits good aesthetic values, including water character, flows, water level, bed and channel characteristics. The Agency requests a study (Study Request 34) to determine the flows needed to support aesthetics in the Bellows Falls bypass. This information will be necessary for the Agency to complete its review under Clean Water Act Section 401.

Cultural Resources (4.2.10) – TransCanada

TransCanada should consult with the Vermont State Historical Preservation Office (SHPO) to address any concerns regarding cultural resources within the vicinity of the project.

Thank you very much for considering our comments.

Very truly yours,

Brian T. Fitzgerald
Streamflow Protection Coordinator

Attachment: VANR Study Requests (with Appendices)

c: Shannon Morrison, Department of Environmental Conservation
Marie Caduto, Department of Environmental Conservation
Lael Will, Department of Fish and Wildlife
Rod Wentworth, Department of Fish and Wildlife
Robert Popp, Department of Fish and Wildlife
Eric Sorenson, Department of Fish and Wildlife
Mark Ferguson, Department of Fish and Wildlife
John Warner, U.S. Fish and Wildlife Service
Melissa Grader, U.S. Fish and Wildlife Service
Gregg Comstock, N.H. Department of Environmental Services
Owen David, N.H. Department of Environmental Services
Gabe Gries, N.H. Fish and Game Department
Caleb Slater, MA Department of Fish and Game
Kevin Mendik, National Park Service
Ralph Abele, U.S. Environmental Protection Agency
John Ragonese, TransCanada
John Howard, FirstLight
David Deen, Connecticut River Watershed Council
Kim Greenwood, Vermont Natural Resources Council
Chris Moore, Trout Unlimited – Vermont Council
James Ehlers, Lake Champlain International

Vermont Agency of Natural Resources

Study Requests

for

Wilder Hydroelectric Project
FERC No. 1892-026

Bellows Falls Hydroelectric Project
FERC No. 1855-045

Vernon Hydroelectric Project
FERC No. 1904-073

Turners Falls Hydroelectric Project
FERC No. 1889-081

Northfield Mountain Pumped Storage Project
FERC No. 2485-063

March 1, 2013

Study Number	Study Topic	Project[1]	Page
1	Shoreline and downstream erosion from water level fluctuation in the impoundment and downstream from peaking operations	WBVTN	4
2	Water quality monitoring within the project impoundment and tailrace	WBVTN	24
3	Continuous water temperature monitoring at various locations within the impoundment and tailrace, and downstream Connecticut River	WBV	34
4	Model river flows and water levels upstream and downstream from the Wilder, Bellows Falls and Vernon stations and integration of project modeling with downstream project operations	WBV	43
5	Climate change as it relates to continued operation of the Vernon, Bellows Falls and Wilder projects	WBV	46
6	Bypass flow and habitat	B	53
7	In-stream flow habitat assessment of downstream reaches	WBV	56
8	Project effects on channel morphology and benthic habitat impacts	WBV	59
9	Juvenile shad outmigration	VTN	64
10	Shad population model for the Connecticut River	V	75
11	Impact of project operations on shad spawning, spawning habitat and egg deposition	BVTN	79
12	Telemetry study of upstream and downstream migrating adult American shad to assess passage routes, effectiveness, delays, and survival	BVTN	85
13	Fish assemblage in project-affected areas	WBVTN	94
14	Impacts of downstream water fluctuations on resident fish spawning	WBV	102
15	Upstream American eel survey	WBV	104
16	Project effects on populations of tessellated darter, *Etheostoma olmstedi*	WBV	109
17	Assessment of adult sea lamprey (*Petromyzon marinus*) spawning within the project areas	WBV	114
18	Impacts of impoundment water level fluctuations on resident fish spawning	WBVTN	118
19	Impacts of project operations on tributary and backwater area access and habitats.	WBVTN	124
20	Evaluation of timing of downstream migratory movements of American eels on the mainstem Connecticut River	WBVTN	131
21	Downstream American eel passage	WBVTN	137
22	Upstream American eel passage assessment	WBVT	152
23	Impingement and entrainment of resident fish species at project intakes	WBV	162
24	Determine upstream passage needs for riverine fish species at project fishways	WBV	163
25	Impact of impoundment water level fluctuations on wetlands	WBV	167
26	Impacts of water level fluctuations on aquatic vegetation, including invasive species, in project impoundments	WBVTN	173
27	Project effects on the dwarf wedgemussel (*Alasmidonta heterodon*)	WB	182

28	Assess the impact of project operations on state-listed rare, threatened and endangered plant species and significant natural communities	WBV	188
29	Survey the number, species and behavior of adult dragonflies and emerging nymphs within the project areas	WBV	194
30	Survey for new and existing populations of adult Cobblestone and Puritan tiger beetle populations within the project areas	WBV	198
31	Survey the distribution, population size and habitat conditions of Fowler's Toad (*Bufo fowleri*) within the project areas	WBV	201
32	Recreational survey and enhancement study	WBV	205
33	Assess the amount of development within the floodplain of the lower Connecticut River	WBV	207
34	Bellows Falls aesthetic flow study	B	209

[1]Project Codes: W – Wilder; B – Bellows Falls; V – Vernon; T – Turners Falls; N – Northfield Mountain Pumped Storage

Wilder Hydroelectric Project – FERC No. 1892-026

Study Request 1: Shoreline and downstream erosion from water level fluctuation in the impoundment and downstream from peaking operations

Goals and Objectives
The goal of this study is to determine how project operations contribute to the shoreline erosion and riverbank failure within the impoundment and downstream of the Wilder Hydro Project.

The objectives of this study are to:

1. determine how water level fluctuations within the minimum and maximum operating range and discharges from peaking operations at the Wilder hydroelectric project contribute to shoreline erosion;
2. identify and determine the effects of shoreline bank erosion and riverbank failure on other resources (i.e. riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, etc.);
3. identify techniques that could be used to mitigate the effects of project operations or other mitigation techniques that could be developed to reduce on riverbank erosion within the impoundment and downstream of the tailrace.

Resource Management Goals
The Connecticut River is considered Class B water by the states of Vermont and New Hampshire. Vermont lists the section of the Connecticut River below the Wilder dam on the Section 303(d) impaired water list due to flow alterations resulting in the destabilization and eroding of shoreline impairing aquatic life and habitat. In Class B waters, Vermont's water quality standards state that water level fluctuation and flow alterations can only occur to the extent that it supports all uses and does not lead to degradation of the water resource or habitat. New Hampshire's surface water quality regulations state that "unless the flows are caused by naturally occurring conditions, surface water quantity shall be maintained at levels adequate to protect existing and designated uses." (Env-Wq 1703.01(d)). The specific New Hampshire water quality criteria for turbidity in Class B waters is not to exceed naturally occurring conditions by more than 10 NTUs (Env-Wq 1703.11).

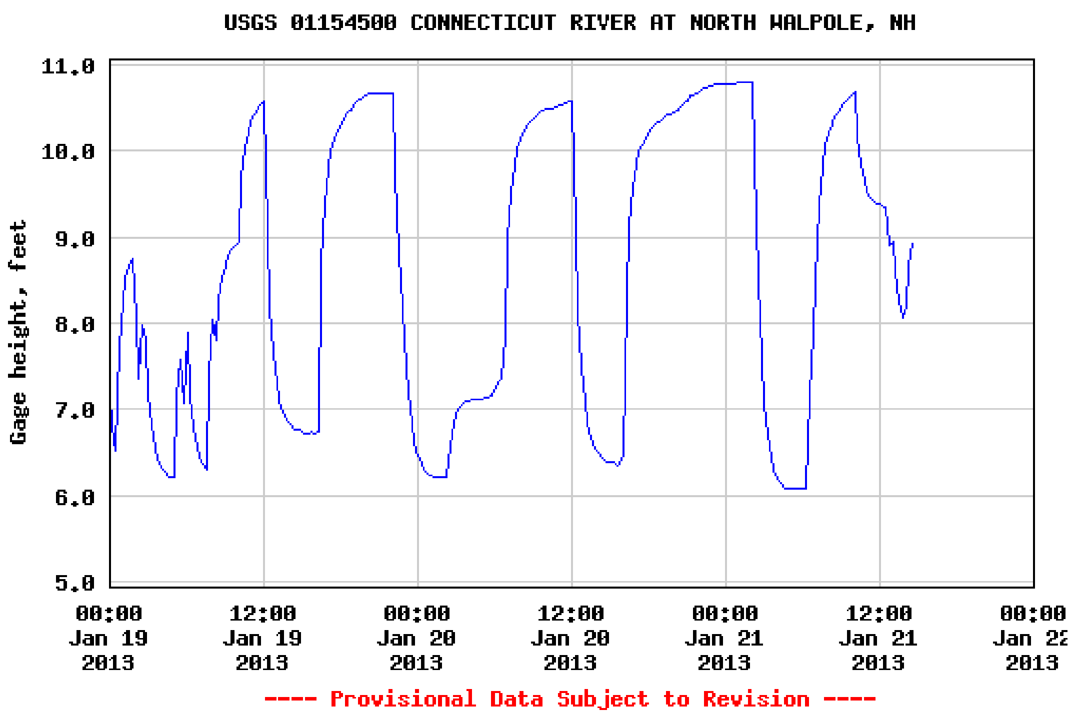
Public Interest Consideration
The Vermont Agency of Natural Resources and the New Hampshire Department of Environmental Services request this study. The requestors are state natural resource agencies.

Existing Information
The PAD references several studies pertaining to shoreline erosion within the Connecticut River, including the study by US Army Corp of Engineers (Simion et al. 1979). This study evaluated the shoreline within the Wilder impoundment and identified water level fluctuation and periodic high flow events as causes of shoreline erosion. The PAD also discusses the erosion survey that TransCanada initiated in 2010 to inventory sites where erosion is occurring within the Wilder impoundment (Kleinschmidt 2011). Bank slumping can occur when fluvial erosional forces act on the toe of the bank slope. The PAD did not address how project related operations contribute to shoreline erosion, could be changed to mitigate impacts on shoreline erosion, or discuss the

impacts of shoreline erosion on other resources (i.e. riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, etc.).

Repetitive water level fluctuations and flow alterations caused by hydroelectric peaking operations are known to be a major contributor to shoreline erosion (Lawson 1985). Sediment from shoreline erosion and riverbank failure is one of the major contributors negatively affecting water quality and habitat by increasing turbidity and sedimentation, smothering aquatic habitat in the United States. Vermont Surface Water Management Strategy identifies sediment from excessive channel erosion as a stressor on Vermont water and aquatic habitat. Additionally, Vermont lists this section of the Connecticut River on the Vermont Section 303(d) impaired water list due to flow alterations resulting from the destabilization and eroding of shoreline impairing aquatic life and habitat.

An example of the water level fluctuations that occur in Lower Connecticut River due to hydropower generation is shown below.



Project Nexus

Wilder Hydroelectric Project operations currently result in daily water level fluctuation in the impoundment by as much as 2.5 feet, which has the potential to affect shoreline erosion in the impoundment. The project is currently permitted to water level fluctuation in the impoundment by 5 feet. Additionally the project "peaking" operation could contribute to bank erosion downstream of the dam by increasing the shear stress on the bank toe. Furthermore, river profile operations during high flow events minimize overland flow by drawing down the impoundment prior to high flows containing high velocity flows to the river channel, possibly increasing shoreline erosion rate within the impoundment. TransCanada is not proposing any changes to project operations.

Proposed Methodology

Kleinschmidt (2011) conducted a shoreline erosion survey on the Connecticut River, from which we have data on the spatial locations, lengths and heights of such erosion. However, this study did not investigate whether the practice of flow modification is a causative agent to this erosion. Consequently, the Vermont Agency of Natural Resources and the New Hampshire Department of Environmental Services recommend TransCanada further investigate sites on the Connecticut River to evaluate the processes that are active along banks. This investigation should build on the erosion survey that was previously completed by determining the process causing erosion at a site, the extent erosion is negatively affecting other resources (i.e. riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, etc.), and determining how erosion could be stabilized or mitigated by changing project operations. This investigation can be completed performing the following tasks.

Task 1: Determine erosion and riverbank failure process at identified sites

Shoreline erosion areas and riverbank failure sites were identified during the Kleinschmidt (2011) survey. A survey similar to Kleinschmidt (2011) should be conducted to document if any additional erosion has occurred, and identify new sites of erosion within the impoundment, given the occurrence of Tropical Storm Irene since the Kleinschmidt survey. For each erosion site, the following erosion process element will be identified by determining soil type and subsoil characteristics (i.e. depth to bedrock, texture, rock content, signs of soil piping), reservoir water levels at the time of observation, water level fluctuation, climatic conditions, ground water seepage, wind-driven waves, boat waves, and recreation. Additional site characteristic to identify and record in the erosion survey will include but not be limited to an estimate of the length and average height of the erosional area, slope of the site, dominant vegetation cover types present, associated vegetation cover types present, an ocular estimate of total plant cover and total cover by plant class (tree, shrub, herbaceous) in surrounding undisturbed areas. Data from each shoreline erosion site will be recorded on a field form and entered into a database. In addition, a photograph or photographs will be taken of each site. Sites should be visited when water levels are lowest.

Erosion processes will be determined by field observations and applying site appropriate geology, geomorphic and hydrological principles. To evaluate the relative influence of water level fluctuations on existing shoreline erosion, a minimum of six select sites (three in the impoundment and three downstream of the dam) will be identified for more detailed measurements and observations. In aid of site selection, comparison of successive aerial photographs will be conducted to identify sites that have experienced visible bank movement. Data from erosion surveys will be examined to identify sites with varying conditions of riparian buffer, vegetation type and bank slope. The sites selected for detailed evaluation will represent different combinations of bank movement, riparian buffer, vegetation type and bank slope. In those bank sites that are selected, rebar pins will be inserted into the banks in a grid at varying heights with each rebar being horizontally level. Initial rebar pin installation will take place when the water level in the impoundment is at its authorized lowest elevation. Each rebar pin will be assigned an individual number and photographed, with the distance from the end of the pin to the bank material measured. A survey will also be conducted of each bank along several bank transects in the immediate vicinity of each site to accurately document bank shape as well as the location and elevation of each rebar and the water surface elevation at the beginning and end of each site visit. Pressure transducers (one in the air and one in the water) will also be installed at each site to automatically record how water surface elevation at each site varies with time.

Biweekly for a period of one year, each of the six sites will be revisited. During each revisit, the bank and each rebar pin will be photographed and the distance from the end of the pin to the bank material will be measured. Any slumping of a pin will be noted. If a pin is found dislodged or removed during a site visit, a new rebar pin will be reinstalled in the approximate location of the previously existing pin.. In addition, a survey of the bank and rebars will be conducted as described above. Surveys will be conducted in the same manner and will use the same benchmark each site visit. Data from pressure transducers will be downloaded and analyzed each site visit to ensure they are working properly. When this dataset is related to the flow record from existing stream gauges in the river segment, this evaluation will allow for a determination as to whether the erosion is Project related, and if so, how Project operations may be impacting the sites.

Task 2: Determining the effects of erosion on other resources

The effects of shoreline erosion and riverbank failure on other resources should be determined. This will required coordination between studies to determine the effects of erosion on riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, and recreation. Erosion sites identified as having an impact on resources will be assess to determine if project operations are causing erosion and a mitigation plan to protect the resource of interest should be developed.

Task 3: Development of a Shoreline Management Plan

The information that is collected during the study should be used to develop a Shoreline Management Plan for the impoundment. If results from the erosion evaluation suggest that Project operations are impacting erosion within the impoundment, further evaluation should be undertaken to determine if there is a feasible way to reduce impacts. This feasibility analysis will be based on field observations and knowledge of current erosion control and slope failure stabilization methods that may be suitable for sites. The analysis will provide a preliminary list of potential control measures necessary to reduce erosion at these sites. Detailed analyses for final design and construction of erosion and slope stabilization control measures will not be part of the study. As part of this process, the landowner should be identified for each of the erosion sites and future mitigation and stabilization techniques should be presented.

The study area for the shoreline erosion study should extend from the upstream end of the impoundment above the Wilder Dam to the beginning of the Bellows Falls impoundment. Water level fluctuations caused by the Project may affect not only the impoundment but also the downstream river reaches below the dam.

Level of Effort and Cost
The cost and effort of this study will be moderate, but is important to document the potential impact project operations on shoreline erosion and riverbank failure, and to determine how this may impact other resources.

Literature Cited

Kleinschmidt (Kleinschmidt Associates, Inc.). 2011. Lower Connecticut River Shoreline Survey Report – 2010: Bellows Falls Project (FERC No. 1855), Wilder Project (FERC No. 1892), Vernon Project (FERC No. 1904). Draft Report March 2011. Prepared for TransCanada Hydro Northeast Inc., Westborough, MA.

Lawson, D.E., 1985, Erosion of northern reservoir shores: An analysis and application of pertinent literature: US Army Corps of Engineers Cold Regions Research and Engineering Laboratory Monograph 85-1, 198 p.

Simons, D.B., Andrews, J.W., Li, R.M., and Alawady, M.A. 1979. Connecticut River Streambank Erosion Study Massachusetts, New Hampshire, and Vermont. Prepared for USACE, New England Division.

Bellows Falls Hydroelectric Project – FERC No. 1855-045

Study Request 1: Shoreline and downstream erosion from water level fluctuation in the impoundment and downstream from peaking operations

Goals and Objectives

The goal of this study is to determine how project operations contribute to the shoreline erosion and riverbank failure within the impoundment and downstream of the Bellows Falls Hydroelectric Project.

The objectives of this study are to:

1. determine how water level fluctuations within the minimum and maximum operating range and discharges from peaking operations at the Wilder hydroelectric project contribute to shoreline erosion;
2. identify and determine the effects of shoreline bank erosion and riverbank failure on other resources (i.e. riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, etc.);
3. identify techniques that could be used to mitigate the effects of project operations or other mitigation techniques that could be developed to reduce on riverbank erosion within the impoundment and downstream of the tailrace.

Resource Management Goals

The Connecticut River is considered Class B water by the states of Vermont and New Hampshire. Vermont list the section of the Connecticut River above and below Bellows Falls dam on the Section 303(d) impaired water list due to flow alterations resulting in the destabilization and eroding of shoreline impairing aquatic life and habitat. In Class B waters, Vermont's water quality standards state that water level fluctuation and flow alterations can only occur to the extent that it supports all uses and does not lead to degradation of the water resource or habitat. New Hampshire's surface water quality regulations state that "unless the flows are caused by naturally occurring conditions, surface water quantity shall be maintained at levels adequate to protect existing and designated uses." (Env-Wq 1703.01(d)). The specific New Hampshire water quality criteria for turbidity in Class B waters is not to exceed naturally occurring conditions by more than 10 NTUs (Env-Wq 1703.11).

Public Interest Consideration

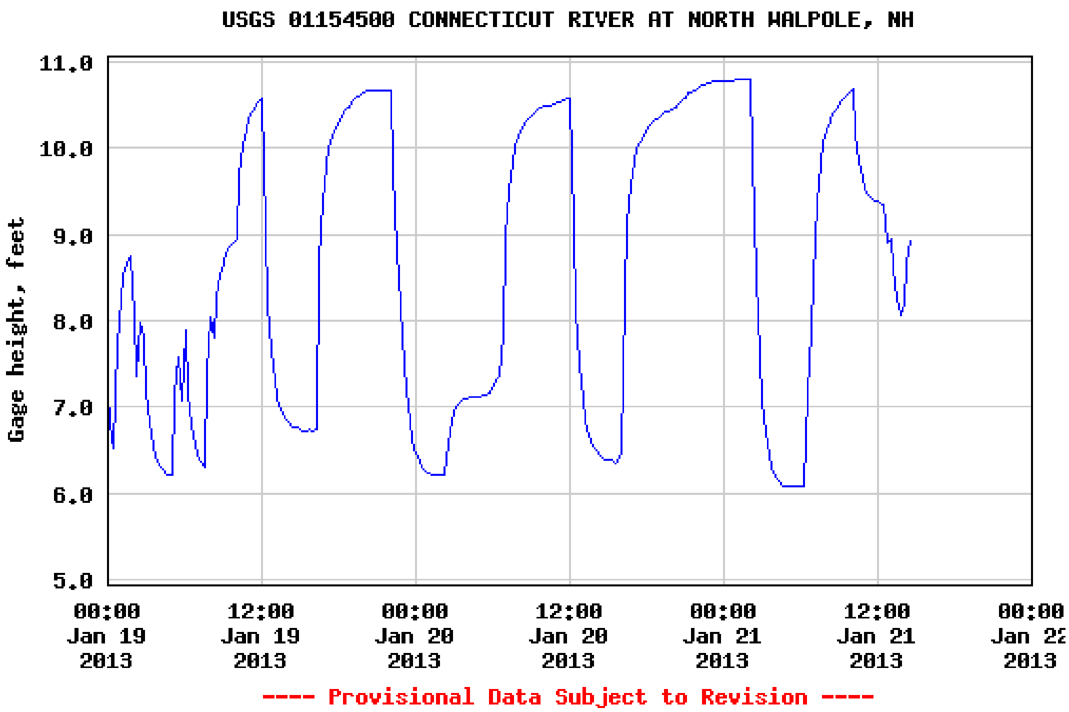
The Vermont Agency of Natural Resources and the New Hampshire Department of Environmental Services request this study. The requestors are state natural resource agencies.

Existing Information

The PAD references several studies pertaining to shoreline erosion within the Connecticut River, including the study by US Army Corp of Engineers (Simion et al. 1979). This study evaluated the shoreline within the Wilder impoundment and identified water level fluctuation and periodic high flow events as causes of shoreline erosion. The PAD also discusses the erosion survey that TransCanada initiated 2010 to inventory sites where erosion is occurring within the Bellows Falls impoundment (Kleinschmidt 2011). Bank slumping can occur when fluvial erosional forces act on the toe of the bank slope. The PAD did not address how project related operations contribute to shoreline erosion, could be changed to mitigate impacts on shoreline erosion, or discuss the impacts of shoreline erosion on other resources (i.e. riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, etc.).

Repetitive water level fluctuations and flow alterations caused by hydroelectric peaking operations are known to be a major contributor to shoreline erosion (Lawson 1985). Sediment from shoreline erosion and riverbank failure is one of the major contributors negatively affecting water quality and habitat by increasing turbidity and sedimentation, smothering aquatic habitat in the United States. Vermont Surface Water Management Strategy identifies sediment from excessive channel erosion as a stressor on Vermont water and aquatic habitat. Additionally, Vermont lists this section of the Connecticut River on the Vermont Section 303(d) impaired water list due to flow alterations resulting from the destabilization and eroding of shoreline impairing aquatic life and habitat.

An example of the water level fluctuations that occur in Lower Connecticut River due to hydropower generation is shown below.



Project Nexus

Bellows Falls Hydroelectric Project operations currently result in daily water level fluctuation in the impoundment by approximately 2 feet, which affects shoreline erosion in the impoundment by increasing the rate of soil piping. The project is currently permitted to water level fluctuation in the impoundment by 3 feet. Additionally the project "peaking" operation could contribute to bank erosion downstream of the dam by increasing the shear stress on the bank toe. Furthermore, river profile operations during high flow events the project impoundment is operated to minimize overland flow by drawing down impoundment prior to high flows containing high velocity flows to the river channel, possibly increasing shoreline erosion rate within the impoundment. TransCanada is not proposing any changes to project operations.

Proposed Methodology

Kleinschmidt (2011) conducted a shoreline erosion survey on the Connecticut River, from which we have data on the spatial locations, lengths and heights of such erosion. However, this study did not investigate whether the practice of flow modification is a causative agent to this erosion. Consequently, the Vermont Agency of Natural Resources and the New Hampshire Department of Environmental Services recommend TransCanada further investigate sites on the Connecticut River to evaluate the processes that are active along banks. This investigation should build on the erosion survey that was previously completed by determining the process causing erosion at a site, the extent erosion is negatively affecting other resources (i.e. riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, etc.), and determining how erosion could be stabilized or mitigated by changing project operations. This investigation can be completed performing the following tasks.

Task 1: Determine erosion and riverbank failure process at identified sites

Shoreline erosion areas and riverbank failure sites were identified during the Kleinschmidt (2011) survey. A survey similar to Kleinschmidt (2011) should be conducted to document if any additional erosion has occurred, and identify new sites of erosion within the impoundment, given the occurrence of Tropical Storm Irene since the Kleinschmidt survey. For each erosion site, the following erosion process element will be identified by determining soil type and subsoil characteristics (i.e. depth to bedrock, texture, rock content, signs of soil piping), reservoir water levels at the time of observation, water level fluctuation, climatic conditions, ground water seepage, wind-driven waves, boat waves, and recreation. Additional site characteristic to identify and record in the erosion survey will include but not be limited to an estimate of the length and average height of the erosional area, slope of the site, dominant vegetation cover types present, associated vegetation cover types present, an ocular estimate of total plant cover and total cover by plant class (tree, shrub, herbaceous) in surrounding undisturbed areas. Data from each shoreline erosion site will be recorded on a field form and entered into a database. In addition, a photograph or photographs will be taken of each site. Sites should be visited when water levels are lowest.

Erosion processes will be determined by field observations and applying site appropriate geology, geomorphic and hydrological principles. To evaluate the relative influence of water level fluctuations on existing shoreline erosion, a minimum of six select sites (three in the impoundment and three downstream of the dam) will be identified for more detailed measurements and observations. In aid of site selection, comparison of successive aerial photographs will be conducted to identify sites that have experienced visible bank movement. Data from erosion surveys will be examined to identify sites with varying conditions of riparian buffer, vegetation type and bank slope. The sites selected for detailed evaluation will represent different combinations of bank movement, riparian buffer, vegetation type and bank slope. In those bank sites that are selected, rebar pins will be inserted into the banks in a grid at varying heights with each rebar being horizontally level. Initial rebar pin installation will take place when the water level in the impoundment is at its authorized lowest elevation. Each rebar pin will be assigned an individual number and photographed, with the distance from the end of the pin to the bank material measured. A survey will also be conducted of each bank along several bank transects in the immediate vicinity of each site to accurately document bank shape as well as the location and elevation of each rebar and the water surface elevation at the beginning and end of each site visit. Pressure transducers (one in the air and one in the water) will also be installed at each site to automatically record how water surface elevation at each site varies with time.

Biweekly for a period of one year, each of the six sites will be revisited. During each revisit, the bank and each rebar pin will be photographed and the distance from the end of the pin to the bank material will be measured. Any slumping of a pin will be noted. If a pin is found dislodged or removed during a site visit, a new rebar pin will be reinstalled in the approximate location of the previously existing pin.. In addition, a survey of the bank and rebars will be conducted as described above. Surveys will be conducted in the same manner and will use the same benchmark each site visit. Data from pressure transducers will be downloaded and analyzed each site visit to ensure they are working properly. When this dataset is related to the flow record from existing stream gauges in the river segment, this evaluation will allow for a determination as to whether the erosion is Project related, and if so, how Project operations may be impacting the sites.

Task 2: Determining the effects of erosion on other resources

The effects of shoreline erosion and riverbank failure on other resources should be determined. This will required coordination between studies to determine the effects of erosion on riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, and recreation. Erosion sites identified as having an impact on resources will be assess to determine if project operations are causing erosion and a mitigation plan to protect the resource of interest should be developed.

Task 3: Development of a Shoreline Management Plan

The information that is collected during the study should be used to develop a Shoreline Management Plan for the impoundment. If results from the erosion evaluation suggest that Project operations are impacting erosion within the impoundment, further evaluation should be undertaken to determine if there is a feasible way to reduce impacts. This feasibility analysis will be based on field observations and knowledge of current erosion control and slope failure stabilization methods that may be suitable for sites. The analysis will provide a preliminary list of potential control measures necessary to reduce erosion at these sites. Detailed analyses for final design and construction of erosion and slope stabilization control measures will not be part of the study. As part of this process, the landowner should be identified for each of the erosion sites and future mitigation and stabilization techniques should be presented.

The study area for the shoreline erosion study should extend from the upstream end of the impoundment above the Bellows Falls Dam to the beginning of the Vernon impoundment. Water level fluctuations caused by the Project may affect not only the impoundment but also the downstream river reaches below the dam.

Level of Effort and Cost

The cost and effort of this study will be moderate, but is important to document the potential impact project operations on shoreline erosion and riverbank failure, and to determine how this may impact other resources.

Literature Cited

Kleinschmidt (Kleinschmidt Associates, Inc.). 2011. Lower Connecticut River Shoreline Survey Report – 2010: Bellows Falls Project (FERC No. 1855), Wilder Project (FERC No. 1892), Vernon Project (FERC No. 1904). Draft Report March 2011. Prepared for TransCanada Hydro Northeast Inc., Westborough, MA.

Lawson, D.E., 1985, Erosion of northern reservoir shores: An analysis and application of pertinent literature: US Army Corps of Engineers Cold Regions Research and Engineering Laboratory Monograph 85-1, 198 p.

Simons, D.B., Andrews, J.W., Li, R.M., and Alawady, M.A. 1979. Connecticut River Streambank Erosion Study Massachusetts, New Hampshire, and Vermont. Prepared for USACE, New England Division.

Vernon Hydroelectric Project – FERC No. 1904-073

Study Request 1: Shoreline and downstream erosion from water level fluctuation in the impoundment and downstream from peaking operations

Goals and Objectives
The goal of this study is to determine how project operations contribute to the shoreline erosion and riverbank failure within the impoundment and downstream of the Vernon Hydroelectric Project.

The objectives of this study are to:

1. determine how water level fluctuations within the minimum and maximum operating range and discharges from peaking operations at the Wilder hydroelectric project contribute to shoreline erosion;
2. identify and determine the effects of shoreline bank erosion and riverbank failure on other resources (i.e. riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, etc.);
3. identify techniques that could be used to mitigate the effects of project operations or other mitigation techniques that could be developed to reduce on riverbank erosion within the impoundment and downstream of the tailrace.

Resource Management Goals
The Connecticut River is considered Class B water by the states of Vermont and New Hampshire. Vermont lists the section of the Connecticut River above and below Vernon dam on the Section 303(d) impaired water list due to flow alterations resulting in the destabilization and eroding of shoreline impairing aquatic life and habitat. In Class B waters, Vermont's water quality standards state that water level fluctuation and flow alterations can only occur to the extent that it supports all uses and does not lead to degradation of the water resource or habitat. New Hampshire's surface water quality regulations state that "unless the flows are caused by naturally occurring conditions, surface water quantity shall be maintained at levels adequate to protect existing and designated uses." (Env-Wq 1703.01(d)). The specific New Hampshire water quality criteria for turbidity in Class B waters is not to exceed naturally occurring conditions by more than 10 NTUs (Env-Wq 1703.11).

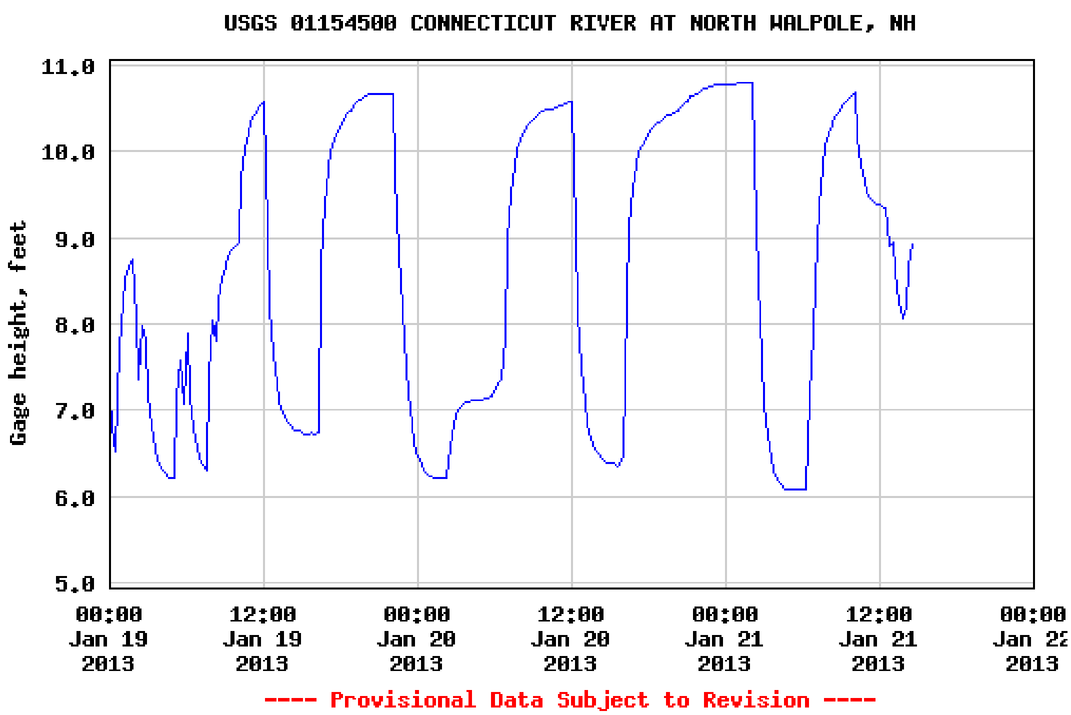
Public Interest Consideration
The Vermont Agency of Natural Resources and the New Hampshire Department of Environmental Services request this study. The requestors are state natural resource agencies.

Existing Information
The PAD references several studies pertaining to shoreline erosion within the Connecticut River, including the study by US Army Corp of Engineers (Simion et al. 1979). This study evaluated the shoreline within the Wilder impoundment and identified water level fluctuation and periodic high flow events as causes of shoreline erosion. The PAD also discusses the erosion survey that TransCanada initiated 2010 to inventory sites where erosion is occurring within the Vernon impoundment (Kleinschmidt 2011). Bank slumping can occur when fluvial erosional forces act on the toe of the bank slope. The PAD did not address how project related operations contribute

to shoreline erosion, could be changed to mitigate impacts on shoreline erosion, or discuss the impacts of shoreline erosion on other resources (i.e. riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, etc.).

Repetitive water level fluctuations and flow alterations caused by hydroelectric peaking operations are known to be a major contributor to shoreline erosion (Lawson 1985). Sediment from shoreline erosion and riverbank failure is one of the major contributors negatively affecting water quality and habitat by increasing turbidity and sedimentation, smothering aquatic habitat in the United States. Vermont Surface Water Management Strategy identifies sediment from excessive channel erosion as a stressor on Vermont water and aquatic habitat. Additionally, Vermont lists this section of the Connecticut River on the Vermont Section 303(d) impaired water list due to flow alterations resulting from the destabilization and eroding of shoreline impairing aquatic life and habitat.

An example of the water level fluctuations that occur in Lower Connecticut River due to hydropower generation is shown below.



Project Nexus

Vernon Hydroelectric Project operations currently result in daily water level fluctuation in the impoundment by approximately 2 feet, which affects shoreline erosion in the impoundment by increasing the rate of soil piping. The project is currently permitted to water level fluctuation in the impoundment by 8 feet. Additionally the project “peaking” operation could contribute to bank erosion downstream of the dam by increasing the shear stress on the bank toe. TransCanada is not proposing any changes to project operations.

Proposed Methodology
Kleinschmidt (2011) conducted a shoreline erosion survey on the Connecticut River, from which we have data on the spatial locations, lengths and heights of such erosion. However, this study did not investigate whether the practice of flow modification is a causative agent to this erosion. Consequently, the Vermont Agency of Natural Resources and the New Hampshire Department of Environmental Services recommend TransCanada further investigate sites on the Connecticut River to evaluate the processes that are active along banks. This investigation should build on the erosion survey that was previously completed by determining the process causing erosion at a site, the extent erosion is negatively affecting other resources (i.e. riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, etc.), and determining how erosion could be stabilized or mitigated by changing project operations. This investigation can be completed performing the following tasks.

Task 1: Determine erosion and riverbank failure process at identified sites

Shoreline erosion areas and riverbank failure sites were identified during the Kleinschmidt (2011) survey. A survey similar to Kleinschmidt (2011) should be conducted to document if any additional erosion has occurred, and identify new sites of erosion within the impoundment, given the occurrence of Tropical Storm Irene since the Kleinschmidt survey. For each erosion site, the following erosion process element will be identified by determining soil type and subsoil characteristics (i.e. depth to bedrock, texture, rock content, signs of soil piping), reservoir water levels at the time of observation, water level fluctuation, climatic conditions, ground water seepage, wind-driven waves, boat waves, and recreation. Additional site characteristic to identify and record in the erosion survey will include but not be limited to an estimate of the length and average height of the erosional area, slope of the site, dominant vegetation cover types present, associated vegetation cover types present, an ocular estimate of total plant cover and total cover by plant class (tree, shrub, herbaceous) in surrounding undisturbed areas. Data from each shoreline erosion site will be recorded on a field form and entered into a database. In addition, a photograph or photographs will be taken of each site. Sites. should be visited when water levels are lowest.

Erosion processes will be determined by field observations and applying site appropriate geology, geomorphic and hydrological principles. To evaluate the relative influence of water level fluctuations on existing shoreline erosion, a minimum of six select sites (three in the impoundment and three downstream of the dam) will be identified for more detailed measurements and observations. In aid of site selection, comparison of successive aerial photographs will be conducted to identify sites that have experienced visible bank movement. Data from erosion surveys will be examined to identify sites with varying conditions of riparian buffer, vegetation type and bank slope. The sites selected for detailed evaluation will represent different combinations of bank movement, riparian buffer, vegetation type and bank slope. In those bank sites that are selected, rebar pins will be inserted into the banks in a grid at varying heights with each rebar being horizontally level. Initial rebar pin installation will take place when the water level in the impoundment is at its authorized lowest elevation. Each rebar pin will be assigned an individual number and photographed, with the distance from the end of the pin to the bank material measured. A survey will also be conducted of each bank along several bank transects in the immediate vicinity of each site to accurately document bank shape as well as the location and elevation of each rebar and the water surface elevation at the beginning and end of each site visit. Pressure transducers (one in the air and one in the water) will also be installed at each site to automatically record how water surface elevation at each site varies with time.

Biweekly for a period of one year, each of the six sites will be revisited. During each revisit, the bank and each rebar pin will be photographed and the distance from the end of the pin to the bank material will be measured. Any slumping of a pin will be noted. If a pin is found dislodged or removed during a site visit, a new rebar pin will be reinstalled in the approximate location of the previously existing pin.. In addition, a survey of the bank and rebars will be conducted as described above. Surveys will be conducted in the same manner and will use the same benchmark each site visit. Data from pressure transducers will be downloaded and analyzed each site visit to ensure they are working properly. When this dataset is related to the flow record from existing stream gauges in the river segment, this evaluation will allow for a determination as to whether the erosion is Project related, and if so, how Project operations may be impacting the sites.

Task 2: Determining the effects of erosion on other resources

The effects of shoreline erosion and riverbank failure on other resources should be determined. This will required coordination between studies to determine the effects of erosion on riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, and recreation. Erosion sites identified as having an impact on resources will be assess to determine if project operations are causing erosion and a mitigation plan to protect the resource of interest should be developed.

Task 3: Development of a Shoreline Management Plan

The information that is collected during the study should be used to develop a Shoreline Management Plan for the impoundment. If results from the erosion evaluation suggest that Project operations are impacting erosion within the impoundment, further evaluation should be undertaken to determine if there is a feasible way to reduce impacts. This feasibility analysis will be based on field observations and knowledge of current erosion control and slope failure stabilization methods that may be suitable for sites. The analysis will provide a preliminary list of potential control measures necessary to reduce erosion at these sites. Detailed analyses for final design and construction of erosion and slope stabilization control measures will not be part of the study. As part of this process, the landowner should be identified for each of the erosion sites and future mitigation and stabilization techniques should be presented.

The study area for the shoreline erosion study should extend from the upstream end of the impoundment above the Vernon Dam to the beginning of the Turner Falls impoundment. Water level fluctuations caused by the Project may affect not only the impoundment but also the downstream river reaches below the dam.

Level of Effort and Cost

The cost and effort of this study will be moderate, but is important to document the potential impact project operations on shoreline erosion and riverbank failure, and to determine how this may impact other resources.

Literature Cited

Kleinschmidt (Kleinschmidt Associates, Inc.). 2011. Lower Connecticut River Shoreline Survey Report – 2010: Bellows Falls Project (FERC No. 1855), Wilder Project (FERC No. 1892), Vernon Project (FERC No. 1904). Draft Report March 2011. Prepared for TransCanada Hydro Northeast Inc., Westborough, MA.

Lawson, D.E., 1985, Erosion of northern reservoir shores: An analysis and application of pertinent literature: US Army Corps of Engineers Cold Regions Research and Engineering Laboratory Monograph 85-1, 198 p.

Simons, D.B., Andrews, J.W., Li, R.M., and Alawady, M.A. 1979. Connecticut River Streambank Erosion Study Massachusetts, New Hampshire, and Vermont. Prepared for USACE, New England Division.

Turners Falls Hydroelectric Project – FERC No. 1889-081
Northfield Mountain Pumped Storage Project – FERC No. 2485-063

Study Request 1: Shoreline and downstream erosion from water level fluctuation in the impoundment and downstream from peaking operations

Goals and Objectives
The goal of this study is to determine how project operations contribute to the shoreline erosion and riverbank failure within the impoundment and downstream of the Turner Falls/Northfield Mountain projects.

The objectives of this study are to:

1. determine how water level fluctuations within the minimum and maximum operating range and discharges from peaking operations at the Turner Falls/Northfield Pump Station hydroelectric project contribute to shoreline erosion;
2. identify and determine the effects of shoreline bank erosion and riverbank failure on other resources (i.e. riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, etc.);
3. identify techniques that could be used to mitigate the effects of project operations or other mitigation techniques that could be developed to reduce on riverbank erosion within the impoundment and downstream of the tailrace.

Resource Management Goals
The Connecticut River is considered Class B water by the states of Vermont. Vermont lists the section of the Connecticut River below the Wilder dam on the Section 303(d) impaired water list due to flow alterations resulting in the destabilization and eroding of shoreline impairing aquatic life and habitat. In Class B waters, Vermont's water quality standards state that water level fluctuation and flow alterations can only occur to the extent that it supports all uses and does not lead to degradation of the water resource or habitat.

Public Interest Consideration
The requestor is a state natural resource agency.

Existing Information
The PAD makes reference to several studies in section 4.2.4 including the Erosion Control Plan (Simons & Associates, 1999), previous Full River Reconnaissance studies (1998, 2001 – maps but no report generated, 2004, and 2008), Field Geology Services' 2007 fluvial geomorphic investigation of the Turners Fall headpond, and 2012 investigations by Simons & Associates.

Field Geology Services' 2007 investigation provided several good recommendations for future work in section 9.3 of his report which, if implemented, could provide for: a) an improved understanding of the causes of erosion; b) more accurate monitoring of erosion; and c) more successful bank stabilization efforts. This document is a good point of reference. The Simons & Associates' (2012) documents are qualitative and based on several unstated assumptions that may not be valid. Full River Reconnaissance efforts have been undertaken using varying methodologies, making for difficult comparisons from one report to the other.

We believe that these existing studies do have data that can be useful if certain new analyses are undertaken. These analyses of existing data would help fill in our gaps of understanding of bank erosion in the Turners Fall headpond. We are also asking for some additional field collected data. With the existing information, it should be possible to better display what changes have occurred to streambanks over time. Current Geographic Information System (GIS) software allows for various types of data to be assembled into a map and into a database such that change over time analysis can be conducted fairly easily. The change over time analysis is a critical analysis that is needed, and was already started under Field (2007).

Photos that have been taken at or near the same location but at different times exist. For example, the last three Full River Reconnaissance efforts have included continuous videotaping of the river banks with locational information. With these data, "snapshots" of the bank at various locations could be extracted and compared over time. Field (2007) photo locations could be re-shot as well. This existing information should be presented such that it is easy to discern where the photo was taken and what changes have occurred over time. A comparison of the bank every 100 ft could be compared over the years.
Historic aerial photography for the Turners Fall headpond should be gathered and analyzed. Examples of good photographic datasets include the Field 2007 appendices and 1929 aerials. The location of the shoreline over time should be noted such that it is easy to discern where bank retreat has been most severe and where the river has been relatively stable since the earliest aerial photograph was taken.

Very little turbidity data for the Turner's Falls headpond, the bypass reach or stretches of the Connecticut River downstream of the Turner's Fall project exist. Thus far, implementation of the *Northfield Mountain Pumped Storage Project Sediment Management Plan* (revised February 15, 2012) has yielded few results, and many technological difficulties (see *2012 Sediment Management Plan – 2012 Summary of Annual Monitoring* dated November 30, 2012). Suspended sediment monitoring equipment is installed at the Route 10 Bridge upstream of the project and inside the powerhouse, theoretically taking readings representative of pumping and discharging through the turbines. An analysis of how turbidity might change relative to rapidly changing headpond levels would be very useful information.

Project Nexus
The construction of the NMPS project was contingent upon the Turner's Falls project raising the dam crest elevation by 5.9 feet which has extended the headpond into Vermont and New Hampshire. The NMPS project operations rely on the Turner's Falls headpond as the source of water to be pumped and to be discharged into. The importance of this river reach to the NMPS operation is made clear by Firstlight's reference to this portion of the river as the "lower reservoir." Daily pumping and discharging changes the ponded elevation of the Connecticut River which in turn leads to bank material that repeatedly becomes saturated and then dewatered. Weakened bank material can then become eroded and the fine grain material from the banks can enter the water column and be transported in suspension in the river and eventually settle onto bed material. The raising of the Turner's Falls headpond also made recreational boating more popular, including the introduction of large, high-horsepower powerboats that were not previously present. Because of the fluctuating water levels, boat wakes impact the shoreline to a much greater extent than would occur if levels were more constant, thus exacerbating both the

effects of the wakes and the fluctuating levels. The requested study will help inform the Agency when contemplating mitigation measures and or operational modifications.

Proposed Methodology

This investigation should build on the erosion survey that was previously completed by determining the process causing erosion at a site, the extent erosion is negatively affecting other resources (i.e. riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, etc.), and determining how erosion could be stabilized or mitigated by changing project operations. This investigation can be completed performing the following tasks.

Task 1: Determine erosion and riverbank failure process at identified sites

Shoreline erosion areas and riverbank failure sites were identified during the previous surveys. A survey should be conducted to document if any additional erosion has occurred, and identify new sites of erosion within the impoundment. For each erosion site, the following erosion process element will be identified by determining soil type and subsoil characteristics (i.e. depth to bedrock, texture, rock content, signs of soil piping), reservoir water levels at the time of observation, water level fluctuation, climatic conditions, ground water seepage, wind-driven waves, boat waves, and recreation. Additional site characteristic to identify and record in the erosion survey will include but not be limited to an estimate of the length and average height of the erosional area, slope of the site, dominant vegetation cover types present, associated vegetation cover types present, an ocular estimate of total plant cover and total cover by plant class (tree, shrub, herbaceous) in surrounding undisturbed areas. Data from each shoreline erosion site will be recorded on a field form and entered into a database. In addition, a photograph or photographs will be taken of each site. Sites should be visited when water levels are lowest.

Erosion processes will be determined by field observations and applying site appropriate geology, geomorphic and hydrological principles. To evaluate the relative influence of water level fluctuations on existing shoreline erosion, a minimum of six select sites (three in the impoundment and three downstream of the dam) will be identified for more detailed measurements and observations. In aid of site selection, comparison of successive aerial photographs will be conducted to identify sites that have experienced visible bank movement. Data from erosion surveys will be examined to identify sites with varying conditions of riparian buffer, vegetation type and bank slope. The sites selected for detailed evaluation will represent different combinations of bank movement, riparian buffer, vegetation type and bank slope. In those bank sites that are selected, rebar pins will be inserted into the banks in a grid at varying heights with each rebar being horizontally level. Initial rebar pin installation will take place when the water level in the impoundment is at its authorized lowest elevation. Each rebar pin will be assigned an individual number and photographed, with the distance from the end of the pin to the bank material measured. A survey will also be conducted of each bank along several bank transects in the immediate vicinity of each site to accurately document bank shape as well as the location and elevation of each rebar and the water surface elevation at the beginning and end of each site visit. Pressure transducers (one in the air and one in the water) will also be installed at each site to automatically record how water surface elevation at each site varies with time.

Biweekly for a period of one year, each of the six sites will be revisited. During each revisit, the bank and each rebar pin will be photographed and the distance from the end of the pin to the bank material will be measured. Any slumping of a pin will be noted. If a pin is found dislodged or removed during a site visit, a new rebar pin will be reinstalled in the approximate location of the previously existing pin. In addition, a survey of the bank and rebars will be conducted as described above. Surveys will be conducted in the same manner and will use the same benchmark each site visit. Data from pressure transducers will be downloaded and analyzed each site visit to ensure they are working properly. When this dataset is related to the flow record from existing stream gauges in the river segment, this evaluation will allow for a determination as to whether the erosion is Project related, and if so, how Project operations may be impacting the sites.

Task 2: Determining the effects of erosion on other resources

The effects of shoreline erosion and riverbank failure on other resources should be determined. This will required coordination between studies to determine the effects of erosion on riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, and recreation. Erosion sites identified as having an impact on resources will be assess to determine if project operations are causing erosion and a mitigation plan to protect the resource of interest should be developed.

Task 3: Development of a Shoreline Management Plan

The information that is collected during the study should be used to develop a Shoreline Management Plan for the impoundment. If results from the erosion evaluation suggest that Project operations are impacting erosion within the impoundment, further evaluation should be undertaken to determine if there is a feasible way to reduce impacts. This feasibility analysis will be based on field observations and knowledge of current erosion control and slope failure stabilization methods that may be suitable for sites. The analysis will provide a preliminary list of potential control measures necessary to reduce erosion at these sites. Detailed analyses for final design and construction of erosion and slope stabilization control measures will not be part of the study. As part of this process, the landowner should be identified for each of the erosion sites and future mitigation and stabilization techniques should be presented.

Level of Effort and Cost
The cost and effort of this study will be moderate, but is important to document the potential impact project operations on shoreline erosion and riverbank failure, and to determine how this may impact other resources.

Literature Cited

Lawson, D.E., 1985, Erosion of northern reservoir shores: An analysis and application of pertinent literature: US Army Corps of Engineers Cold Regions Research and Engineering Laboratory Monograph 85-1, 198 p.

Simons, D.B., Andrews, J.W., Li, R.M., and Alawady, M.A. 1979. Connecticut River Streambank Erosion Study Massachusetts, New Hampshire, and Vermont. Prepared for USACE, New England Division.

Wilder Hydroelectric Project – FERC No. 1892-026

Study Request 2: Water quality monitoring within the project impoundment and tailrace

Goals and Objectives

The goal of this study is to determine if the operational impacts of the Wilder Hydroelectric Project are causing or contributing to violations of New Hampshire and/or Vermont state water quality standards.

The objective of this study will be to collect water temperature, dissolved oxygen, specific conductance, pH, nutrients, and chlorophyll-a data at multiple locations in the project area. This monitoring effort will consist of both instantaneous measurements and continuous data collected via multi-parameter dataloggers. Data should be collected under normal operating conditions and ambient conditions that include periods of low flow and higher water temperatures. Weekly profiles and grab samples should reflect various flow conditions. The water quality data will be compared to both Vermont and New Hampshire water quality standards to determine if the project is causing or contributing to water quality standard violations.

Resource Management Goals

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Vermont lists the section of the Connecticut River below the Wilder dam on the Section 303(d) impaired water list due to flow alterations aquatic life and habitat.

All sections of the Connecticut River related to the project are classified by New Hampshire as Class B. It should be noted that although the classification name is the same as Vermont’s, New Hampshire surface water criteria for Class B waters, are in some cases, different from Vermont's.

New Hampshire surface water quality standards (Env-Wq 1703.01) state that the surface water quality criteria for all surface waters shall be restored to meet the water quality criteria for their designated classification, including existing and designated uses, and to maintain the chemical, physical, and biological integrity of surface water.

Public Interest Consideration

The Vermont Agency of Natural Resources and the New Hampshire Department of Environmental Services are requesting this study. The requestors are state natural resource agencies.

Existing Information

The PAD contains information on water quality monitoring that was completed between June 20, 2012 and September 11, 2012 in the tailrace and just upstream of the dam. The data indicated that Vermont Water Quality Standards for dissolved oxygen were not met during a seven day period in August. The PAD does not provide information on the water quality throughout the impoundment or how water quality is affected by project operations. The PAD does indicate that in general temperature, specific conductance, and pH did increase from upstream to downstream while dissolved oxygen decreased, reflecting the impacts of the impoundment.

Project Nexus

The project impounds 45 miles of river that would otherwise be free flowing. It currently operates in a peaking mode, with allowable impoundment fluctuations of up to 5 feet, with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (675 cfs). Water quality can be affected by the operating mode of a hydropower project. The PAD provides limited information on how project operations affect water quality within the project impoundment and tailrace.

Operations of the project must conform to Vermont and New Hampshire water quality standards. The Vermont Agency of Natural Resources and the New Hampshire Department of Environmental Services request a study that will provide the data needed to determine if the Connecticut River in the vicinity of the Wilder Hydroelectric Project is or is not attaining the water quality standards of both states.

Proposed Methodology

The methodology for this study should be similar to TransCanada's water quality monitoring in 2012 including weekly vertical profiles within the impoundment, weekly water quality samples of nutrients and chlorophyll-a for laboratory analysis and the deployment of multi-parameter continuous dataloggers at multiple locations within the impoundment and tailrace. An additional site should be monitored in the free flowing section of the river above the impoundment to serve as a "reference site". At each designated datalogger monitoring location at least 10 days of data should be collected at 15 minute increments during a period of low flow (≤3 x 7Q10) and high temperatures (preferably over 23 degrees C) between June 1 and September 30. Dataloggers deployed in the impoundment should be set at the bottom of the epilimnion (if stratified) or at 25% depth if not stratified. A vertical dissolved oxygen and water temperature profile should be conducted at the time of deployment of dataloggers in the impounded section to determine if river is stratified and thus the appropriate depth for deployment. Water quality results should be graphically compared to both state water quality standards and project operations, including the generation status, impoundment elevation, and discharge.

If low flow conditions are not met the first year of the study, a second year of data may be necessary.

It is preferable that the water quality monitoring for all three projects be coordinated so that sampling can occur at each location within each project during the same period of time and under the same operational, flow, and environmental conditions.

Level of Effort and Cost

The cost and effort of this study will be moderate, but is important to document the potential impact operations have on water quality and determine if they meet Vermont and New Hampshire water quality standards.

Bellow Falls Hydroelectric Project – FERC No. 1855-045

Study Request 2: Water quality monitoring within the project impoundment, bypass, and tailrace

Goals and Objectives
The goal of this study is to determine if the operational impacts of the Bellows Falls Hydroelectric Project are causing or contributing to violations of New Hampshire and/or Vermont state water quality standards.

The objective of this study will be to collect water temperature, dissolved oxygen, specific conductance, pH, nutrients, and chlorophyll-a data at multiple locations in the project area. This monitoring effort will consist of both instantaneous measurements and continuous data collected via multi-parameter dataloggers. Data should be collected under normal operating conditions and ambient conditions that include periods of low flow and higher water temperatures. Weekly profiles and grab samples should reflect various flow conditions. The water quality data will be compared to both Vermont and New Hampshire water quality standards to determine if the project is causing or contributing to water quality standard violations.

Resource Management Goals
The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Vermont list the section of the Connecticut River above and below Bellows Falls dam on the Section 303(d) impaired water list due to flow alterations impairing aquatic life and habitat.

All sections of the Connecticut River related to the project are classified by New Hampshire as Class B. It should be noted that although the classification name is the same as Vermont’s, New Hampshire surface water criteria for Class B waters, are in some cases, different from Vermont's.

New Hampshire surface water quality standards (Env-Wq 1703.01) state that the surface water quality criteria for all surface waters shall be restored to meet the water quality criteria for their designated classification, including existing and designated uses, and to maintain the chemical, physical, and biological integrity of surface water.

Public Interest Consideration
The Vermont Agency of Natural Resources and the New Hampshire Department of Environmental Services are requesting this study. The requestors are state natural resource agencies.

Existing Information
The PAD contains information on water quality monitoring that was completed between June 20, 2012 and September 12, 2012 in the tailrace, bypass reach and just upstream of the dam. Additionally, weekly water column profiles were collected at three locations within the impoundment. The data indicated that Vermont and New Hampshire water quality standards for dissolved oxygen were not met in the bypass reach and in the impoundment. Furthermore, pH

readings collected in water profile measurements indicated that in two different locations during two separate events in the impoundment did not meet Vermont and New Hampshire water quality standards. The PAD does not provide information on the continuous water quality throughout the impoundment or how water quality is affected by project operations. The PAD indicates that in general temperature, specific conductance, and pH did increase from upstream to downstream while dissolved oxygen decreased, reflecting the impacts of the impoundment.

Project Nexus
The project impounds 26 miles of river that would otherwise be free flowing. It currently operates in a peaking mode, with allowable impoundment fluctuations of up to 3 feet, with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (1083 cfs). Water quality can be affected by the operating mode of a hydropower project. The PAD provides limited information on how project operations affect water quality within the project impoundment, bypass reach and tailrace.

Operations of the project must conform to Vermont and New Hampshire water quality standards. The Vermont Agency of Natural Resources and the New Hampshire Department of Environmental Services request a study that will provide the data needed to determine if the Connecticut River in the vicinity of the Wilder Hydroelectric Project is or is not attaining the water quality standards of both states.

Proposed Methodology
The methodology for this study should be similar to TransCanada's water quality monitoring in 2012 including weekly vertical profiles within the impoundment, weekly water quality samples of nutrients and chlorophyll-a for laboratory analysis and the deployment of multi-parameter continuous dataloggers at multiple locations within the impoundment, the bypass reach, and tailrace. An additional site should be monitored in the 17 mile free flowing section of the river above the impoundment to serve as a "reference site". At each designated datalogger monitoring location at least 10 days of data should be collected at 15 minute increments during a period of low flow ($\leq$3 x 7Q10) and high temperatures (preferably over 23 degrees C) between June 1 and September 30. Dataloggers deployed in the impoundment should be set at the bottom of the epilimnion (if stratified) or at 25% depth if not stratified. A vertical dissolved oxygen and water temperature profile should be conducted at the time of deployment of dataloggers in the impounded section to determine if river is stratified and thus the appropriate depth for deployment. Water quality results should be graphically compared to both state water quality standards and project operations, including the generation status, impoundment elevation, and discharge.

If low flow conditions are not met the first year of the study, a second year of data may be necessary.

It is preferable that the water quality monitoring for all three projects be coordinated so that sampling can occur at each location within each project during the same period of time and under the same operational, flow, and environmental conditions.

Level of Effort and Cost

The cost and effort of this study will be moderate, but is important to document the potential impact operations have on water quality and determine if they meet Vermont and New Hampshire water quality standards.

Vernon Hydroelectric Project – FERC No. 1904-073

Study Request 2: Water quality monitoring within the project impoundment and tailrace

Goals and Objectives

The goal of this study is to determine if the operational impacts of at the Vernon Hydroelectric Project are causing or contributing to violations of New Hampshire and/or Vermont state water quality standards.

The objective of this study will be to collect water temperature, dissolved oxygen, specific conductance, pH, nutrients, and chlorophyll-a data at multiple locations in the project area. This monitoring effort will consist of both instantaneous measurements and continuous data collected via multi-parameter dataloggers. Data should be collected under normal operating conditions and ambient conditions that include periods of low flow and higher water temperatures. Weekly profiles and grab samples should reflect various flow conditions. The water quality data will be compared to both Vermont and New Hampshire water quality standards to determine if the project is causing or contributing to water quality standard violations.

Resource Management Goals

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Vermont lists the section of the Connecticut River above and below Vernon dam on the Section 303(d) impaired water list due to flow alterations impairing aquatic life and habitat.

All sections of the Connecticut River related to the project are classified by New Hampshire as Class B. It should be noted that although the classification name is the same as Vermont’s, New Hampshire surface water criteria for Class B waters, are in some cases, different from Vermont's.

New Hampshire surface water quality standards (Env-Wq 1703.01) state that the surface water quality criteria for all surface waters shall be restored to meet the water quality criteria for their designated classification, including existing and designated uses, and to maintain the chemical, physical, and biological integrity of surface water.

Public Interest Consideration

The Vermont Agency of Natural Resources and the New Hampshire Department of Environmental Services are requesting this study. The requestors are state natural resource agencies.

Existing Information

The PAD contains information on water quality monitoring that was completed between June 20, 2012 and September 11, 2012 in the tailrace and just upstream of the dam. Temperature data indicated that it reached levels that would be critical threshold for salmonids, and above the natural regime for the river. The PAD does not provide information on the water quality throughout the impoundment or how water quality is affected by project operations. The PAD does indicates that in general temperature, specific conductance, and pH did increase from upstream to downstream while dissolved oxygen decreased, reflecting the impacts of the impoundment on increase travel time in the river.

Project Nexus
The project impounds 26 miles of river that would otherwise be natural free-flowing. It currently operates in a peaking mode, with allowable impoundment fluctuations of up to 8 feet, with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (1250 cfs). Water quality can be affected by the operating mode of a hydropower project. The PAD provides limited information on how project operations affect water quality within the project impoundment and tailrace.

Operations of the project must conform to Vermont and New Hampshire water quality standards . The Vermont Agency of Natural Resources and the New Hampshire Department of Environmental Services request a study that will provide the data needed to determine if the Connecticut River in the vicinity of the Wilder Hydroelectric Project is or is not attaining the water quality standards of both states.

Proposed Methodology
The methodology for this study should be similar to TransCanada’s water quality monitoring in 2012 including weekly vertical profiles within the impoundment, weekly water quality samples of nutrients and chlorophyll-a for laboratory analysis and the deployment of multi-parameter continuous dataloggers at multiple locations within the impoundment and tailrace. An additional site should be monitored in the free flowing section of the river above the impoundment to serve as a “reference site”. At each designated datalogger monitoring location at least 10 days of data should be collected at 15 minute increments during a period of low flow ($\leq$3 x 7Q10) and high temperatures (preferably over 23 degrees C) between June 1 and September 30. Dataloggers deployed in the impoundment should be set at the bottom of the epilimnion (if stratified) or at 25% depth if not stratified. A vertical dissolved oxygen and water temperature profile should be conducted at the time of deployment of dataloggers in the impounded section to determine if river is stratified and thus the appropriate depth for deployment. Water quality results should be graphically compared to both state water quality standards and project operations, including the generation status, impoundment elevation, and discharge.

If low flow conditions are not met the first year of the study, a second year of data may be necessary.

It is preferable that the water quality monitoring for all three projects be coordinated so that sampling can occur at each location within each project during the same period of time and under the same operational, flow, and environmental conditions.

Level of Effort and Cost
The cost and effort of this study will be moderate, but is important to document the potential impact project operations have on water quality and determine if they meet Vermont and New Hampshire water quality standards.

Turners Falls Hydroelectric Project – FERC No. 1889-081
Northfield Mountain Pumped Storage Project – FERC No. 2485-063

Study Request 2: Water quality monitoring within the project impoundment and tailrace

Goals and Objectives
The goal of this study is to determine if the operational impacts of at the Turner Falls Project are causing or contributing to violations of New Hampshire and/or Vermont state water quality standards.

The objective of this study will be to collect water temperature, dissolved oxygen, specific conductance, pH, nutrients, and chlorophyll-a data at multiple locations in the project area. This monitoring effort will consist of both instantaneous measurements and continuous data collected via multi-parameter dataloggers. Data should be collected under normal operating conditions and ambient conditions that include periods of low flow and higher water temperatures. Weekly profiles and grab samples should reflect various flow conditions. The water quality data will be compared to both Vermont and New Hampshire water quality standards to determine if the project is causing or contributing to water quality standard violations.

Resource Management Goals
The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Vermont lists the section of the Connecticut River below Vernon dam on the Section 303(d) impaired water list due to flow alterations impairing aquatic life and habitat.

Public Interest Consideration
The requestor is a state natural resource agency.

Existing Information
The PAD provides a summary of existing water quality data. While a number of monitoring efforts have taken place and include sample sites within the project boundary, none of those studies were designed to comprehensively investigate whether all relevant project areas currently meet Class B standards, and no data was collected in the section of the impoundment between Vermont and New Hampshire: The Massachusetts DEP's Connecticut River watershed assessment monitoring occurred in 2003, only had two stations located within the project area (both upstream of the Turners Falls dam) and only collected five to six samples from late April to early October; the Connecticut River Watershed Council's volunteer monitoring program only had one sample site within the project area (at Barton's Cove in the Turners Falls headpond) and while those data are more recent, only three samples were collected in 2007 and only six samples in 2008 (over the course of three to four months each year); and the U.S. Geological Survey's long-term water quality monitoring station located downstream of the Cabot Station tailrace only collects information roughly once per month (and no dissolved oxygen data are provided).

No directed, site-specific surveys have been conducted to determine whether waters within the Project area in Vermont and New Hampshire meet State standards. This information gap needs to be filled so that resource agencies can evaluate properly the potential impact of project operations on water quality.

Project Nexus

The project creates a 20-mile-long impoundment where there would naturally be a free-flowing river with 5.7 miles between Vermont and New Hampshire. It currently operates in a peaking mode, with allowable headpond fluctuations of up to 9 feet, with proposals to continue as such. Portions of the headpond are nearly 100 feet-deep. There is a 2.7 mile-long reach of river bypassed by the Turners Falls power canal with only a nominal seasonal release required (equal to 0.05 cfsm). The below-project flow requirement is equal to 0.20 cfsm (1,433 cfs). Water quality can be affected by the operating mode of a hydropower project. Impoundments can stratify, resulting in a near-hypoxic hypolimnion. If the project intake draws off of these deep waters then it could cause low dissolved oxygen levels downstream from the project discharge.

The Vermont Agency of Natural Resources requests that the applicant conduct a water quality survey of the impoundment reach within Vermont in order to determine whether state water quality standards are being met under all currently-licensed operating conditions (i.e., during periods of generation and non-generation). Results of the survey would be used, in conjunction with other studies requested herein, to determine an appropriate below-Project flow prescription, bypass reach flow(s), and to recommend an appropriate water level management protocol for the headpond (e.g., limiting impoundment fluctuations to protect water quality).

Operation of upstream hydroelectric projects as well as the Turners Falls Project and Northfield Mountain Project may impact water quality through the use of water for hydropower generation.

Proposed Methodology

The methodology for this study should include weekly vertical profiles within the impoundment, weekly water quality samples of nutrients and chlorophyll-a for laboratory analysis and the deployment of multi-parameter continuous dataloggers at multiple locations within the impoundment. An additional site should be monitored in the free flowing section of the river above the impoundment to serve as a “reference site”. At each designated datalogger monitoring location at least 10 days of data should be collected at 15 minute increments during a period of low flow ($\leq$3 x 7Q10) and high temperatures (preferably over 23 degrees C) between June 1 and September 30. Dataloggers deployed in the impoundment should be set at the bottom of the epilimnion (if stratified) or at 25% depth if not stratified. A vertical dissolved oxygen and water temperature profile should be conducted at the time of deployment of dataloggers in the impounded section to determine if river is stratified and thus the appropriate depth for deployment. Water quality results should be graphically compared to both state water quality standards and project operations, including the generation status, impoundment elevation, and discharge.

If low flow conditions are not met the first year of the study, a second year of data may be necessary.

It is preferable that the water quality monitoring be coordinated with TransCanada so that sampling can occur at each location within each project during the same period of time and under the same operational, flow, and environmental conditions.

Level of Effort and Cost

The cost and effort of this study will be moderate, but is important to document the potential impact project operations have on water quality and determine if they meet Vermont water quality standards.

Wilder Hydroelectric Project – FERC No. 1892-026

Study Request 3: Continuous water temperature monitoring at various locations within the impoundment and tailrace, and downstream Connecticut River

Goals and Objectives

The goal of this study is to determine the potential impacts (both project specific and cumulative) of the Wilder Hydroelectric Project operations on hourly/daily temperature fluctuations and spatial thermal distribution within the Wilder Hydroelectric Project Impoundment and Tailrace**,** and the Connecticut River downstream of the Wilder Dam.

The objectives of this study are to:

1. Obtain continuous temperature data (every 15 minutes) at various locations and depths throughout the project impoundment, tailrace, and downstream Connecticut River using temperature loggers;

2. Analyze data for hourly/daily shifts in temperature regime and thermal distribution (aquatic isotherm maps) associated project specific and cumulative impacts associated with project operations; and

3. Determine if any shifts in hourly temperature regime or thermal distribution are impacting aquatic habitat within the project impoundment and tailrace and lower Connecticut River (e.g., thermal blocks to migration, thermal stress, habitat degradation).

Resource Management Goals

Temperature is an important habitat consideration for many aquatic species including migratory fish and rare, threatened, endangered species. Temperature influences the distribution, behavior, metabolism, growth, reproduction, and survival of fishes (Diana 2004). The Connecticut River is considered a Class B waters cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Additionally the Vermont Water Quality Standards states that in Class B cold water fish habitat, the total increase in from any activity or discharge should not result in a temperature increase that exceeds 1.0°F.

Public Interest Consideration

The requestor is a state natural resource agency.

Existing Information

The PAD provides limited information on impacts of project operations ("daily run-of-river") on temperature in the project impoundment, tailrace or lower Connecticut River. Hourly/daily temperature shifts associated with project operations at Wilder Dam can impact aquatic habitat rendering it unsuitable for some organisms. The information in the PAD does not define the spatial extent of temperatures (aquatic isotherm map) within the impoundment, lower Connecticut River. The PAD mainly indicates that in general, temperature did increase from

upstream to downstream while dissolved oxygen decreased, reflecting the impacts of the impoundment.

Project Nexus

The project impounds 45 miles of river that would otherwise be free flowing. It currently operates in a peaking mode, with allowable impoundment fluctuations of up to 5 feet, with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (675 cfs). Water temperature can be affected by the operating mode of a hydropower project. The impounded water increases the water surface area of the river reach containing the project. The increased surface acts as a large solar radiation collector and the thermal mass of the impounded water acts a heat sink storing heat from solar radiation. At night the increased surface area may act as convective radiator that releases heat. Together these attributes may contribute to unnatural thermal properties in the project impoundment that may impact natural temperature regime and influence habitat conditions for fish, wildlife and plant resources (temperature tolerance, life cycle timing (e.g., reproduction or migration), and food availability).

The project discharges regulated Connecticut River flows ("daily run-of-river") from the impoundment to the downstream seventeen mile reach of the Connecticut River. The project can sporadically release large volumes of impoundment water that may be of a different temperature than the receiving water downstream of the dam. Unnatural and rapid shifts in temperature regimes in the downstream water can impact fish, wildlife and plant resources and instream habitat. The Agency requests that more recent temperature data is collected in a more intensive, systematic and scientific manner in order to assess project specific and cumulative impacts on fish, wildlife and plant resources at the project. Results from this study may be used to directly inform the evaluation of project effects on related resources, such as a fish and other aquatic species.

Proposed Methodology

Use of temperature loggers to gain information on thermal trends has been a standard technique to look at impacts of water storage associated with hydroelectric projects. We recommend that transects be established in the upper, middle, and lower project impoundment, as well as in the tailrace and downstream project. An additional transect should be established in the free flowing section of river above the impoundment to serve as a "reference site". Inexpensive temperature loggers should be deployed along each transects at a minimum of three locations: at depths of 1 meter subsurface, mid-depth, and 1 meter off the bottom (on buoy lines) where water depths permit. The temperature loggers should be deployed from April 1 – November 15 and be set to record temperature at 15 minute intervals. The temperature loggers should be checked and the data downloaded on the monthly basis. The data from the loggers should then be used to develop hourly/daily aquatic isotherm maps, and temperature change and distribution as a result of project and cumulative impacts should be assessed.

Level of Effort and Cost

The effort and cost of this study is expected to be moderate to high, but the potential project specific and cumulative thermal alteration impacts have never been studied in a comprehensive manner and their potential impacts to aquatic habitat and fish, wildlife, and resources has not been adequately studied.

Literature Cited

Diana, J.S. 2004. Biology and Ecology of Fishes. 2nd edition. Biological Sciences Press.

Bellows Falls Hydroelectric Project – FERC No. 1855-045

Study Request 3: Continuous water temperature monitoring at various locations within the impoundment and tailrace, and downstream Connecticut River

Goals and Objectives

The goal of this study is to determine the potential impacts (both project specific and cumulative) of the Bellows Falls Hydroelectric Project operations on hourly/daily temperature fluctuations and spatial thermal distribution within the Bellows Falls Hydroelectric Project Impoundment and Tailrace**,** and the Connecticut River downstream of the Bellows Falls Dam.

The objectives of this study are to:

1. Obtain continuous temperature data (every 15 minutes) at various locations and depths throughout the project impoundment, tailrace, and downstream Connecticut River using temperature loggers.

2. Analyze data for hourly/daily shifts in temperature regime and thermal distribution (aquatic isotherm maps) associated project specific and cumulative impacts associated with project operations.

3. Determine if any shifts in hourly temperature regime or thermal distribution are impacting aquatic habitat within the project impoundment and tailrace and lower Connecticut River (e.g., thermal blocks to migration, thermal stress, habitat degradation).

Resource Management Goals

Temperature is an important habitat consideration for many aquatic species including migratory fish and rare, threatened, endangered species. Temperature influences the distribution, behavior, metabolism, growth, reproduction, and survival of fishes (Diana 2004). The Connecticut River is considered a Class B waters cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Additionally the Vermont Water Quality Standards states that in Class B cold water fish habitat, the total increase in from any activity or discharge should not result in a temperature increase that exceeds 1.0°F.

Public Interest Consideration

The requestor is a state natural resource agency.

Existing Information

The PAD provides limited information on impacts of project operations (“daily run-of-river”) on temperature in the project impoundment, tailrace or lower Connecticut River. Hourly/daily temperature shifts associated with project operations at Bellows Falls Dam can impact aquatic habitat rendering it unsuitable for some organisms. The information in the PAD does not define the spatial extent of temperatures (aquatic isotherm map) within the impoundment, lower Connecticut River. The PAD mainly indicates that in general, temperature did increase from

upstream to downstream while dissolved oxygen decreased, reflecting the impacts of the impoundment.

Project Nexus

The project impounds 26 miles of river that would otherwise be free flowing. It currently operates in a peaking mode, with allowable impoundment fluctuations of up to 3 feet, with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (1083 cfs). Water quality can be affected by the operating mode of a hydropower project. The PAD provides limited information on how project operations affect water quality within the project impoundment, bypass reach and tailrace. Water temperature can be affected by the operating mode of a hydropower project. The impounded water increases the water surface area of the river reach containing the project. The increased surface acts as a larger solar radiation collector and the thermal mass of the impounded water acts a heat sink storing heat from solar radiation. At night the increased surface area may act as convective radiator that releases heat. Together these attributes may contribute to unnatural thermal properties in the project impoundment that may impact natural temperature regime and influence habitat conditions for fish, wildlife and plant resources (temperature tolerance, life cycle timing (e.g., reproduction or migration), and food availability).

The project discharges regulated Connecticut River flows ("daily run-of-river") from the impoundment to the downstream seventeen mile reach of the Connecticut River. The project can sporadically release large volumes of impoundment water that may be of a different temperature than the receiving water downstream of the dam. Unnatural and rapid shifts in temperature regimes in the downstream water can impact fish, wildlife and plant resources and instream habitat. The Agency requests that more recent temperature data is collected in a more intensive, systematic and scientific manner in order to assess project specific and cumulative impacts on fish, wildlife and plant resources at the project. Results from this study may be used to directly inform the evaluation of project effects on related resources, such as a fish and other aquatic species.

Proposed Methodology

Use of temperature loggers to gain information on thermal trends has been a standard technique to look at impacts of water storage associated with hydroelectric projects. We recommend that transects be established in the upper, middle, and lower project impoundment, as well as in the tailrace and downstream project. An additional transect should be established in the free flowing section of river above the impoundment to serve as a "reference site". Inexpensive temperature loggers should be deployed along each transects at a minimum of three locations: at depths of 1 meter subsurface, mid-depth, and 1 meter off the bottom (on buoy lines) where water depths permit. The temperature loggers should be deployed from April 1 – November 15 and be set to record temperature at 15 minute intervals. The temperature loggers should be checked and the data downloaded on the monthly basis. The data from the loggers should then be used to develop hourly/daily aquatic isotherm maps, and temperature change and distribution as a result of project and cumulative impacts should be assessed.

Level of Effort and Cost

The effort and cost of this study is expected to be moderate to high, but the potential project specific and cumulative thermal alteration impacts have never been studied in a comprehensive manner and their potential impacts to aquatic habitat and fish, wildlife, and resources has not been adequately studied.

Literature Cited

Diana, J.S. 2004. Biology and Ecology of Fishes. 2nd edition. Biological Sciences Press.

Vernon Hydroelectric Project – FERC No. 1904-073

Study Request 3: Continuous water temperature monitoring at various locations within the impoundment and tailrace, and downstream Connecticut River

Goals and Objectives

The goal of this study is to determine the potential impacts (both project specific and cumulative) of the Vernon Hydroelectric Project operations on hourly/daily temperature fluctuations and spatial thermal distribution within the Vernon Hydroelectric Project Impoundment and Tailrace**,** and the Connecticut River downstream of the Vernon Dam to the Massachusetts line.

The objectives of this study are to:

1. Obtain continuous temperature data (every 15 minutes) at various locations and depths throughout the project impoundment, tailrace, and downstream Connecticut River using temperature loggers.

2. Analyze data for hourly/daily shifts in temperature regime and thermal distribution (aquatic isotherm maps) associated project specific and cumulative impacts associated with project operations.

3. Determine if any shifts in hourly temperature regime or thermal distribution are impacting aquatic habitat within the project impoundment and tailrace and lower Connecticut River (e.g., thermal blocks to migration, thermal stress, habitat degradation).

Resource Management Goals

Temperature is an important habitat consideration for many aquatic species including migratory fish and rare, threatened, endangered species. Temperature influences the distribution, behavior, metabolism, growth, reproduction, and survival of fishes (Diana 2004). The Connecticut River is considered a Class B waters cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Additionally the Vermont Water Quality Standards states that in Class B cold water fish habitat, the total increase in from any activity or discharge should not result in a temperature increase that exceeds 1.0°F.

Public Interest Consideration

The requestor is a state natural resource agency.

Existing Information

The PAD provides limited information on impacts of project operations ("daily run-of-river") on temperature in the project impoundment, tailrace or lower Connecticut River. Hourly/daily temperature shifts associated with project operations at Vernon Dam can impact aquatic habitat rendering it unsuitable for some organisms. The information in the PAD does not define the spatial extent of temperatures (aquatic isotherm map) within the impoundment, lower Connecticut River. The PAD mainly indicates that in general, temperature did increase from

upstream to downstream while dissolved oxygen decreased, reflecting the impacts of the impoundment.

Project Nexus

The project impounds 26 miles of river that would otherwise be natural free-flowing. It currently operates in a peaking mode, with allowable impoundment fluctuations of up to 8 feet, with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (1250 cfs). Water temperature can be affected by the operating mode of a hydropower project. The impounded water increases the water surface area of the river reach containing the project. The increased surface acts as a larger solar radiation collector and the thermal mass of the impounded water acts a heat sink storing heat from solar radiation. At night the increased surface area may act as convective radiator that releases heat. Together these attributes may contribute to unnatural thermal properties in the project impoundment that may impact natural temperature regime and influence habitat conditions for fish, wildlife and plant resources (temperature tolerance, life cycle timing (e.g., reproduction or migration), and food availability).

The project discharges regulated Connecticut River flows (“daily run-of-river”) from the impoundment to the downstream seventeen mile reach of the Connecticut River. The project can sporadically release large volumes of impoundment water that may be of a different temperature than the receiving water downstream of the dam. Unnatural and rapid shifts in temperature regimes in the downstream water can impact fish, wildlife and plant resources and instream habitat. The Agency requests that more recent temperature data is collected in a more intensive, systematic and scientific manner is needed to assess project specific and cumulative impacts on fish, wildlife and plant resources at the project. Results from this study may be used to directly inform the evaluation of project effects on related resources, such as a fish and other aquatic species.

Proposed Methodology

Use of temperature loggers to gain information on thermal trends has been a standard technique to look at impacts of water storage associated with hydroelectric projects. We recommend that transects be established in the upper, middle, and lower project impoundment, as well as in the tailrace and downstream project. An additional transect should be established in the free flowing section of river above the impoundment to serve as a “reference site”. Inexpensive temperature loggers should be deployed along each transects at a minimum of three locations: at depths of 1 meter subsurface, mid-depth, and 1 meter off the bottom (on buoy lines) where water depths permit. The temperature loggers should be deployed from April 1 – November 15 and be set to record temperature at 15 minute intervals. The temperature loggers should be checked and the data downloaded on the monthly basis. The data from the loggers should then be used to develop hourly/daily aquatic isotherm maps, and temperature change and distribution as a result of project and cumulative impacts should be assessed.

Level of Effort and Cost

The effort and cost of this study is expected to be moderate to high, but the potential project specific and cumulative thermal alteration impacts have never been studied in a comprehensive manner and their potential impacts to aquatic habitat and fish, wildlife, and resources has not been adequately studied.

Literature Cited

Diana, J.S. 2004. Biology and Ecology of Fishes. 2nd edition. Biological Sciences Press.

Wilder Hydroelectric Project – FERC No. 1892-026
Bellows Falls Hydroelectric Project – FERC No. 1855-045
Vernon Hydroelectric Project – FERC No. 1904-073

Study Request 4: Model river flows and water levels upstream and downstream from the Wilder, Bellows Falls and Vernon stations and integration of project modeling with downstream project operations

Goals and Objectives

The goal of this study is to develop river flow models that permit the evaluation of the hydrologic changes to the river caused by the physical presence and operation of the Wilder, Bellows Falls, and Vernon Hydroelectric Projects and the interrelationships between the operation of all five hydroelectric projects up for relicensing and river inflows. Specific objectives of this study include:

1. Conduct quantitative hydrologic modeling of the hydrologic influences and interactions that exist between the water surface elevations of the Wilder, Bellows Falls, and Vernon project impoundments and discharges from the Wilder, Bellows Falls, and Vernon projects and the downstream hydroelectric projects including:
    a. Inflows into the Wilder, Bellows Falls, and Vernon impoundments from the Fifteen Mile Falls Project, FERC No. 2007, and other sources;
    b. Existing and potential discharges from the Wilder, Bellows Falls, and Vernon project generating facilities and spill flows, including existing and potential minimum flow and other operational requirements;
    c. Existing and potential water level fluctuation restrictions (maximum and minimum pond levels) of the Wilder, Bellows Falls, and Vernon impoundments, and consequent changes in downstream project discharges; and
    d. Incorporation of the potential effects of climate-altered flows on project operations over the course of the license.
2. Assess how existing and potential operations of the Wilder, Bellows Falls, and Vernon projects affect the operations of the Northfield Mountain and Turners Falls Projects, including:
    a. How Wilder, Bellows Falls, and Vernon flow fluctuations affect pool levels of the Turners Falls impoundment; and
    b. How operations of the Wilder, Bellows Falls, and Vernon projects affect Turners Falls discharges.

Resource Management Goals

The Agency's goals related to aquatic natural resources are to:

1. Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.

3. Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.

The Connecticut River is considered Class B water by the states of Vermont. Vermont lists the section of the Connecticut River below the Wilder dam to Massachusetts line on the Section 303(d) impaired water list due to flow alterations impairing aquatic life and habitat. In Class B waters, Vermont's water quality standards state that water level fluctuation and flow alterations can only occur to the extent that it supports all uses and does not lead to degradation of the water resource or habitat.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures under the Vermont Water Quality Standards.

Public Interest Consideration
The requestor is a state natural resource agency.

Existing Information
Available information in the PAD does not indicate how project operations have altered the hydrology downstream from each of these facilities, which may affect resident and migratory fish, macroinvertebrates, rare, threatened and endangered species, aquatic plants and other biota and natural processes in the Connecticut River. It is also unclear how operations at one facility affect the operations at another.

Project Nexus
The Wilder, Bellows Falls, and Vernon projects are each currently operated with required minimum flows of 675, 1,083, and 1,250 cfs (or inflows if less) for each facility, respectively, though in practice minimum flows are operated as 700, 1300, and 1600 cfs, respectively. There is presently no required minimum flow for the bypassed reach of the Bellows Falls Project. Each of the projects operates as a daily peaking facility, such that "Generation can vary during the course of any day between the required minimum flow and full capacity if higher flows are available" (p. 2-28, p. 2-29, and p. 2-30 in the Wilder, Bellows Falls and Vernon PADs, respectively). Total hydraulic capacity of each facility is 12,700, 11,010, and 12,634 cfs, respectively. Regular daily fluctuations on the order of 9,000 cfs or greater are commonly recorded at USGS gages 01144500 (Connecticut River at West Lebanon, below Wilder Dam) and 01154500 (Connecticut River at North Walpole, NH, below Bellows Falls Dam). Daily fluctuations in headpond elevation are approximately 2.5' (382' to 384.5' MSL), 1.2' (289.9' to 291.1' MSL), and 1.2' (218.6' to 219.8' MSL) at the Wilder, Bellows Falls, and Vernon impoundments, respectively.

These described changes affect biotic habitat and biota upstream and downstream of each project. Project operations and potential changes to operations to mitigate impacts at each facility are influenced by inflows and operations of upstream projects. Results of river flow analyses will provide necessary information regarding changes that can be made to the Wilder, Bellows Falls, and Vernon Project flow releases and/or water level restrictions, how such changes may be constrained by inflows and upstream project operations, and how these changes potentially affect downstream resources. This information will then be used to develop flow-related license requirements and/or other mitigation measures.

Proposed Methodology

River hydrology statistics and hourly flow modeling are commonly employed at hydroelectric projects to assess implications of project operations on the river environment.

Level of Effort and Cost

Level of effort and cost of model development are expected to be moderate as much of the baseline modeling has already been completed, but running of various scenarios through the model(s) will be needed throughout the relicensing process to assess the implications of changes to the operations of each project on other projects and other resources. The modeling exercise will also require coordination and cooperation between TransCanada and the downstream licensee to assure that the model inputs and outputs can be accurately related.

We would anticipate that the expected level of effort and anticipated costs will be comparable to that experienced on similar FERC relicensing projects of this size (e.g., Conowingo, FERC No. 405).

Wilder Hydroelectric Project – FERC No. 1892-026
Bellows Falls Hydroelectric Project – FERC No. 1855-045
Vernon Hydroelectric Project – FERC No. 1904-073

Study Request 5: Climate change as it relates to continued operation of the Vernon, Bellows Falls and Wilder projects

Goals and Objectives

The goal of this study is to determine how climate change relates to the continued operation of the Vernon, Bellows Falls, and Wilder projects.

The objectives of this study are:

1. Quantify the amount of thermal loading contributed by each respective impoundment
2. Using climate change prediction models, calculate how much warmer the project impoundments are projected to get in the next 30-50 years.
3. Model the effect of various project modifications on river temperature under current conditions and climate change predictions (e.g., converting to run-of-river, deep-water releases, dam removal, large-scale riparian revegetation, etc.).
4. Using climate change prediction models, determine if the projects actually provide an environmental benefit with respect to mitigating against climate change impacts (warming of air and water temperatures) by producing low greenhouse gas emitting energy.
5. Determine how climate change predictions will impact management of high flow events at the three projects and evaluate if changes to dam structures would mitigate adverse impacts of the existing flood management protocols.

Resource Management Goals

The Agency's goals related to aquatic natural resources are to:

1. Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
3. Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.

The Connecticut River is classified by the State of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the Vermont Fish and Wildlife Department's mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).

Two of the Department's planning goals are:

1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.

2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

Specific to climate change, Executive Order 11-05 by the Governor established the Climate Cabinet to provide coordinated leadership in the states effort to adapt to climate change.
The Agency goals as it relates to climate change initiatives are:

1. Improve our understanding on the effects of climate change in Vermont on natural resources and ecosystem services.
2. Identify adaptation strategies that could be used to protect Vermonter's, their property, and the state's natural resources and ecosystem services they provide.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Agency goals.

Public Interest Consideration

The requester is a resource agency.

Existing Information

The PADs contains no information relative to climate change and how climate change predictions may impact future operation of the hydroelectric plants, nor of how the projects either mitigate for or exacerbate predicted climate change impacts to freshwater ecosystems.

TransCanada's PADs provide a summary of water quality data collected in 2012. Table 1 below is a synthesis of the temperature data collected by TransCanada. It should be noted that the upper and mid-impoundment stations at each project represent the average of temperature readings taken over the entire water column, while the continuous loggers (Lower Cont. and TR) were located near the water surface. These data indicate that from the upstream end of the Wilder headpond to the Vernon tailrace, water temperature increased approximately 6°C.

Table 1. Median water temperature at monitoring stations located within the impoundments and tailraces of the three hydropower projects.

	Median Water Temperature °C			
Project	Upper Imp.	Mid-Imp.	Lower Cont.	TR
Wilder	20.86	21.83	24.08	23.59
BF	22.43	23.67	24.86	24.38
Vernon	23.81	24.49	26.73	26.35

Relative to existing flood management protocols at each station, TransCanada's PADs identify that all three dams utilize stanchion bays (two at Vernon, three at Bellows Falls, and four at Wilder). When inflows to each dam reach certain levels, the stanchion bays are removed, and cannot be replaced until inflows subside. The depth of these bays and the flows they are removed at are outlined in Table 2, below.

Table 2. Summary of pertinent stanchion bay Information for the Vernon, Bellows Falls, and Wilder projects.

Project	Stanchion Height (feet)	Flow Triggering Complete Stanchion Removal
Wilder	17	145,000 cfs
BF	13	50,000 cfs
Vernon	10	105,000 cfs

The PADs provide no information on the history of stanchion removal at any of the projects (frequency, duration, timing), nor a discussion of how predicted climate change might alter management of the stanchion bays in the future (with respect to the frequency and seasonality of occurrence). There also is no discussion of potential impacts to headpond resources that occurs as a result of stanchion bay removal. These information gaps need to be filled so resource agencies can assess the relative and cumulative impact of project operations with respect to the Agency's management goals and objectives.

Data provided by the National Oceanic and Atmospheric Administration, Climate Data Center, illustrates long-term increasing air temperatures in the Northeast (Figure 1). Long-term, monthly mean water temperature data for the Vernon Dam impoundment, monitored by Vermont Yankee, has shown significant differences over time (ANOVA analyses, $P < 0.05$) that when plotted and further analyzed by linear regression, show a significant increasing trend for the period 1974 – 2011 for the months of January, September, and October (Figure 2). These analyses were performed with data from Vermont Yankee, analyzed by the Massachusetts Department of Environmental Protection.

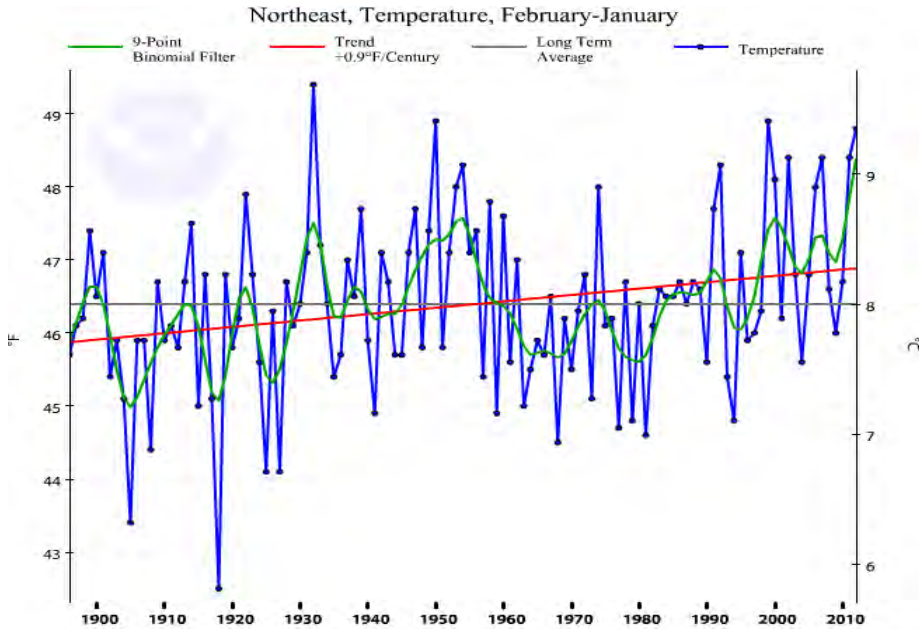


Figure 1. NOAA National Climate Data Center, Northeast 12-month average temperature for the period 1896 through 2012 (October).

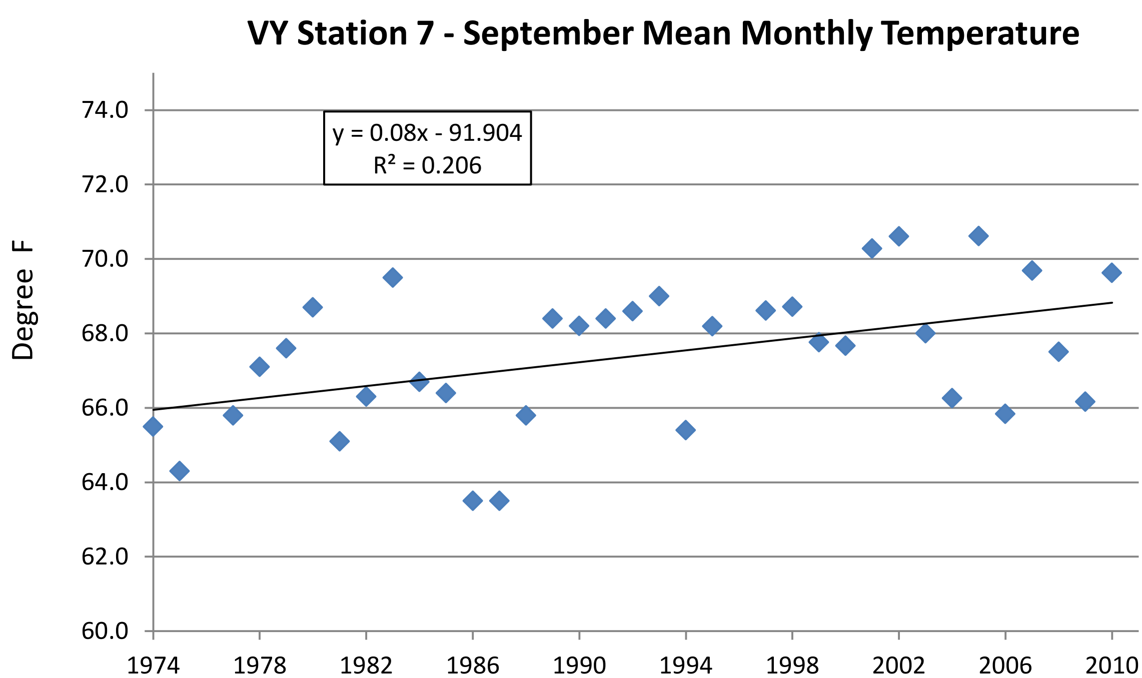


Figure 2. A plot of September's mean temperatures for Vermont Yankees' Station 7 (excludes outlier 1996 data point) for the period 1974 through 2011.

Project Nexus

The three mainstem projects have very long impoundments capable of storing large volumes of water (Table 3, below). These impoundments effectively have converted large portions of the Connecticut River into a series of in-river “lakes.” Because water velocities slow in these impounded sections of river, it allows for increased thermal loading and resultant higher water surface temperatures than in free-flowing sections of river.

Table 3. Relevant characteristics of the reservoirs behind the Wilder, Bellows Falls, and Vernon.

Project	Headpond Length (miles)	Gross Storage Volume (acre-ft.)	Average Depth (ft.)	Surface Area (acres)	Flushing Rate (days)
Wilder	45	34,350	11	3,100	3
BF	26	26,900	10	2,804	<2
Vernon	26	40,000	16	2,550	2

Depending on where the hydropower intakes withdraw water, these warmer surface waters may be discharged downstream, raising the temperature of those waters as well (the data in Table 1 above suggest that the projects do draw water from the upper levels of the reservoirs). This effect may be felt for miles downstream. If there are a series of impoundments (like on the Connecticut River), the cumulative impact is an overall warming of the river. Even small run-of-river dams have been shown to elevate downstream water temperature (Lessard and Hayes 2003; Saila et al. 2005). The most recent climate change prediction models specific to the northeast forecast warmer air temperatures, more frequent high precipitation events, more heat waves, and an increase in the incidence of short term droughts (Karl et al. 2009).

Resource concerns related to this project effect include the potential impacts to populations (reductions in abundance, structure, condition) or loss of species not tolerant of increases in temperature and other effects related to physiology such as energetic costs with warmer temperatures (Leggett 2004). As one example, American shad restoration target numbers for fish passage at mainstem dams into upstream historic habitat could be negatively impacted from artificially increased water temperatures. Water temperature has been identified as a factor in the timing (i.e., duration) of this species migration, as well as its role in gonad development and spawning (Glebe and Leggett 1981; Leggett 2004). These factors can be logical reasoned to potentially result in accelerated rates of energy reserve use and a reduced migration window, possibly reducing the ability of fish to reach up-river habitats and further reducing the ability to survive downstream outmigration.

With respect to project operations during high flow events, all TransCanada projects have stanchion bays that are used to manage water during high flow events. Each time these stanchion bays are removed, the headponds are lowered substantially (from 10 to 17 feet, depending on the project) and must remain lowered until inflows subside. Depending on the timing and duration of these deep drawdowns, headpond resources could be negatively impacted.

All of the dams also contain other mechanisms for managing flows, such as Tainter gates, sluice gates, roller gates, skimmer gates and hydraulic flood gates. All of these gates have an advantage over stanchion bays in that they do not require flows to subside significantly before they can be closed to return impoundment levels back to normal. One climate change prediction for the northeast is that we will see more frequent high precipitation events which will result in high flow conditions on rivers. Therefore, it is likely that the stanchion bay removal protocol will have to be employed more frequently in the future.

Proposed Methodology

1. In order to quantify the amount of thermal loading contributed by each respective impoundment, detailed bathymetry will need to be collected. This bathymetry, combined with storage volume, tributary hydrology, and project operations, should be used to calculate the thermal loading of each headpond. The individual and cumulative increase in surface water temperature due to the impoundments should then be used to predict future warming based on climate change models.

2. Analyze different mitigation strategies to understand which have the greatest benefit in terms of building resilience against the impacts of climate change on water temperature. Potential scenarios to analyze include converting the projects to run-of-river, implementing deep-water releases, removing one or more dams, conducting large-scale riparian revegetation, etc.).

3. Input to climate change models the amount of GHG emissions that would be generated if fossil fuel plants were producing the equivalent amount of net energy as the three hydropower projects to determine the impact on air and surface water temperatures.

4. Climate change prediction model output should be assessed to determine if the frequency and timing of high flow events is likely to change in the future. If high flow events that necessitate initiating the stanchion bay removal protocol are predicted to increase in frequency and/or shift in timing, the applicant should evaluate structural and/or operational alternatives that would mitigate adverse impacts of the existing flood management protocols.

Level of Effort and Cost

The level of cost and effort for the thermal loading analysis would be low to moderate. Collecting bathymetry in the three TransCanada headponds would take two staff less than one week to collect (it took the Kansas Biological Survey two days to collect bathymetry at a 3,500 acre lake; Jakubauskas et al. 2011). The remaining work would be desk-based; loading relevant information into an appropriate thermal loading model to compute the estimated thermal loading of each headpond and then comparing this information to surface water data from climate change prediction models.

The high flow flood protocol study is a desktop analysis that should require low cost and effort. Climate change models already exist and that output would be downloaded and analyzed. The remaining analysis requires a review of alternative means of managing flows without the use of stanchion bays.

The applicant did not propose any studies to meet this need in the PAD.

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Bellows Falls Hydroelectric Project – FERC No. 1855-045

Study Request 6: Bypass flow and habitat

Goals and Objectives

The goal of this study is to determine appropriate bypass flows meet Vermont surface water quality standards and that will protect and enhance the aquatic resources of the Bellows Falls bypass reach.

The objective of the study will be to evaluate the relationship between flow and habitat suitability in the bypass reach and evaluate the impacts of the "barrier dam" in the downstream portion of the bypass reach.

Resource Management Goals

The Connecticut River is considered Class B water by the states of Vermont. Vermont lists the section of the Connecticut River below the Wilder dam on the Section 303(d) impaired water list due to flow alterations impairing aquatic life and habitat. In Class B waters, Vermont's water quality standards state that water level fluctuation and flow alterations can only occur to the extent that it supports all uses and does not lead to degradation of the water resource or habitat.

The Agency's goals related to aquatic natural resources are to:

4. Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
5. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
6. Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.

Specific to aquatic resources within the Bellows Falls bypass reach, the Agency's goals are:

1. Protect, enhance, or restore, diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
2. Provide appropriate flows in the bypass reach that meets the life history requirements of resident fish and wildlife, including freshwater mussels and other benthic invertebrates.
3. Minimize current and potential negative project operation effects on water quality and aquatic habitat.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures under the Vermont Water Quality Standards.

Public Interest Consideration

The requester is a resource agency.

Existing Information

The Bellows Falls Project bypasses a 3,500 foot-long section of the Connecticut River. There is a small concreter barrier dam in the lower portion of the bypass reach which was installed to "prevent upstream migrating fish from being attracted by spillway discharge into the reach and later becoming trapped in isolated pools after the spill ends." Presently this bypass reach only receives flow when inflow exceeds the hydraulic capacity of the Bellow Falls station. According to exceedance curves provided in the PAD, on a monthly basis the bypass reach receives flow the following amount of time:

Month	**% time flow > 11,000 cfs**	**Month**	**% Time Flow >11,000 cfs**
Jan.	15	July	10
Feb.	15	August	8
March	50	Sept.	4
April	90	Oct.	20
May	60	Nov.	35
June	20	Dec.	26

No information exists on the adequacy of the existing bypass flow regime to protect water quality and aquatic life. The bypass reach receives flow less than 30% of the time on an annual basis. While TransCanada did conduct a preliminary water quality study in the summer of 2012 that indicated water quality at the bypass reach sample station was not meeting state water quality standards, only a summary of the data are provided in the PAD. It does not indicate where the sonde was located, nor the bypass reach conditions during the study period (e.g., what was the flow into the bypass reach during the study? Was the sonde located in the only wetted area of the bypass reach?). Further, the PAD provides no detailed description of the physical or biological characteristics of the bypass reach.

An empirical study is needed to provide information on the relationship between flow and habitat in the bypass reach for the Agency to use in determining appropriate flows in the bypass reach.

Project Nexus

The Project includes a 3,500-foot-long bypass reach. Absent a mandated discharge at the dam, this habitat would remain dewatered during those times when inflow was within the hydraulic capacity of the units (~70% of the time on an annual basis). The existing license does not require any flow through the bypass reach. The current situation does not sufficiently protect the aquatic resources inhabiting or potentially inhabiting the bypass reach.

The Connecticut River in the project vicinity is dominated by sections that are impounded, backwatered from downstream impoundments or otherwise deep and slow-flowing. In contrast, the Bellows Falls bypass channel is very irregular and diverse, consisting of both coarse substrate of various sizes and in the more downstream segment, jagged, irregular ledge. Given an adequate flow regime, the bypass could provide habitat types that are now rare and therefore of great importance.

Results of the flow study will be used by the Agency to determine an appropriate flow recommendation that will protect and/or enhance the aquatic resources in the bypass reach for the duration of any new license issued by the Commission.

Proposed methodology

The Agency requests a bypass flow study be conducted at the Project. Bypass flow habitat assessments are commonly employed in developing flow release protocols that will reduce impacts or enhance habitat conditions in reaches of river bypassed by hydroelectric projects.

Given the size of the bypass reach (3,500 feet long) and the rareness of the habitat types it contains in this portion of the Connecticut River, we believe a study methodology that utilizes an IFIM approach is appropriate for this site. This same protocol was used during the relicensing of the Housatonic River Project (FERC No. 2576),[1]and has been accepted by the Commission in other licensing proceedings[2].

Given the unique channel formation habitat modeling using standard PHABSIM 1-dimensional modeling may not be sufficient to assess the habitat suitability in the bypass reach but rather 2-dimensional, (2D) modeling may be needed to better characterize flows and velocities in this reach. We recommend that the approach to habitat modeling be determined during the study plan development stage based on consultations between the applicant and the resource agencies.

Level of effort and cost

The expected level of effort and anticipated costs will be comparable to that experienced on similar FERC relicensing projects of this size.

Field work for flow studies can be reasonably extensive but will depend on consultation with the applicant on study methodology and on-site decisions on locations for data collection and the number of collection locations. Post-fieldwork data analysis would be a moderate cost and effort. Field work associated with this study could be done in conjunction with the Instream Flow Study Request. We anticipate that the level of effort and costs will be comparable to that experienced on similar FERC relicensing projects (e.g., the Glendale Project, FERC No. 2801).

[1] Housatonic River Project License Application, Volume 4, Appendix F. Connecticut Light and Power Company, August 1999.

[2] Glendale Project (FERC No. 2801) Final Bypass Reach Aquatic Habitat and Instream Flow Study in Glendale Hydroelectric Project Application for Subsequent License (FERC No. 2801), Volume 2, Appendix B, pages 7-8, October 2007.

Wilder Hydroelectric Project – FERC No. 1892-026
Bellows Falls Hydroelectric Project – FERC No. 1855-045
Vernon Hydroelectric Project – FERC No. 1904-073

Study Request 7: In-stream flow habitat assessment of downstream reaches

Goals and Objectives

The goal of this study is to determine an appropriate flow regime that will protect and enhance the aquatic resources below the Wilder, Bellows Falls, and Vernon projects. Specifically, the objective of this study is to conduct an instream flow habitat study to assess the impacts of the range of proposed project discharges on the wetted area and optimal habitat for key species.

The study should include non-steady flow approaches to assess effects of within-day flow fluctuations due to peaking power operations on target fish species and benthic invertebrate communities. Target species will include but are not limited to: American shad, fallfish, white sucker, yellow perch, smallmouth bass, walleye, and dwarf wedge mussel.

Resource Management Goals

The Connecticut River is considered Class B water by the states of Vermont. Vermont lists the section of the Connecticut River below the Wilder dam on the Section 303(d) impaired water list due to flow alterations impairing aquatic life and habitat. In Class B waters, Vermont's water quality standards state that water level fluctuation and flow alterations can only occur to the extent that it supports all uses and does not lead to degradation of the water resource or habitat.

The Agency's goals related to aquatic natural resources are to:

7. Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
8. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
9. Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures under the Vermont Water Quality Standards.

Public Interest Consideration

The requestor is a state natural resource agency.

Existing Information

The distance from the upstream end of the Wilder impoundment downstream to the Vernon dam is 120 miles. A total of 97 miles (81%) of this segment is impounded. The remaining riverine habitat is within the 17 miles downstream of Wilder dam and the 6 miles downstream of Bellows Falls. At the scoping meetings, First Light also indicated that their project assessment may provide evidence that the upstream extent of the Turners Falls impoundment may not reach all the way to Vernon Dam. This would suggest that there may be additional riverine habitat for a presently unknown distance below the Vernon project.

The Wilder, Bellows Falls, and Vernon projects are each operated as daily peaking facilities. Total hydraulic capacity of each facility is 12,700, 11,010, and 12,634 cfs, respectively. Each of the PADs for these projects indicate that "Generation can vary during the course of any day between the required minimum flow and full capacity if higher flows are available" (p. 2-28, p. 2-29, and p. 2-30 in the Wilder, Bellows Falls and Vernon PADs, respectively). Regular daily fluctuations on the order of 9,000 cfs or greater are commonly recorded at USGS gages 01144500 (Connecticut River at West Lebanon, below Wilder Dam) and 01154500 (Connecticut River at North Walpole, NH, below Bellows Falls Dam). Required minimum flows are 675, 1,083, and 1,250 cfs (or inflows if less) for each facility, respectively, though in practice minimum flows are operated as 700, 1300, and 1600 cfs, respectively. The PADs for these projects do not indicate how these minimum flow requirements were established or what specific ecological resources they are intended to benefit. The Agency is not aware of any previously conducted studies that have evaluated the adequacy of this minimum flow in protecting aquatic resources in the 23+ miles of riverine habitat below these projects, nor project effects of daily hydropeaking on riverine habitat. Therefore, in order to fill this important information gap, an empirical study is needed to provide information on the relationship between flow and habitat in the Connecticut River downstream of the Wilder, Bellows Falls, and Vernon projects. Results will be used by the Agency to determine an appropriate flow recommendation.

Project Nexus

The Wilder, Bellows Falls, and Vernon projects are currently operated with a minimum flow release that was not based on biological criteria or field study. Further, the projects generate power in a peaking mode resulting in substantial within-day flow fluctuations between the minimum and project capacity. The large and rapid changes in flow releases from peaking hydropower dams are known to cause adverse effects on downstream habitat and biota (Cushman 1985, Blinn et al. 1995, Freeman et al. 2001). There are at least 23 miles of lotic (flowing) habitat below the project's discharge that are impacted by peaking operations from these projects. This section of the Connecticut River contains habitat that supports native riverine species, including the federally endangered dwarf wedge mussel, and could include spawning and rearing habitat for migratory fish such as American shad. While the existing licenses of the Wilder, Bellows Falls, and Vernon projects do require a continuous minimum flow of 675, 1,083, and 1,250 cfs, respectively, we do not believe this flow sufficiently protects the aquatic resources, including endangered species, of these river reaches, especially in the context of the magnitude, frequency, and duration of changes in habitat that likely occur due to hydropeaking operations.

Results of the flow study will be used by the Agency to determine an appropriate flow recommendation that will protect and/or enhance the aquatic resources below the Project.

Proposed Methodology

In-stream flow habitat assessments are commonly employed in developing operational flow regimes that will reduce the impacts or enhance habitat conditions downstream of hydroelectric projects.

The Service requests a flow study be conducted in the following areas: in the approximately 17 miles between the Wilder Dam and the headwaters of the Bellows Falls pool, in the approximately 6 miles between the Bellows Falls Dam and the headwaters of the Vernon pool, and in the approximately 1.5 miles between Vernon Dam and the downstream end of Stebbins Island (or the upstream extent of the Turners Pool as determined by First Light, whichever river length is greater).

Given the length of river reach (23+ miles) impacted by project operations, we believe a study methodology that utilizes an IFIM approach is appropriate for this context. Similar protocols have been used and accepted by FERC in numerous other licensing proceedings.

The study design should involve collecting wetted perimeter, depth, velocity, and substrate data along transects in the deep, straight-channel areas of the specified river reaches mentioned above. Two-dimensional hydraulic modeling should be conducted in the sections of river with more complex features such as islands, braiding, falls, and shallow-water shoals. The measurements should be taken over a range of flows sufficient to model the full extent of the operational flow regime. This information should then be synthesized to quantify habitat suitability (using mutually agreed-upon habitat suitability index (HSI) curves) over a range of flows for target species identified by the fisheries agencies. Data should be collected in such a way that allows a dual-flow analysis and habitat time series or similar approaches that will permit assessment of how quality and location of habitat for target species changes over the range of flows that occur as part of the operational flow regime.

Level of Effort and Cost

Field work for instream flow studies can be reasonably extensive but will depend on consultation with the applicant on study methodology and on-site decisions on locations for data collection and the number of collection locations. Use of laser measurements, GPS, and/or an Acoustic Doppler Current Profiler (ADCP, if available) can improve efficiency and accuracy of field measurements. Post-fieldwork data analysis would be a moderate cost and effort. We anticipate that the level of effort and costs will be comparable to that of other FERC relicensing projects of similar size to these projects.

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Wilder Hydroelectric Project – FERC No. 1892-026
Bellows Falls Hydroelectric Project – FERC No. 1855-045
Vernon Hydroelectric Project – FERC No. 1904-073

Study Request 8: Project effects on channel morphology and benthic habitat impacts

Goals and Objectives

It is well known that dams interrupt the downstream continuum of sediment supply and transport, which in turn can affect channel morphology and limit the amount of coarse (i.e. gravel/cobble) substrate available for aquatic biota. The Vernon, Bellows Falls and Wilder projects' effects on fluvial processes, channel formation and associated anadromous and riverine fish habitat, as well as aquatic invertebrate habitat, is unclear. This study request aims to provide information on coarse sediment supply and transport as it relates to aquatic benthic habitat (e.g. gravel bars). Results will be used to identify techniques to minimize and/or mitigate impacts to this valuable habitat.

The goal of this study is to understand how the projects affect bedload distribution, particle size and composition as it relates to habitat availability (amount and size of coarse substrate material) for different life-history stages of anadromous (e.g. sea lamprey) and riverine fishes (e.g. walleye), as well as invertebrates (e.g. mussels, tiger beetles).

The study objectives include:

1. Assess the distribution and extent of the existing substrate types, including gravel and cobble bars within the project affected areas.

2. Identify the current conditions of the channel and determine the stability of the present substrate/benthic habitat and identify if flow or sediment measures are necessary to improve the aquatic benthic habitat.

Resource Management Goals

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the VTFWD's mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).
Two of the Department's planning goals are:

1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.

2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

Gravel/cobble habitat is utilized by various riverine fish species during different life history stages and seasons, as it provides sites for spawning, feeding, and refuge (Gore and Shields 1995). Many fish species and aquatic invertebrates (e.g., fresh water mussels, snails, worms, and aquatic insects) live on or near gravel habitat, because it provides a source of food and cover (Miller 1988). Gravel bars also play an important role in water quality, hydrology, and morphology of rivers (Lewis 2005).

As identified in Vermont's Wildlife Action plan (Kart et al. 2005), several state listed mussel species are known to utilize gravel-type substrate. Furthermore, sea lamprey (*Petromyzon marinus*) spawning occurs over substrate composed of a mixture of sand, gravel and rubble. The sea lamprey, within the Connecticut River drainage, is one of New Hampshire and Vermont's Species of Greatest Conservation Need (SGCN). The conservation status of sea lamprey in New Hampshire is listed as "vulnerable." One of the threats identified in Vermont's Wildlife Action Plan (Kart et al. 2005) is degraded spawning habitat, which is second to habitat fragmentation. In support of VTFWD's mission, and the Vermont Water Quality Standards, gaining a better understanding of the benthic habitat present in project affected areas how projects operations may be affecting this habitat is important.

Public Interest Consideration

The requestor is a state natural resource agency.

Existing Information

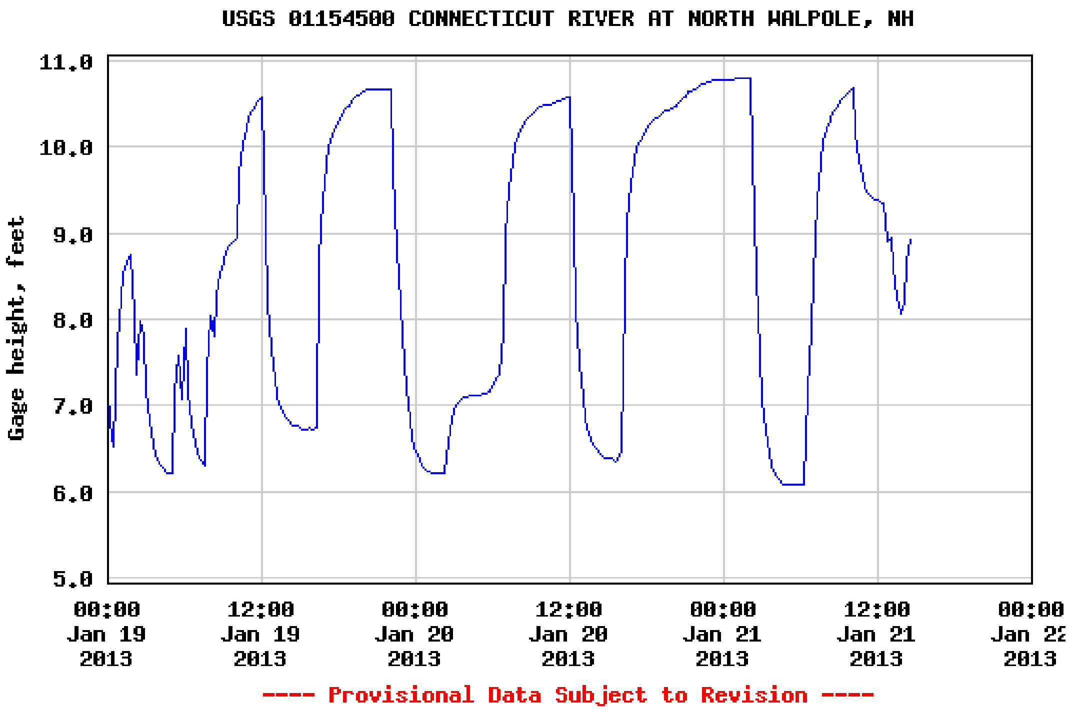
The PAD generally focusses on erosional impacts due to the projects' operations, but lacks specific information on fluvial geomorphic processes and substrate composition as it relates to impacts to aquatic benthic habitat. Recent studies assessing fluvial geomorphic process and substrate composition in Connecticut River tributaries have documented the impacts of regulated flows from dams on substrate composition, and the possible impacts on the mainstem of the river.

Curtis et al. (2010) utilized a combination of historical aerial photographs, mainstem- and tributary-channel pebble counts, and HEC-RAS flow modeling in the West and White River watersheds (tributaries to the Connecticut River). They documented the time series of post-regulation channel narrowing and associated bar growth due to the influx of tributary sediment. In the West River, Svendsen et al. (2009) quantified changes in channel bed morphology as a result of flow regulation. Utilizing bi-monthly cross-section data from the gauging stations they determined the mean water depth and bed elevation for each cross-section measurement during the pre-dam and post-dam periods. In addition, annual peak stream flow data for each station were used to calculate the flood recurrence, and surface grain distributions at sampling sites upstream and downstream of each tributary confluence using Wolman pebble counts. They found that the sediment load from tributaries are impacting the flow-regulated mainstem West River rather than ameliorating conditions, and that these impacts are reflected in the benthic community structure. These results indicate that environmental flows that mimic the natural hydrograph are needed in regulated reaches of river.

Project Nexus

Dams have major impacts on geomorphic processes, ecological function and in turn biotic communities. Changes to substrate composition can significantly affect aquatic life include stability of channel habitats, size distribution and embeddedness of substrate, and decreased habitat diversity and heterogeneity. The projects impound a large portion of the Lower Connecticut River that otherwise would be free flowing and would transport fine sediment downstream leaving larger substrate material (gravel/cobble) exposed to be utilized by aquatic biota. By interrupting the downstream continuum of sediment supply and transport, dams can result in increased bed scour and bank erosion downstream (Kondolf and Matthews 1993). Given the large number of mainstem dams on the Connecticut River, any gravel coming in from tributaries becomes very important to the system. However, many of the tributaries in the project reach have also been dammed, predominantly for flood control. Therefore, there is reason to be concerned about the effects the project dams are having on river processes and physical habitat. Currently, the projects operate as hydro-peaking facilities as is evident from the USGS stream flow gauge at North Walpole, NH; with large water releases below the dam that increase shear stress on the river bed, substrate is mobilized that otherwise would only be moved during seasonal high flow events. Operations of the existing TransCanada hydroelectric projects likely affect channel morphology and fluvial processes including substrate mobility, and particle size distribution. Project-induced changes to natural fluvial processes and channel morphology and substrate composition can have negative impacts on aquatic resources. For example, changes in sediment composition could relocate or decrease important walleye and sea lamprey spawning habitat. In a similar fashion, project-induced changes could make some habitats unsuitable for aquatic invertebrates, including the federally-endangered dwarf wedgemussel. The Vermont Agency of Natural Resources requests a study investigating the impacts of project operations on fluvial processes, substrate composition and stability as it relates to aquatic benthic habitat. Results of this study will be used to develop potential license requirements to protect aquatic habitat in the project-affected areas, and may be used to inform other studies that evaluate project effects on related resources. Possible mitigation measures could include gravel augmentation, changes in flow regulation, and instream channel restoration.

An example of the water level fluctuations that occur in Lower Connecticut River due to hydropower generation is shown below.



Proposed Methodology
Geomorphology studies are generally conducted during hydroelectric relicensing projects to determine channel condition, and substrate composition, and determine whether changes in project operations or sediment measures are necessary and/or whether channel restoration is necessary to improve aquatic benthic habitat.
The Agency recommends a methodology similar to previously approved FERC studies (FERC No. 2246 and 2206). Specific study methods include but are limited to utilizing a combination of historical aerial photographs, pebble counts, and HEC-RAS flow modeling to document and compare temporal changes in morphology and sediment transport dynamics in the Project effected areas.
Additional study methods can be found in the FERC Project No. 2246, Yuba County Water Agencies Study Plan Determination: Study 1.1. Lemonds (2006) also conducted an empirical-based study for the Yadkin-Pee Dee River Hydroelectric Project No. 2206.
The study plan should be developed in consultation with the Agency.

Level of Effort and Cost
At a minimum the study would require a combination of historical aerial photographs, pebble counts, and HEC-RAS flow modeling. Cross-section data from the gauging stations could be used to determine the mean water depth and bed elevation for each cross-section measurement. TransCanada has not proposed any studies to meet this need.

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Vernon Hydroelectric Project – FERC No. 1904-073

Study Request 9: Juvenile shad outmigration

Goals and Objectives

Determine if project operations affect juvenile American shad outmigration survival, recruitment, and production. The following objectives will address this request:

- Assess project operation effects of Vernon Dam on the timing, routes, migration rates, and survival of juvenile shad;
- Determine the proportion of juvenile shad that as a downstream passage route choose or are directed to existing downstream bypass structures, gate structures, or are entrained into the station turbines and assess delay, survival, timing, and related impacts with these locations under a full range of operational conditions, over the period of outmigration;
- Determine survival rates for juvenile shad entrained into Vernon Station units.

If it is determined that the project operations or related effects are adversely affecting juvenile shad survival, migration timing, or other deleterious population effects are noted, identify operational solutions or other solutions that will reduce and minimize impacts, within the project affected area. This study will require two years of field data to capture inter-annual variability of river discharge, water temperature, and variability in run size and juvenile production (and timing of developmental stages) and variability in outmigration timing which may relate to spring, summer and fall conditions.

Resource Management Goals

The Agency's goals related to aquatic natural resources are to:

1. Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
3. Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the VTFWD's mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).

Two of the Department's planning goals are:

1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.
2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

Vermont Fish and Wildlife Department's Strategic Plan (2002 -2010) focuses towards four major areas of concern: resource conservation, fish and wildlife-based recreation and use, human health and safety, efficient operations, and effective management.

The Connecticut River Atlantic Salmon Commission (CRASC) was established by Congress in 1983 (and reauthorized in 2002 for another 20 years) through the Connecticut River Atlantic Salmon Compact (Public Law 98-138). The Vermont Fish and Wildlife Department is a CRASC member agency, and a senior biologist from the department serves on the Technical Committee. The Connecticut River Atlantic Salmon Commission developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following:

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.
2. Maximize outmigrant survival for juvenile and spent adult shad.

The Atlantic States Marine Fisheries Commission Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010 includes the following objective:

- Maximize the number of juvenile recruits emigrating from freshwater stock complexes.

The Agency seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to American shad, the Agency's goals are:

- Minimize current and potential negative project operation effects on juvenile American shad survival, production, and recruitment.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), and the Federal Power Act (16 U.S.C. §791a, *et seq*.).

Public Interest Consideration

The requestor is a resource agency.

Existing Information

Adult shad are counted annually as they pass above the Vernon Dam. Juvenile American shad production has been monitored upstream of the Vernon Dam and immediately downstream of that dam by Vermont Yankee Nuclear as part of an annual monitoring program using both boat electrofishing (since 1991) and beach seining (since 2000). A seasonal average annual index of juvenile American shad standing crop in Vernon reservoir has been calculated since 2000. Estimates of juvenile shad growth rates in the Vernon impoundment have been calculated annually beginning in 2004, and also in a study conducted in 1995 (Smith and Downey 1995).

Although there were numerous studies of downstream passage facilities at the Vernon Project for Atlantic salmon smolts, studies passage studies for American shad were limited to tests in 1991 and 1992 of a high frequency sound field to guide fish to the fish pipe, the primary downstream fishways in 1991 and 1992 (RMC 1993). Although the studies were deemed incomplete, the technology indicated some level of response by juvenile shad. However, despite that conclusion, there is no indication that this technology or other downstream passage studies with juvenile shad were subsequently pursued.

Project Nexus
Juvenile American shad production occurs in the river reach between the Vernon Dam and the Bellows Falls Dam, which is thought to be the historic upstream limit of the shad migration in the Connecticut River. Juvenile American shad require safe and timely downstream passage measures to have the opportunity to contribute to the restoration target population size.

There is little information available regarding the total impact of the Vernon project on downstream migration of juvenile shad. Migration delays, increased predation, mortality during passage over the dam or through turbines, and changes in route selection under different flow conditions are potential influences of the Vernon Dam on the juvenile shad population in the upper Connecticut River. Effective upstream and downstream passage and successful in-river spawning and juvenile production are necessary to help achieve shad management restoration goals for the Connecticut River, particularly in the upstream reaches. Delays in juvenile American shad outmigration may affect survival rates in the transition to the marine environment (Zydlewski et al. 2003).

Proposed Methodology
The impact to juvenile shad outmigrants would be best studied by a combination of approaches including hydroacoustics, radio telemetry (including passive integrated transponder (PIT) telemetry), and turbine balloon tags. Project discharge adjustments at the dam should be examined relative to timing, duration, and magnitude of juvenile shad migration to and through the dam, with hydroacoustic equipment for natural/wild fish information. In addition, study fish should be collected and tagged (PIT, radio, balloon) to then empirically determine rates of survival for fish passed through the project under varied operations, from minimum flows up to full spill conditions. The release of tagged fish (radio, PIT) at a number of potential sites will provide data on delay and route selection as juvenile shad move through the Vernon project area. The number and location of release sites will depend on the availability of tagged fish.

Additional hydroacoustic assessment immediately upstream and downstream of the Vernon Dam will provide information on the timing of migration to and through this area. A more focused survival study, using balloon tags, PIT tags, or other appropriate methods, should be conducted in the second year based upon the first year of study findings relative to the frequency, magnitude, timing, and route selection of juvenile American shad through the Vernon project.

Level of Effort and Cost

TransCanada does not propose any studies to meet this need. Estimated cost for the study is expected to be up to $150,000 with the majority of costs associated with equipment (hydroacoustic gear, radio tags, radio receivers, and PIT readers) and related fieldwork labor.

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Turners Falls Hydroelectric Project – FERC No. 1889-081
Northfield Mountain Pumped Storage Project – FERC No. 2485-063

Study Request 9: Juvenile shad outmigration

Goals and Objectives

Determine if project operations affect juvenile American shad outmigration survival, recruitment, and production. The following objectives will address this request:

- Assess project operations effects of NMPS and Turners Falls Dam on the timing, orientation, routes, migration rates, and survival of juvenile shad;
- Determine the proportion of juvenile shad that select the Gatehouse into the power canal versus the dam spill gates as a downstream passage route, under varied operational conditions, including a range of spill conditions up to full spill;
- Determine if there are any delays with downstream movement related to either spill via dam gates or through the Gatehouse and within the impoundment due to operations (i.e., NMPS pumping and generation);
- Determine survival rates for juvenile spilled over/through dam gates, under varied operation conditions, including up to full spill during the annual fall power canal outage period;
- Determine the juvenile downstream passage timing and route selection in the power canal to: Station 1; Cabot Station; and the Cabot Station log sluice bypass, and assess delays associated with each of these locations and with project operations (e.g., stockpiling in the canal);
- Based upon year 1 study results on route selection, determine the survival rate for juvenile shad entrained into Station 1; and
- Determine the survival rates for juvenile shad entrained into Cabot Station units;

If it is determined that the Project operations are adversely affecting juvenile shad survival, migration timing, or other deleterious population effects , identify operational solutions or other passage measures that will reduce and minimize these impacts within the project area. This study will require two years of field data to capture inter-annual variability of river discharge, water temperatures, and variability in the timing and abundance of juvenile production and their outmigration timing, which may relate to spring, summer, and fall conditions. This study will compliment the NMPS Fish Entrainment Study Request which includes assessment of impacts to juvenile shad.

Resource Management Goals

The Agency's goals related to aquatic natural resources are to:

1. Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
3. Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the VTFWD's mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).

Two of the Department's planning goals are:

1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.
2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

Vermont Fish and Wildlife Department's Strategic Plan (2002 -2010) focuses towards four major areas of concern: resource conservation, fish and wildlife-based recreation and use, human health and safety, efficient operations, and effective management.

The Connecticut River Atlantic Salmon Commission (CRASC) was established by Congress in 1983 (and reauthorized in 2002 for another 20 years) through the Connecticut River Atlantic Salmon Compact (Public Law 98-138). The Vermont Fish and Wildlife Department is a CRASC member agency, and a senior biologist from the department serves on the Technical Committee.

The Connecticut River Atlantic Salmon Commission developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following:

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.
2. Maximize outmigrant survival for juvenile and spent adult shad.

The Atlantic States Marine Fisheries Commission *Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management*), approved in 2010 includes the following objective:

- Maximize the number of juvenile recruits emigrating from freshwater stock complexes.

and Recommendation:

- To enhance survival at dams during emigration, evaluate survival of post spawning and juvenile fish passed via each route (e.g., turbines, spillage, bypass facilities, or a combination of the three) at any given facility, and implement measures to pass fish via the route with the best survival rate.

The Agency seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.

2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to American shad, the Agency's goals are:

- Minimize current and potential negative project operation effects on juvenile American shad survival, production, and recruitment.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), Silvio O. Conte National Fish and Wildlife Refuge Act (P.L. 102-212; H.R. 794), the Federal Power Act (16 U.S.C. §791a, *et seq*.), the Atlantic States Marine Fisheries Compact (P.L. 539, 77th Congress, as amended by P.L. 721, 81st Congress), and the Atlantic Coastal Fisheries Cooperative Management Act (16 U.S.C. 5107).

Public Interest Consideration

The requestor is a resource agency.

Existing Information

Since the construction of the Turners Falls Dam upstream fishways in 1980, American shad have had access to spawning and rearing habitat upstream of Turners Dam. A number of modifications to the Turners Falls fishways have occurred since that time, with the numbers of adult shad passed at Gatehouse Ladder (into Turners Falls Dam impoundment) reaching as much 60,089 in 1992 when a record 721,764 shad passed upstream of Holyoke Dam. However, since 1980 an average of only 3.6 % of the adult shad passed upstream of Holyoke Dam subsequently have passed upstream of Turners Falls Dam, and this value has never exceeded 11%. This value is well below the CRASC 1992 Shad Plan objective of 40-60% passage from the previous dam. In addition, population number and passage numbers past Holyoke have declined substantially, with the average Holyoke passage number over the last 10 years being 211,850. Because historic data suggests that approximately half the returning adult shad to the Connecticut River pass the Holyoke Dam, recent adult returns are far below management goals. Effective upstream and downstream passage and successful in-river spawning and juvenile production are necessary to help achieve shad management restoration goals for the Connecticut River, which extends to the Bellows Falls Dam. In 1990, FirstLight's predecessor, Northeast Utilities, CRASC and its member agencies, signed an MOA on downstream fish passage to address both juvenile and adults at the Turners Falls Project and Northfield Mountain Pumped Storage Project.

American shad broadcast spawn with the highest spawning activity occurring in runs and lowest activity in pools and riffle/pools (Ross et al. 1993). Field research by Ross et al. (1993) in the Delaware River further noted that a combination of physical characteristics that seems to be avoided by spawning adults is slow current and greater depth. American shad year-class strength has been shown to depend on parent stock size and environmental conditions during the larval life stages (Creeco and Savoy 1984). Delays in juvenile American shad outmigration may affect survival rates in the transition to the marine environment (Zydlewski et al. 2003). One published study on the Connecticut River, identified that juvenile shad outmigration began when declining autumn temperatures reached 19C and peaked at 16C (O'Leary and Kynard 1986).

Juvenile American shad production has been monitored upstream of the Vernon Dam and immediately downstream of that dam by Vermont Yankee Nuclear as part of an annual monitoring program using both boat electrofishing (since 1991) and beach seining (since 2000). Sampling of juvenile shad was also conducted by a contractor hired by Northeast Utilities in the Turners Falls impoundment in 1992. O'Donnell and Letcher (2008) examined juvenile shad early life history and migration upstream and downstream of Turners Falls Dam. Their study results led to the decision by the agencies to require earlier operation of downstream fishways to protect early season juvenile shad out-migrants (1 September prior to 2010, 15 August in 2010, and since 2011, 1 August).

Downstream juvenile clupeid passage studies at Turners Falls were conducted in the fall of 1991 which included the objectives of determining the percentage of juvenile shad and herring that pass via the bypass log sluice or that were entrained in the Cabot Station turbines and related data (e.g., catch rates) were compared. The 1991 Downstream Clupeid Study did not assess survival rates for juveniles for either of these passage routes. The 1991 study report documented a higher rate entrainment into the project turbines (23.0 fish per minute) versus through the bypass sluice (11.6 fish per minute). It was concluded that only an estimated 54% (average bypass rate, weighted by estimated number bypassed) of the juvenile American shad approaching Cabot Station were bypassed via the log sluice. The range of the percent bypassed varied widely by date, between nearly 0 and 83%, with 'no clear explanation as to why." The report did not identify the percentage entrained into the turbines but it can be reasoned to be substantial based on the data presented in the report or assumed as the remaining balance (46%). as there were no spill events reported during this study, and therefore nowhere else for them to pass. It was further noted that entrainment rates for juveniles were consistently greatest for units 1 and 6 (ends), not uniform across all units. Although no concurrent bypass sampling occurred during the first entrainment sampling events, it was noted that "entrainment rates were relatively high during the end of September." Additional modifications have occurred over time without quantitative evaluation to improve downstream passage attraction and use to the bypass sluice, including lighting systems.

The 1994 Downstream Juvenile Shad Study report assessed juvenile shad survival from passage via the log sluice, reported to be 98%, based on tagged and recaptured fish (held for up to 48 hours). Scale loss (<20%) (22 of treatment fish) compared with scale loss of >20% (5 of treatment fish) was examined and determined to occur in an overall total of 10% of study fish (adjusted by control fish data).

Project Nexus
Adult American shad passed upstream of Turners Falls Dam utilize upstream spawning habitat. Juvenile American shad production occurs in these habitats upstream of Turners Falls Dam on an annual basis. Juvenile American shad require safe and timely downstream passage measures to have the opportunity to contribute to the fishery agencies' target restoration population size.

The Agency is not aware of any studies being conducted specifically designed to determine:

- When spill gates are open at the Turners Falls Dam?;
- What proportion of juvenile outmigrant shad take that route of passage?;
- What is the rate of survival under a range of spill and gate configurations?
- What is the timing, duration, and magnitude of juvenile shad outmigrants in summer and fall to the Turners Falls Dam and Gatehouse?
- Are there delays in migration/movement at the dam, Gatehouse, Cabot Station, or Station 1?
- For juveniles that enter the power canal, what proportion subsequently enter the Station 1 power canal?
- As there is no downstream passage facilities at Station #1, and trash rack spacing is 2.6 inches, what is the survival rate of juvenile shad entrained at Station #1?
- What is the rate of movement through the Turners Power Canal, relative to r delay to outmigrant juvenile shad and the potential accumulation of juveniles (e.g., prior to the canal drawdown in September)?
- What proportion of juvenile shad use the downstream sluice bypass versus the Cabot Station turbines under varied operational conditions given that project operations may change (PAD notes possible increase in turbine capacity at Cabot)?
- Based upon earlier facility studies (1991 Downstream Clupeid) a large proportion and number of juvenile shad are entrained into Cabot Station turbines. What are the associated impacts in terms of short-term and longer term survival and injury (i.e., scale loss)?

The Agency is concerned that project operations may impact juvenile shad outmigration survival and be contributing to the failure of the Connecticut River shad population to meet management targets. In the PAD, proposed modification include; Station 1 may be upgraded with new turbines, Station 1 may be closed, and/or the turbine capacity at Cabot may be increased. It is unclear how these scenarios will affect the questions identified in this request.

Proposed Methodology

The impact to juvenile shad outmigrants by project operations would be best studied by a combination of approaches including hydroacoustic, radio telemetry, and turbine balloon tags. Project discharge over a full range of existing and, to the extent possible, potential future operational conditions at Station 1 and Cabot, at the dam (likely increased bypass reach flows in new license) and in relation to the Gatehouse, should be examined relative to timing, duration, and magnitude of juvenile shad migration to and through these areas, with hydroacoustic equipment for natural/wild fish evaluation. In addition, study fish should be collected and tagged (PIT, radio, other mark, balloon) to also empirically determine rates of survival for fish passed over or through the dam’s gates, under varied operations, including up to full spill condition that occurs annually in fall with canal outage period. The understanding of the timing, magnitude, duration of the wild fish outmigration will help inform the design, data/results, and assessment of tagged study fish. The release of tagged or marked fish (radio, PIT) upstream of the Gatehouse induction into the power canal, will provide data on concerns of delay and route selection to Station 1, Cabot Station downstream bypass, Cabot Station spill gates, and Cabot Station turbines. Additional hydroacoustic assessment at Cabot Station forebay will provide information on wild/natural juvenile fish timing, magnitude, and duration to and through this area. Based upon Year 1 study findings relative to the frequency, magnitude, timing of juvenile American shad that end up in the forebay of Station 1, the determination of whether an entrainment survival study at that site is necessary will be made. Release sites for tagged fish will be determined based upon further consultation among the parties.

Radio tagged juvenile shad will be released in areas upstream of the NMPS facility at multiple release locations, to determine operation effects on migration rates, route, orientation, entrainment, and survival, over a full range of permitted and operational conditions.

Level of Effort and Cost

First Light does not propose any studies to meet this need. Estimated cost for the study is expected to be high, between $200,000 and $300,000, with the majority of costs associated with equipment (hydroacoustic gear, radio tags, radio receivers, and PIT readers) and related fieldwork labor.

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Vernon Hydroelectric Project – FERC No. 1904-073

Study Request 10: Shad population model for the Connecticut River

Goals and Objectives

Develop an American shad annual step, mathematical simulation population model for the Connecticut River to quantify how project operations and potential restoration/mitigation measures impact the population of shad in the Connecticut River.

The goal of the model is to assess impacts of both upstream and downstream passage at each of the Connecticut River projects and potential management options for increasing returns to the river.

Specific objectives include:

- Annual projections of returns to the Connecticut River;
- A deterministic and stochastic option for model runs
- Life history inputs of Connecticut River shad
- Understanding the effect of upstream and downstream passage delay at projects
- Calibration of the model with existing data
- Analysis of the sensitivity of model inputs
- Analysis of sensitivity to different levels of up- and downstream passage efficiencies at all projects
- Multiple output formats including a spreadsheet with yearly outputs for each input and output parameter

Resource Management Goals

The Agency's goals related to aquatic natural resources are to:

1. Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
3. Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the VTFWD's mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).

Two of the Department's planning goals are:

1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.

2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

Vermont Fish and Wildlife Department's Strategic Plan (2002 -2010) focuses towards four major areas of concern: resource conservation, fish and wildlife-based recreation and use, human health and safety, efficient operations, and effective management.

The Connecticut River Atlantic Salmon Commission (CRASC) developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following:

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.
2. Achieve annual passage of 40 to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem.
3. Maximize out-migrant survival for juvenile and spent adult shad.

The Service seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to American shad, the Service's goals are:

- Minimize current and potential negative project operation effects on American shad spawning and recruitment.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), and the Federal Power Act (16 U.S.C. §791a, *et seq*.).

Public Interest Consideration
The requestor is a resource agency.

Existing Information
Since the construction of the first fish lift facility at Holyoke Dam in 1967, American shad have had access to spawning and rearing habitat upstream from Holyoke Dam. A number of improvements to the Holyoke fishway have occurred since that time, but while the numbers of shad lifted at Holyoke have reached as much as 721,764 and the overall shad population to the river exceeded 1.6 million shad in 1992 (CRASC 1992), total shad populations, and numbers of shad passing Holyoke, Turners Falls and Vernon Dam have not met CRASC management goals.

Population and passage numbers past Holyoke have declined substantially from those totals in recent years, with average Holyoke passage numbers since 2000 of 229,876. Whole river population estimates have shown that approximately half of the returning population of shad pass upstream of Holyoke. Recent returns to Holyoke are far below management goals. Average passage efficiency of shad at Turners Falls (Gatehouse counts) and Vernon since 2000 has been 3.1 and 20.4 % respectively. These too are well below the CRASC management goals.

Safe, timely and effective up- and downstream passage along with successful spawning and juvenile production are necessary to help achieve shad management goals for the Connecticut River.

Project Nexus

Existing project operations and fish ladder efficiencies have a direct effect on shad populations in the Connecticut River. Poor upstream passage efficiencies and delays restrict river access to returning shad. Fish unable to reach upriver spawning grounds may not spawn or have reduced fitness or survival of young. Poor downstream passage survival and downstream passage delays affect outmigration and consequently repeat spawning, an important ecological aspect of the iteroparous Connecticut River shad population (Limberg et al. 2003).

The Service is concerned that poor passage efficiencies and delays at projects may be limiting access to upstream reaches of the river, altering spawning behavior, decreasing outmigration survival and contributing to the failure of the Connecticut River shad population to meet management targets (Castro-Santos and Letcher 2010).

Development of a population model will allow an assessment of individual project impacts on the population as well as the cumulative impacts of multiple projects. The model will allow managers to direct their efforts in the most efficient manner toward remedying the conditions that most impact the shad population.

Proposed Methodology

Population models are commonly used to assess anthropomorphic and natural impacts and are consistent with accepted practice. A model similar to this request was constructed for the Susquehanna River by Exelon (FERC #405, RSP 3.4). The model is constructed in Microsoft Access

Specific parameters that would be included in the model:

- Upstream passage efficiency at Holyoke, Turners Falls (Cabot, Gatehouse and Spillway Ladders), Vernon fishways, and any impacts associated with Northfield Mountain.
- Distribution of shad approaching the Turners Falls project between the Cabot Ladder and the spillway at the dam
- Downstream passage efficiencies at Vernon, Northfield Mountain, Turners Falls, and Holyoke projects for juveniles and adults
- Entrainment at Mount Tom and Vermont Yankee
- Sex ratio of returning adults
- The proportion of virgin female adults returning at 4, 5, 6, and 7 years

- The proportion of repeat spawning females at 5, 6 and 7 years
- Spawning success of females in each reach
- Fecundity
- Percent egg deposition
- Fertilization success
- Larval and juvenile in-river survival
- Calibration factor to account for unknown parameters such as at sea survival
- Options for fry stocking and trucking as enhancement measures
- Start year and model run years
- Start population
- Rates of movement to and between barriers
- Temperature, river discharge, and other variable of influence to migration and other life history events

The model should be adaptable to allow the input of new data and other inputs.

Level of Effort and Cost

Neither First Light nor TransCanada have proposed any study to meet this need. Estimated cost for the study is expected to be low to moderate. As the model describes the impacts of multiple projects and two owners, both project owners would share the cost of model development.

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Bellows Falls Hydroelectric Project – FERC No. 1855-045
Vernon Hydroelectric Project – FERC No. 1904-073
Turners Falls Hydroelectric Project – FERC No. 1889-081
Northfield Mountain Pumped Storage Project – FERC No. 2485-063

Study Request 11: Impact of project operations on shad spawning, spawning habitat and egg deposition

Goals and Objectives

Determine if project operations (under the permitted and proposed operational ranges) affect American shad spawning site use and availability, spawning habitat quantity and quality, and spawning activity in the river reaches downstream from Cabot Station and in the project bypass reach of Turners Falls Dam, in the Turners Falls Dam impoundment and in relation to Northfield Mountain Pump Storage operations, downstream and upstream of the Vernon Dam, and in the project area downstream of Bellows Falls Dam. The following objectives will address this request:

- Determine areas utilized by American shad for spawning by conducting night-time visual observation of spawning activity, identify and define areas geospatially, and obtain data on physical habitat conditions effected by project operations (e.g., water depth, velocity, discharge, substrate, exposure and inundation of habitats);
- Determine project operation effects on observed spawning activity, under a range of permitted or proposed project operation conditions;
- Quantify effects (e.g., water velocity, depths, inundation, exposure of habitats) of project operation on identified spawning areas for a range of conditions, over the complete period of spawning activity;
- Quantify spawning activity as measured by night-time spawning/splash surveys and egg collection in areas of spawning activity, and downstream of these areas, to further determine project operation effects (location extent of exposure from changing water levels and flows and on associated habitats from project operations).

If it is determined that the Project operations are adversely affecting the spawning activity of American shad and impacting spawning area habitat, identify operational regimes that will reduce and minimize impacts spawning habitat and spawning success, within the project area. This study will require two years of field data to capture inter-annual variability to river discharge and water temperatures and to allow for evaluation of alternative flow regimes if year one studies determine that the present peaking regime negatively affects spawning.

Resource Management Goals

The Connecticut River Atlantic Salmon Commission (CRASC) was established by Congress in 1983 (and reauthorized in 2002 for another 20 years) through the Connecticut River Atlantic Salmon Compact (Public Law 98-138). The Vermont Fish and Wildlife Department is a CRASC member agency, and a senior biologist from the department serves on the Technical Committee.

The Connecticut River Atlantic Salmon Commission developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following:

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.
2. Achieve annual passage of 40% to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem.

The Atlantic States Marine Fisheries Commission, Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010 includes the following objective:

1. Maximize the number of juvenile recruits emigrating from freshwater stock complexes and recommendations:
2. To mitigate hydrological changes from dams, consider operational changes such as turbine venting, aerating reservoirs upstream of hydroelectric plants, aerating flows downstream, and adjusting in-stream flows.
3. Natural river discharge should be taken into account when instream flow alterations are being made to a river (flow regulation) because river flow plays an important role in the migration of diadromous fish.
4. Ensure that decisions on river flow allocation (e.g., irrigation, evaporative loss, out of basin water transport, hydroelectric operations) take into account instream flow needs for American shad migration, spawning, and nursery use, and minimize deviation from natural flow regimes.
5. When considering options for restoring alosine habitat, include study of impacts and possible alteration of dam-related operations to enhance river habitat.

The Agency's goals related to aquatic natural resources are to:

1. Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
3. Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the VTFWD's mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).

Two of the Department's planning goals are:

1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.

2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

Vermont Fish and Wildlife Department's Strategic Plan (2002 -2010) focuses towards four major areas of concern: resource conservation, fish and wildlife-based recreation and use, human health and safety, efficient operations, and effective management.

The Agency seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to American shad, the Agency's goals are:

- Minimize current and potential negative project operation effects on American shad spawning and recruitment.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), Silvio O. Conte National Fish and Wildlife Refuge Act (P.L. 102-212; H.R. 794),The Federal Power Act (16 U.S.C. §791a, *et seq*.), The Atlantic States Marine Fisheries Compact (P.L. 539, 77th Congress, as amended by P.L. 721, 81st Congress), and the Atlantic Coastal Fisheries Cooperative Management Act (16 U.S.C. 5107).

Public Interest Consideration

The requestor is a state resource agency.

Existing Information

Since the construction of the first fish lift facility at Holyoke Dam in 1967, American shad have had access to spawning and rearing habitat upstream from Holyoke Dam. A number of improvements to the Holyoke fishway have occurred since that time, but while the numbers of shad lifted at Holyoke have reached as much as 721,764 and the overall shad population to the river exceeded 1.6 million shad in 1992 (CRASC 1992), total shad population, and numbers of shad passing Turners Falls and Vernon Dam have not met CRASC management plan objectives. Population number and passage numbers past Holyoke have declined substantially from those totals in recent years, with average Holyoke passage numbers over the last 10 years of 211,850. Since historically approximately half of the returning population of shad to the river passed upstream of Holyoke, recent returns are far below management goals. Effective upstream and downstream passage and successful in-river spawning and juvenile production are necessary to help achieve shad management goals for the Connecticut River.

American shad broadcast spawn in congregations over shallow flats and rocky or sandy substrates (Davis et al, 1970, Mansuetti and Kolb 1953), at depths less than 10 feet and often far shallower with spawning fish swimming vigorously near the surface in a closely packed circle (Marcy 1972, Mackenzie et al 1985). Fertilized eggs drift downstream until hatching (Mackenzie et al 1985).

American shad are known to spawn downstream from the Turners Falls Project. Layzer (1974) identified 6 spawning sites from an area below the mouth of the Deerfield River (river mile 191.9) to river mile 161.7 below the Mill River in Hatfield, MA. Kuzmeskus (1977) verified 16 different spawning sites ranging from downstream of the Cabot tailrace to just upstream of the Holyoke dam (river mile 87.1). The only parameter that all spawning sites had in common was current (Kuzmeskus 1977). The Agency is not aware of any more recent studies that document whether these 16 sites are still viable spawning locations for shad. We are not aware of any studies that have determined American shad spawning habitat or spawning sites upstream of Vernon Dam to Bellows Fall Dam (historic extent of upstream range).

First Light Power conducted studies in the late spring and summer of 2012, examined habitat conditions downstream of the Turners Falls Dam. The study documented that in low flow conditions, Cabot Station project operations produced fluctuations in water level elevations that can range over 4 feet in magnitude (daily operation) at the USGS Montague Gage Station, to lower values of 2 to 3 feet at the Route 116 Bridge, Sunderland, MA (PAD). Similar short-term, limited monitoring in the upper Turners Falls Dam impoundment identified water level changes due to project operations that d cyclically varied several feet on a sub-daily frequency.

Project Nexus
American shad are known to spawn at five locations downstream from the Turners Falls Project from an area below the mouth of the Deerfield River (river mile 191.9) and ten other locations downstream to river mile 161.7 below the Mill River in Hatfield (Layzer 1974, Kuzmeskus 1977).

Shad spawning is likely influenced by river flow, which fluctuates greatly due to the project's peaking mode of operation. These fluctuations may impact shad spawning activity by altering current velocities and water depth at the spawning sites. Effects on spawning behavior could include suspension of spawning activity, poor fertilization, flushing of eggs into unsuitable habitat due to higher peaking discharges, eggs dropping out into unsuitable substrate and being covered by sediment deposition and/or eggs becoming stranded on dewatered shoal areas as peak flows subside.

While a number of shad spawning and egg deposition studies were conducted in the 1970s, that research was aimed at assessing the potential impact of developing a nuclear power station in the Montague Plains section of the Connecticut River. The Agency is not aware of any studies being conducted specifically designed to determine if a relationship between spawning behavior, habitat use, and egg deposition and project operations effects of the Turners Falls, Northfield Mountain Pump Storage and Vernon projects and downstream of Bellows Falls Dam..

The Agency is concerned that peaking operations may be altering spawning behavior and contributing to the failure of the Connecticut River shad population to meet management targets.

Proposed Methodology

The first year of study should examine known spawning areas downstream of the Turners Falls Dam project, to determine operation effects on shad spawning behavior, activity, and success. In areas upstream of Turners Falls Dam to the Bellow Falls Dam tailrace, the study should identify areas utilized for spawning by American shad. In the second year, should results from year one determine project operations affected spawning activity, access to habitat, or success, downstream of Turners Falls Dam, then an identical more detailed assessment (identified objectives) should be conducted in spawning areas upstream of Turners Falls Dam to the Bellows Falls Dam tailwater. Measures to reduce or eliminate any documented project operation impacts should be explored and evaluated in year two, downstream of Turners Falls Dam.

The impacts to spawning behavior would best be studied by night-time observations of actual in-river spawning behavior (Ross et al. 1993). Project discharge increases or decreases during actual observed spawning activity will provide empirical evidence of change in behaviors. The observational methodology should follow the protocol specified in Layzer (1974) and/or as described in Ross et al. (1993). The analysis should utilize the observational field data in conjunction with operational data from the projects (station generation and spill on a sub-hourly basis). To assess the impacts of changes in generation flows, the study should include scheduled changes in project operation to ensure that routine generation changes that occur during the nighttime spawning period affect downstream spawning habitats selected for study while shad are spawning. Stier and Crance (1985) provide optimal water velocities during spawning to range between 1 to 3 ft/sec.

In areas used for spawning, the characteristics of those areas (e.g., location, depth, flow, substrate) should be recorded. The effect of project operations (discharge, water velocity, inundation and exposure) should be assessed. Drift nets will be used to collect eggs to quantify egg production before and after flow changes at the spawning site.

In the reaches above the Turners Falls dam, night time observations of splashing associated with shad spawning should be done in each reach as sufficient numbers of shad are passed above each dam. Observations should be done regularly until the end of the spawning season. The use of radio-tagged adult shad from a separate Study Request will aid in this effort. An estimate of the total area used for spawning and an index of spawning activity should be recorded for each site.

Level of Effort and Cost

Neither First Light or TransCanada propose any studies to meet this need. Estimated cost for the study is expected to be moderate (up to $40,000) for each owner, with the majority of costs associated with fieldwork labor.

Literature Cited

Atlantic States Marine Fisheries Commission. 2010. Amendment #3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management). Washington, D.C.

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Vernon Hydroelectric Project – FERC No. 1904-073
Turners Falls Hydroelectric Project – FERC No. 1889-081
Northfield Mountain Pumped Storage Project – FERC No. 2485-063

Study Request 12: Telemetry study of upstream and downstream migrating adult American shad to assess passage routes, effectiveness, delays, and survival

Goals and Objectives

Assess behavior, approach routes, passage success, survival, and delay by adult American shad as they encounter the projects during both upstream and downstream migrations, under permitted project operations conditions, proposed operational conditions, and study treatment operational conditions at First Light Power's Turners Falls and Northfield Mountain Pumped Storage projects and TransCanada's Vernon Project. There are multiple fishways and issues related to both upstream and downstream passage success at the projects. Some of these issues at the Turners Falls Project are similar to and/or pertain directly to the Northfield Mountain and Vernon projects. Therefore, it is reasonable to address passage issues at all projects in a similar manner.

Telemetry Study - This requested study requires use of radio telemetry using both radio and Passive Integrated Transponder (PIT) tag types to provide information to address multiple upstream and downstream fish passage issues. The following objectives shall be addressed in these studies:

- Assessment of any migration delays resulting from the presence of the dam and peaking flow operations of the Turners Falls Project;
- Determine route selection and behavior of upstream migrating shad at the Turners Falls Project under various spill flow levels (e.g., movement to the dam, attraction to Cabot Station, attraction to Station 1 discharge, movement between locations, delay, timing, etc.). A plan and schedule for dam spill flow releases will need to be developed that provides sufficient periods of spill flow conditions, and various generating levels from Turners #1 Station coupled with Cabot Station generation flows (e.g., treatments will require multiple days of consistent discharge). Evaluated spill flows should include flows between 2,500 – 6,300 cfs, which relate to bypass flows identified as providing spawning opportunities for shortnose sturgeon in the lower bypass reach at the Rock Dam. (Kieffer and Kynard 2012). Sturgeon spawning and upstream shad passage occur concurrently;
- Assess near field, attraction to and entrance efficiency of the Spillway Ladder by shad reaching the dam spillway, under a range of spill conditions;
- Evaluate the internal efficiency of the Turners Falls Spillway Ladder;
- Continue data collection of Cabot Station Ladder and Gatehouse Ladder efficiency, to include rates of approach to fishway entrances, entry into fishways, and passage through them, under different operational conditions that occur in these areas;
- Evaluate modifications to the Cabot and/or Spillway fishways recommended by the Service if they are implemented;

- Assess upstream migration from Turners Falls to the Vernon Dam in relation to Northfield Mountain's pumping and generating operations and Vernon Project peaking generation operations. Typical existing and proposed project operation alterations should be evaluated;
- Assess near field, attraction to and entrance efficiency of the Vernon Dam Ladder;
- Assess internal efficiency of the Vernon Dam Ladder;
- Assess upstream passage past Vermont Yankee's thermal discharge (also located on the west bank of the river 0.45 mile upstream of fish ladder exit)
- Assess upstream migration from Vernon Dam in relation to the peaking generation operations of the Bellows Falls Project. Typical existing and proposed project operation alterations should be evaluated;
- Determine post-spawn downstream migration route selection, passage efficiency, delays and survival related to the Vernon Project, including evaluation of the impact of the Vermont Yankee heated water discharge plume on downstream passage route, migrant delay/timing, efficiency and survival;
- Assess impacts of Northfield Mountain operations on up- and downstream adult shad migration, including delays, entrainment, and behavioral changes and migration direction shifts under existing and proposed project operations;
- Determine downstream passage route selection, timing/delay, and survival under varied project operational flows into the power canal and spill flows at Turners Falls Dam;
- Determine downstream passage route selection, timing/delay in the canal, Cabot Station fish bypass facility effectiveness, and survival of Cabot-bypassed adult shad that enter the Turners Falls Canal system;
- Compare rates and or measures of delay, movement and survival etc., among project areas or routes utilized (e.g., spill at dam vs. power canal) under the range of permitted and proposed conditions; and
- Utilize available data sets and further analyze raw data (e.g., 2003- 2012 Conte Lab Studies) where possible to address these questions and inform power analyses and experimental design.

Information to address all of these questions would rely on the tagging of upstream migrating adult shad at Holyoke Dam and releasing them to migrate naturally from Holyoke through the Turners Falls and Vernon projects and back downstream after spawning. Additional tagged individuals would likely need to be released farther upstream (Turners Falls Canal, upstream of Turners Falls Dam, and upstream of Vernon Dam), to ensure that enough tagged individuals encounter project dams on both upstream and downstream migrations, that these individuals are exposed to a sufficient range of turbine and operational conditions to test for project effects, and to provide adequate samples sizes for statistically valid data analyses to address the many objectives listed. This study will require two years of field data collection to attempt to account for inter-annual variability in river discharge and water temperatures.

Evaluation of Past Study Data- In addition to collection and analysis of new telemetry data, substantial data has already been collected at Turners Falls from multiple years of passage assessments conducted for First Light by U.S. Geological Survey's Conte Anadromous Fish Research Center (Conte Lab) researchers and there are also data from the 2011 and 2012 full river study conducted by the Conte Lab that address Turners Falls, Northfield Mountain and

Vernon project migration and passage questions that have not yet been analyzed. These data include several million records each year from more than 30 radio telemetry receivers deployed between Middletown, CT and Vernon Dam. This data will provide substantial information free from the field data collection costs and therefore should be analyzed as part of this study. This data analysis should be completed in 2013 to help inform the design of subsequent field studies.

Evaluation of Methods to Get Shad Past Cabot Station for Spillway Passage at the Turners Falls Dam – The poor passage efficiency of the Cabot Ladder, the first and most used fishway encountered by shad arriving at the Turners Falls Project, and at the entrance to the Gatehouse Ladder, which all Cabot fishway-passed fish must use, has resulted in very poor overall shad passage efficiency at the project. An alternative to passing fish at the Cabot Station is to install a fish lift at the dam that would put fish directly into the Turners Falls pool, thereby eliminating problems with the Cabot Fishways, and the Gatehouse Fishway entrance and the variable passage efficiency of the Gatehouse Fishways. For this to be effective, attraction of shad to the Cabot Station discharge and associated delays would need to be overcome. It is possible that spillway flow releases coupled with behavioral measures at Cabot Station that dissuade shad from that tailrace could achieve this end. In order to assess the possibilities, we recommend the following study:

1. A literature search and desk-top assessment of the possible behavioral measures that could be effective in getting shad to pass Cabot Station tailrace and continue upstream to the dam.

2. Based on results of the desk-top assessment, possible evaluation of behavioral measures that are likely to be effective.

3. Field evaluation of the effect of different levels of spill at the dam that would induce fish to move past the Cabot Station into the bypass reach and up to the dam (as noted in objectives).

Besides passage success and delays at passage facilities, these studies would assess the impacts of project operations on migration passage delay, route, timing, injury, mortality, and passage structure attraction, retention, and success. Of particular interest will be fish behavior during periods when flow releases from the project increase from the required minimum flows to peak generation flows and when flows subside from peak generation flows to minimum flows and the operation of NMPS in pumping and generation modes.

Resource Management Goals

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat.

The Agency's goals related to aquatic natural resources are to:

1. Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.

2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
3. Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.

Furthermore, the VTFWD's mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).

Two of the Department's planning goals are:
1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.
2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

Vermont Fish and Wildlife Department's Strategic Plan (2002 -2010) focuses towards four major areas of concern: resource conservation, fish and wildlife-based recreation and use, human health and safety, efficient operations, and effective management.

The Connecticut River Atlantic Salmon Commission (CRASC) was established by Congress in 1983 (and reauthorized in 2002 for another 20 years) through the Connecticut River Atlantic Salmon Compact (Public Law 98-138). The Vermont Fish and Wildlife Department is a CRASC member agency, and a senior biologist from the department serves on the Technical Committee. The CRASC developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following
1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually. (Table 1)
2. Achieve annual passage of 40 to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem.
3. Maximize outmigrant survival for juvenile and spent adult shad.

The Atlantic States Marine Fisheries Commission, Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010 includes the following objective:

- Maximize the number of juvenile recruits emigrating from freshwater stock complexes and recommendations:

Upstream Passage –
1. American shad must be able to locate, enter, and pass the passage facility with little effort and without stress.
2. Where appropriate, improve upstream fish passage effectiveness through operational or structural modifications at impediments to migration.
3. Fish that have ascended the passage facility should be guided/routed to an appropriate area so that they can continue upstream migration, and avoid being swept back downstream below the obstruction.

Downstream Passage –

- To enhance survival at dams during emigration, evaluate survival of post spawning and juvenile fish passed via each route (e.g., turbines,, spillage, bypass facilities, or a combination of the three) at any given facility, and implement measures to pass fish via the route with the least delay and best survival rate.

Based on the CRASC plan, the Agency seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to American shad movement and migration, the Agency's goals are:

- Minimize current and potential negative project operation effects such as migration delays, false attraction, turbine entrainment, survival of project passage routes, and trashrack impingement that could hinder management goals and objectives.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), Silvio O. Conte National Fish and Wildlife Refuge Act (P.L. 102-212; H.R. 794), the Federal Power Act (16 U.S.C. §791a, *et seq*.), the Atlantic States Marine Fisheries Compact (P.L. 539, 77th Congress, as amended by P.L. 721, 81st Congress), and the Atlantic Coastal Fisheries Cooperative Management Act (16 U.S.C. 5107).

Public Interest Consideration

The requestor is a state natural resource agency.

Existing Information

Passage of adult shad at the Turners Falls fishway complex has been the subject of intense study by the Conte Lab since before 1999. These studies have clearly demonstrated that passage through the existing fishways at Cabot and Spillway is poor (<10% in many years). Passage through the Gatehouse fishway is better, but still rarely exceeds 80%, despite the short length of this ladder. In addition to poor passage for fish entering the ladders, shad that ascend the Cabot Fishway experience extensive delays before entry into the Gatehouse Fishway. Shad that ascend Spillway frequently fall back into the canal and are also subject to these upstream delays. A new entrance to the Gatehouse Fishway installed in 2007 led to dramatic improvements in passage out of the canal (from 5% to over 50% in 2011), but passage still falls well short of management goals. In addition, shad spend considerable time (up to several weeks) attempting to pass. These delays likely influence spawning success and survival. Adult shad, unable to pass Gatehouse, experience similar delays in downstream passage, even after they have stopped trying to pass

Gatehouse. Without spill, all outmigrating shad that have passed Gatehouse must enter the canal at the Gatehouse and may be subject to delays exiting the canal.

During the course of these studies a very large dataset has been compiled that could yield useful information for further improving passage of shad out of the canal in both the upstream and downstream directions. A unique feature of these data is a 2-dimensional array covering the canal just downstream of Gatehouse, documenting fine scale movements and occupancy of this zone. These data should be combined with computational fluid dynamics (CFD) and real-time hydraulic data to determine how canal hydraulics influence the ability of shad to locate and enter the fishway, and to identify modifications that are likely to lead to improvements in approach and entry rates. A separate CFD modeling study is requested that includes modeling of the Gatehouse Fishway entrance are at the head of the power canal.

In addition, whole-river shad telemetry studies performed in 2011 and 2012 will likely provide useful information and should be analyzed. These data should allow quantification of delay below Turners Falls, and could help guide studies requested above. Preliminary analyses of data through 2011 have been made available to FirstLight and the resource agencies (Castro-Santos and Haro 2005; Castro-Santos and Haro 2010).

The whole-river studies have also shown that, at least in 2011, most shad that pass Turners Falls rapidly progress upstream to Vernon Dam where extensive delays also occur. Data from the 2012 study were not available at this time, but Dr. Castro-Santos stated similar patterns were noted in the data between the years on the topic of upstream delay (personal communication, Dr. Theodore Castro-Santos). Similarly, concerns relative to the downstream passage of spent shad also remain relative to delays, with existing unpublished USGS telemetry data sets suggesting this is an issue within the Turners Falls canal.

Since the first year of operation of the Turners Falls upstream fishways (1980), the percent passage of American shad annually passed upstream of Turners Falls Dam compared to the number passed at the Holyoke Fish Lift has averaged 3.6% (1980-2012 data). The highest values for this metric has not exceed 11% and are well below the noted CRASC Management Plan target range for this objective noted earlier as 40-60% on a five year running average.

Since the first year of operation of the Vernon Dam upstream fish ladder (1981), the percent passage of American shad annually passed at Vernon compared to the number passed upstream of Turners Falls Dam (Gatehouse counts) has averaged 39.4%, ranging from 0.42% to 116.4% (> 100% due to counting error at one or both facilities, unknown).

Project Nexus

Existing project operations (peaking power generation) and limited bypass flows have a direct impact on instream flow and zones of passage (migration corridors). Project flow releases affect passage route selection, entry into fishways, and create delays to upstream migration. Inefficient downstream bypasses can result in migration delays and increased turbine passage. Mortality of adult shad passing through these turbines is expected to be high (Bell and Kynard 1985), additional stresses associated with passage and delay may cause mortality as shad are unable to return to salt water in a timely manner. The project's upstream and downstream passage facilities need to be designed and operated to provide timely and effective upstream and downstream fish passage to meet restoration goals of passage to upstream habitat and maximize post-spawn survival. These factors are all critically important to the success of restoration efforts.

Proposed Methodology

Use of radio including passive-integrated transponder (PIT) telemetry is widely accepted as the best method to assess fish migratory behavior and passage success and has been used extensively to assess migration and passage issues at Turners Falls as well as other Connecticut River projects. These studies include one conducted in 2011 and 2012 by the Service and U.S. Geological Survey's Conte Anadromous Fish Research Center, which has provided substantial information related to some of the issues identified here. The requested study will build and expand on the information collected over the past two years.

The study design must specify sample sizes, tag configurations and receiver configurations, to ensure that rates of entry and exit to the tailraces, fishways, downstream bypasses, and the bypassed reach can be calculated with sufficient precision to determine effectiveness of flow and ensonification treatments (separate Study Request). For project assessments at Turners Falls (e.g., Cabot, Spillway and Gatehouse ladder attraction and entry, route selection, operational effects), double tagged (radio and PIT) shad will be required for release from Holyoke Dam. Additional shad must be released directly into the Turners Falls Canal to support assessment of the various operational and structural conditions in effect, to be modified in this period, and proposed conditions within the Turners Falls power canal relative to entrances to the Gatehouse fishway. A related request on CFD modeling in the Cabot Station tailrace, the upper power canal near Gatehouse, and in the area around the entrance of the Spillway Ladder will address related project operational effects that will also address identified objectives in this telemetry request. Shad captured at Holyoke and tagged and release upstream of Turners Falls Dam, or tagged out of Gatehouse Ladder, would help to ensure an adequate sample size for evaluations in the vicinity of NMPS and to the Vernon Dam and the ability to address identified study objectives in those project areas. Additional tagged shad are expected to be required for release upstream of the Vernon Dam, which should ensure adequate sample for a separate study request, where shad spawn upstream of Vernon Dam as well as ensuring there is an adequate number of outmigrating spent adults to address related study objectives for adult outmigrants. The required number of tagged fish to address study objectives may be adjusted accordingly from area to area depending on target numbers (i.e., best information on resultant viable tagged fish and power analyses to detect effects) to account for typical passage rates, survival rates, and handling effects as examples.

Existing information on captured, handled, tagged fish performance (e.g., percent that drop back, unsuitable for tracking) and factors such as timing of tagging and potentially transport, must all be carefully considered to ensure an adequate sample size of healthy (e.g., viable to characterize behavior, survival, etc.) tagged fish is available to address the many questions identified in this request (as supported by a statistical power analysis). Additionally, ensuring adequate downstream adult fish sample sizes (to address project effect questions above) requires close consideration as expected losses of healthy tagged fish during upstream passage, natural mortality rates, and tagging related effects, are expected to reduce sample sizes on downstream passage objectives/questions as the season progresses. The use of single PIT tagged fish can help improve sample sizes, but will be of limited use to answer some of the passage questions we have identified.

Due to environmental variability, two years of study work will be necessary. A large array of stationary monitoring stations (radio and PIT) will be needed to address the issues identified among the project areas. A sufficient level of radio receiver and PIT reader coverage will be required, to provide an appropriate level of resolution, for data analyses, to answer these questions on project operational effects. The study will provide information on a variety of structural and operational aspects of fish migration, relative to route selection, timing, survival, and up and downstream passage attraction, retention, delay, efficiency, survival as some examples at three projects (Turners Falls, NMPS, and Vernon). The use of video monitoring may also be utilized for specific study areas such as the Spillway Ladder, to provide additional information on shad entrance activity, with the understanding of some data limitations associated with this approach (fish identification, water visibility). This study will be coordinated with the proposed study request to evaluate ensonification as a shad behavioral deterrent at the Cabot Station tailrace which will be an additional treatment of the telemetry study.

In addition to the tagging studies, use of video monitoring of the Spillway Fishway would provide additional overall data on Spillway Fishway efficiency as all shad attempting to pass could be monitored versus just those shad that have been tagged.

Level of Effort and Cost

The requested study is extensive and will require a substantial effort and cost to capture, PIT tag, and radio tag a sufficient number of shad at Holyoke to release at upstream locations. We are not aware of any other study technique that would provide project specific fish behavior and migration information to adequately assess existing project operations and provide insight in possible alternative operations and measures needed to address observed negative impacts to fish migration success. Cost for the entire multi-project tagging, tracking and data analysis are expected to range from $400,000 to $500,000 based on past Turners Falls' studies and the 2011 and 2012 shad telemetry studies. Video monitoring of the Spillway fishway would add a modest cost to this study.

Due to the fact tagged shad will move throughout the larger five project area, to varying degrees, there will be expected cost savings (e.g., radio tags) to both owner/operators, provided cooperation in study planning and implementation occurs.

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Wilder Hydroelectric Project – FERC No. 1892-026
Bellows Falls Hydroelectric Project – FERC No. 1855-045
Vernon Hydroelectric Project – FERC No. 1904-073

Study Request 13: Fish assemblage in project-affected areas

Goals and Objectives

The goal of this study request is to determine the occurrence, distribution, and relative abundance of fish species present in the project-affected areas of the Vernon, Bellows Falls and Wilder Projects, which potentially includes Species of Greatest Conservation Need (SGCN) for both New Hampshire and Vermont.

Specific objectives include:
1) Document fish species occurrence, distribution and abundance within the project-affected areas along spatial and temporal gradients.

2) Compare historical records of fish species occurrence in the project-affected areas to results of this study.

Resource Management Goals

The Agency's goals related to aquatic natural resources are to:

1. Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
3. Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the VTFWD's mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).

Two of the Department's planning goals are:

1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.
2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

Vermont Fish and Wildlife Department's Strategic Plan (2002 -2010) focuses towards four major areas of concern: resource conservation, fish and wildlife-based recreation and use, human health and safety, efficient operations, and effective management.

Riverine fish species are an important component of the river's ecology and are the basis for the sport fishery. Furthermore, several of the states' SGCN have been documented in the project-affected area.

Determining species occurrence, distribution and abundance will help address research and monitoring needs for species whose populations are poorly known. For example, as outlined in Vermont's Wildlife Action Plan (Kart et al.2005), research and monitoring needs for SGCN include monitoring and assessing populations and habitats for current conditions and future changes, and identifying and monitoring problems for species and their habitats.

A study that aims to provide a comprehensive investigation that documents which fish species are utilizing the project-affected areas in relation to spatial, temporal and environmental gradients (i.e. temperature, dissolved oxygen, pH, turbidity) will allow for a fuller understanding and examination of potential impacts that the Vernon, Bellows Falls and Wilder Project's operations have on the species that reside there. As noted below, there is little information concerning riverine fish in the project-affected areas as related to this study request.

Public Interest Consideration
The requestor is a state natural resource agency.

Existing Information
A thorough and comprehensive assessment of the fish assemblage present in the project-affected areas of the Bellows Falls and Wilder Projects is lacking. The PAD for the Bellows Falls Project acknowledges that, "Little comprehensive information is available regarding characterization of the fish community in relation to the Project." The PAD for the Wilder Project states, "No targeted studies have been conducted to characterize the fish community in relation to the Project."

The most relevant fish study related to the Bellows Falls and Wilder project-affected areas is a Connecticut River electrofishing survey conducted in 2008 (Yoder et al., 2009). While some sampling was conducted in both project-affected areas during the 2008 survey, this survey did not have the same goals and objectives as those outlined above. Additionally, both the Bellows Falls and Wilder PADs acknowledged that fish species assemblage data are limited and that the synthesized data may not be a full representation of species occurrence in the project-affected areas. Although, fish data has been collected by Vermont Yankee for many years in the Vernon Dam project-affected area, objectives and methodology for those fish surveys differ from those stated here, and gear types were generally limited to boat electrofishing which may not be suitable for properly assessing all species present in the project-affected areas. It is unknown if other species may inhabit or utilize aquatic habitats in the projects area that to this date have not been documented by previous surveys. It follows that without more information on the fish community in the project-affected areas, project impacts on fish species are also unknown.

Project Nexus

Project operations have the potential to directly impact fish species life history requirements, biological interactions, and habitat quantity and quality. For example, headpond and tailwater water level fluctuations could dewater important spawning areas or change available habitat, thus limiting productivity of important game fish species by direct impacts to their spawning success or indirectly by limiting the spawning success of forage fish species. Furthermore, several of New Hampshire and Vermont's SGCN have been documented in the project-affected area. Accordingly, a thorough understanding of the current fish assemblage structure and associated metrics are needed in order to examine any potential project-related impacts.

Proposed Methodology

An accepted and robust field sampling design (e.g., as described in Pollock et al. 2002 or MacKenzie et al. 2006) and accepted methods for collecting fish species likely to be present in the project-affected areas (Bonar et al. 2009) should be used to conduct field surveys. Randomly sampling multiple habitat types using a multi-gear approach will be required to ensure that all fish species present are sampled. The spatial scope of the study will be from the most upstream area influenced by the Wilder Dam to the most downstream area influenced by the Vernon Project. Sampling should occur at each selected site across multiple seasons (spring, summer, and fall). Digital photographs should be taken to avoid misidentifying certain species such as Cyprinids.

The sampling design should include replicate samples for estimation of species detection probability. Sample replicates may be gathered temporally, using different methods, by independent observers, or by randomly sampled spatial replicates (MacKenzie et al. 2006). For each replicate sample, data that may be important for describing variation in species occurrence and presence/absence should be collected and recorded, such as gear type, mesohabitat type, depth, velocity, flow, water temperature, substrate, time of day, day of year, presence of cover, proportion of vegetation cover, size of individuals collected (juveniles may select different habitat), and other factors as determined by a qualified biologist. Species detection, occurrence, and/or abundance as related to these parameters should be estimated using methods as described by Kery et al. (2005), MacKenzie et al. (2006), Wenger and Freeman (2008), or Zipkin et al. (2010).

Based on first year study results, specific studies examining impacts of project operations on specific fish species may be requested. A second year of study may be required if first year data collection is limited due to environmental or other conditions, or if river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period.

Level of Effort and Cost

The cost of the study will be moderate to high as seasonal sampling with several types of gear will be required. However, cost will also be partially dependent on the number of sites sampled, the number of sample replicates, and the extent of the covariate data that are measured. Provided the collected data are of high quality, analysis and synthesis should take approximately 10-20 days. TransCanada did not propose any studies specifically addressing this issue

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Turners Falls Hydroelectric Project – FERC No. 1889-081
Northfield Mountain Pumped Storage Project – FERC No. 2485-063

Study Request 13: Fish assemblage in project-affected areas

Goals and Objectives
The goal of this request is to determine the occurrence, distribution, and relative abundance of fish species present in the Project affected areas of the Turners Falls and Northfield Mountain Project Areas, which potentially includes Species of Greatest Conservation Need (SGCN) for Massachusetts, New Hampshire, and Vermont.

Specific objectives include:
1) Document fish species occurrence, distribution and abundance within the project affected area along spatial and temporal gradients.

2) Compare historical records of fish species occurrence in the project affected area to results of this study.

Resource Management Goals
The Agency's goals related to aquatic natural resources are to:
1. Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
3. Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the VTFWD's mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).

Two of the Department's planning goals are:
1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.
2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

Vermont Fish and Wildlife Department's Strategic Plan (2002 -2010) focuses towards four major areas of concern: resource conservation, fish and wildlife-based recreation and use, human health and safety, efficient operations, and effective management.

Riverine fish species are an important component of the river's ecology and are the basis for the sport fishery. Furthermore, several of the states' SGCN have been documented in the project-affected area.

Determining species occurrence, distribution, and abundance will better clarify what species occur in the project area both spatially and temporally, relative to habitats which may be affected by project operations of the Turners Falls or Northfield Mountain Pump Storage projects. This information will better inform other results from other study requests that will be examining project operation effects on various aquatic habitats, water quality and other related concerns such as entrainment concerns at NFMPS. This information will be used to make recommendations and provide full consideration for all species, including those that might not otherwise be known to occur in the project-affected area and impacts that may affect their population status through direct or indirect effects of the projects.

Public Interest Consideration
The requestor is a natural resource agency.

Existing Information
A thorough and comprehensive assessment of the fish assemblage present in the project-affected areas of the Turners Falls and NFMPS projects is lacking. The PAD for these projects sites notes resident fish surveys conducted by the State of Massachusetts in the early to mid 1970s and a limited 2008 sampling effort by Midwest Biodiversity Inst. (contracted by EPA). The PAD identifies a total of 22 fish species in the project area which omits, as an example of its limited information basis, northern pike, tessellated darter, burbot, eastern silvery minnow, and channel catfish (Ken Sprankle, USFWS, and Jessie Leddick, MADFW, personal communication). It is unknown how many other species may inhabit or utilize aquatic habitats in the projects area, potentially including species of greatest conservation need.

The most relevant recent fish survey study related to the project affected areas is a Connecticut River electrofishing survey conducted in 2008 (Yoder et al., 2009). While some sampling was conducted in both project areas during the 2008 survey, this survey did not have the same goals and objectives as those outlined above. Due to the design of the study limitations in geographic/habitat type coverage both spatially and temporally, and the use of a single gear type, limits the use of these data and that synthesized data may not be a full representation of species occurrence in the project affected areas. It follows that since information is limited regarding the composition of the fish community and their use of habitats in the project-affected area, project impacts on fish species are also unknown.

Project Nexus
Project operations have the potential to directly impact fish species life history requirements, biological interactions, and habitat quantity and quality. For example, headpond and tailwater water level fluctuations could dewater important spawning areas, or affect habitat availability, thus limiting productivity of fish species by direct impacts to their spawning success or indirectly by limiting the spawning success of forage fish species. Accordingly, a thorough understanding of the current fish assemblage structure and associated metrics are needed in order to examine any potential project-related impacts. A Study Request to examine project effects on aquatic

habitats, as well as impacts to spawning habitats (e.g., sea lamprey and black bass) has been submitted and will compliment this request.

Proposed Methodology

An accepted and robust field sampling design (e.g., as described in Pollock et al. 2002 or MacKenzie et al. 2006) and accepted methods for collecting fish species likely to be present in the project-affected areas (Bonar et al. 2009) should be used to conduct field surveys. Randomly sampling multiple habitat types using a multi-gear approach will be required to ensure that all fish species present are sampled. The spatial scope of the study will be from the headwaters of the Turners Falls pool downstream to Sunderland, Massachusetts, and will omit the upper reservoir of Northfield Mountain Pump Storage Project. Sampling should occur at each selected site across multiple seasons (spring, summer, and fall). Digital photographs should be taken to avoid misidentification of certain species such as Cyprinids.

The sampling design should include replicate samples for estimation of species detection probability. Sample replicates may be gathered temporally, using different methods, by independent observers, or by randomly sampled spatial replicates (MacKenzie et al. 2006). For each replicate sample, data that may be important for describing variation in species occurrence and presence/absence should be collected and recorded, such as gear type, mesohabitat type, depth, velocity, flow, water temperature, substrate, time of day, day of year, presence of cover, proportion of vegetation cover, size of individuals collected (juveniles may select different habitat), and/or other factors as determined by a qualified biologist. Species detection, occurrence, and/or abundance and related habitat measures on these parameters should be estimated using methods as described by Kery et al. (2005), MacKenzie et al. (2006), Wenger and Freeman (2008), or Zipkin et al. (2010).

This will be a one year study provided river discharge conditions fall within 25th to 75th percentile for weekly averages. Based upon this study's results, and the additional information obtained on requests to survey aquatic habitats and littoral zone fish spawning, an additional study may be required if evidence of project operation affects on population status or habitat for identified species.

Level of Effort and Cost

The cost of the study will be moderate to high as seasonal sampling with several types of gear will be required. However, cost will also be partially dependent on the number of sites sampled, the number of sample replicates, and the extent of the covariate data that are measured, all which may be flexible. Based on first year study results, a second year of sampling or specific studies examining impacts of project operations on specific fish species may be needed and requested. Provided the collected data are of high quality, analysis and synthesis should take approximately 10-20 days. FirstLight did not propose any studies specifically addressing this issue.

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Wilder Hydroelectric Project – FERC No. 1892-026
Bellows Falls Hydroelectric Project – FERC No. 1855-045
Vernon Hydroelectric Project – FERC No. 1904-073

Study Request 14: Impacts of downstream water fluctuations on resident fish spawning

Goals and Objectives
The goal of this study is to determine if the full range of project induced flow and water level fluctuations in the project-affected areas below the Vernon, Bellows Falls and Wilder Dams negatively impact resident fish spawning (smallmouth bass, common white sucker, walleye and fallfish), and if impacts are found to occur, to develop appropriate mitigation measures.

Specific objectives include:
1) Conduct field studies in the project-affected areas downstream from the Vernon, Bellows Falls and Wilder Dams to assess timing and location of fish spawning. Nesting locations should be mapped.

2) Conduct field studies in the Project affected areas below the Vernon, Bellows Falls and Wilder Dams to evaluate potential impacts of the full range of project induced water level fluctuations on nest abandonment, spawning fish displacement and egg dewatering. The study should also evaluate if changes in fluctuation range would mitigate for identified impacts and/or if other mitigative measures would lessen these impacts.

Resource Management Goals
The Agency's goals related to aquatic natural resources are to:
1. Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
3. Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the VTFWD's mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).

Two of the Department's planning goals are:

1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.
2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

Resident fish species are an important component of the river's ecology and in some cases are the basis for a sport fishery. This requested study will help protect and conserve resident fish species by ensuring Project operations do not negatively impact their spawning success.

Public Interest Consideration
The requestor is a resource agency.

Existing Information
To our knowledge, no information exists related to this requested study.

Project Nexus
Project operations have the potential to impact fish species by influencing spawning success and spawning habitat quality and quantity. For example, flow and water level changes due to Project operations could create conditions where fish eggs are exposed to air, where quality spawning habitat is dewatered, and/or where fish abandon nests containing eggs. A study of a regulated river found temporal fluctuations of streamflow appeared to be the most important abiotic factor determining smallmouth bass nesting success or failure (Lukas and Orth 1995). Similarly, other research suggests stream discharge during and immediately after spawning could be important to smallmouth bass recruitment success (Smith et al. 2005). Current can also impact early survival of walleye by moving eggs and larvae from spawning sites (Humphrey et al. 2012).

Proposed Methodology
Common tools to evaluate fish spawning would be used including electrofishing, visual observations, and telemetry. Specific areas of interest are locations in project-affected areas below the Vernon, Bellows Falls and Wilder Dams where it is determined that the before mentioned fish species spawn. A second year of study may be required if first year data collection is limited due to environmental or other conditions, or if river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period.

Level of Effort and Cost
TransCanada does not propose any studies to meet this need. Estimated cost for the study is moderate.

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Wilder Hydroelectric Project – FERC No. 1892-026
Bellows Falls Hydroelectric Project – FERC No. 1855-045
Vernon Hydroelectric Project – FERC No. 1904-073

Study Request 15: Upstream American eel survey

Goals and Objectives

The goal of this study is to provide baseline data relative to the presence of American eel upstream of the Vernon, Bellows Falls, and Wilder dams.

The objective of the study is to determine the relative abundance and distribution of American eel upstream of the Vernon, Bellows Falls and Wilder dams in both riverine and lacustrine habitat.

Resource Management Goals

The Agency's goals related to aquatic natural resources are to:

1. Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
3. Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the VTFWD's mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).

Two of the Department's planning goals are:

1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.
2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

Vermont Fish and Wildlife Department's Strategic Plan (2002 -2010) focuses towards four major areas of concern: resource conservation, fish and wildlife-based recreation and use, human health and safety, efficient operations, and effective management.

The American eel (*Anguilla rostrata*), is listed as one of both New Hampshire's and Vermont's Species of Greatest Conservation Need (SGCN). The status for conservation need in Vermont is listed as high priority (Kart et al. 2005), and the species is listed as "vulnerable" in New Hampshire. As identified in Vermont's Wildlife Action Plan (Kart et al. 2005), threats to the species include the construction of large dams on rivers which obstruct juvenile fish access to critical rearing habitats, as well as mortality associated with passing through hydroelectric facilities' turbines during their outmigration to sea.

As outlined in Vermont's Wildlife Action Plan (Kart et al. 2005), research and monitoring needs for this SGCN include determining their distribution and abundance, as the contribution of eels in northern regions to overall stock is unknown. One of the conservation strategies for this species is to support efforts to enhance access of American eels to Vermont waters by eliminating or minimizing impacts of dams and other obstructions along the Richelieu, St. Lawrence, and Connecticut Rivers.

The Atlantic States Marine Fisheries Commission has developed two documents related to the management of American eel:

1. Interstate Fishery Management Plan for American Eel. April 2000. Atlantic States Marine Fisheries Commission.

2. Addendum II to the Fishery Management Plan for American Eel. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

Objectives of the management plan include: (1) protect and enhance American eel abundance in all watersheds where eel now occur; and (2) where practical, restore American eel to those waters where they had historical abundance but may now be absent by providing access to inland waters for glass eel, elvers, and yellow eel and adequate escapement to the ocean for pre-spawning adult eel.

Addendum II contains specific recommendations for improving upstream and downstream passage of American eel, including requesting that member states and jurisdictions seek special consideration for American eel in the FERC relicensing process.

The Connecticut River Atlantic Salmon Commission (CRASC) was established by Congress in 1983 (and reauthorized in 2002 for another 20 years) through the Connecticut River Atlantic Salmon Compact (Public Law 98-138). The Vermont Fish and Wildlife Department is a CRASC member agency, and a senior biologist from the department serves on the Technical Committee. The CRASC developed A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin in 2005. The goal of the plan is "to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem…" Management objectives in the plan include the following:

1. Protect and enhance eel populations where they currently exist;

2. Where practical, restore populations to waters where they had historical abundance;

3. Provide effective upstream and downstream fish passage around dams and other barriers within the species' range in the basin; and

4. Comply with all requirements of the Fishery Management Plan of the ASMFC.

Based on these plans, the Agency seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to American eels, the Agency's goals are:

3. Protect, enhance, or restore, diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
4. Understand the baseline condition with respect to the presence of American eel within and upstream of the project area.
5. Minimize current and potential negative project operation effects on American eel inhabiting the project area and/or moving through the area during upstream and downstream migrations

Our study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), and the Federal Power Act (16 U.S.C. §791a, *et seq*.).

Public Interest Consideration

The requestor is a resource agency.

Existing Information

According to the PADs, very few American eels were collected in the Fish Assemblage and Habitat Assessment of the Upper Connecticut River (Yoder et al., 2009). In the Vernon Project area upstream of the dam, only one eel was collected; no eels were collected from the Bellows Falls pool, and none were found upstream of the Wilder Dam. However, in 2012 over 200 eels were documented using the upstream fish ladder at the Vernon Project and the New Hampshire Fish and Game Department has observed eels upstream of the Bellows Falls and Wilder dams. More recently, eels have been observed in Lake Morey, Vermont, which is located upstream of Wilder Dam (Lael Will, VDFW, personal communication). Therefore, while it is clear that some eels are passing all three dams (Vernon, Bellows Falls, and Wilder), it remains unknown how many eels may be rearing in the mainstem habitat upstream of the dams or in tributaries and lakes and ponds that feed into the mainstem river.

No targeted eel surveys have been conducted to determine the abundance and distribution of American eels in riverine and lacustrine habitat upstream of the three projects. This information gap needs to be filled so resource agencies can evaluate properly the need for, and timing of, downstream passage and protection measures for outmigrating silver phase eels.

It should be noted that within the past seven years, the USFWS has received two petitions to list the American eel under the Endangered Species Act. The first petition was received on

November 18, 2004. On July 6, 2005 the USFWS issued a substantial 90-day finding on the petition and initiated a 12-month status review that concluded on February 2, 2007 with a finding that listing was not warranted. The second petition was filed on April 30, 2010 by the Council for Endangered Species Act Reliability. On September 29, 2011 the USFWS issued a substantial 90-day finding and initiated a 12-month status review. The USFWS is still accepting new American eel information for the ongoing status review. The USFWS also is currently in settlement negotiations with CESAR on their legal complaint that the USFWS failed to complete the 12-month finding within the statutory timeframe. It is likely that the USFWS's 12-month finding on the latest petition will be made prior to any new licenses being issued for the projects.

Project Nexus
The project configurations present problems with respect to providing safe, timely and effective passage for outmigrating eels. The intakes are deep and, while no specification for the trashracks were provided in the PADs, it is unlikely that they would prevent impingement and/or entrainment of eels. Existing anadromous downstream passage facilities at the projects also would not be expected to be effective for eels; the target anadromous species are surface-oriented, while eels tend to move much deeper in the water column. If eels are utilizing habitat upstream of the dams, then appropriate protection and downstream passage measures will be needed.

In order to understand the need for, and timing of, downstream eel passage at the projects, we are requesting that TransCanada undertake eel surveys in the Connecticut River upstream of the three dams and in tributaries feeding into the mainstem river within the project areas. Surveying tributary habitat is necessary because surveying the mainstem alone may lead to an underestimation of eel abundance, particularly if there are relatively short tributary streams that lead to a lake or pond (where eels may accumulate, leading to true high densities).

Proposed methodology
The Agency requests an eel survey be conducted in the mainstem river an tributaries upstream from the three projects. The methodology should be similar to that used in the relicensing of the Saluda Hydroelectric Project, FERC No. 516 (Appendix A), the eel assessment for the Merrimack River completed by the USFWS's Central New England Fishery Resources Office (Appendix B), and the proposed study plan for the relicensing of the Eastman Falls Project (FERC No. 2457)[3].

In general, a combination of electroshocking (backpack in wadeable rivers and boat-mounted in larger rivers and lakes) and eel pots should be used to collect eels and determine catch rates. Sampled habitat should include: the mainstem Connecticut River from upstream of Vernon Dam to below the Ryegate Dam; tributaries to the Connecticut within that stretch where eels have been collected previously; and lakes and ponds (such as, but not limited to, Spofford Lake and Lake Morey), where eels have been collected previously. Sampling should occur during the summer (July through September).

[3] FERC Accession No. 20121214-5121

Level of Effort and Cost

The expected level of effort and anticipated costs will be comparable to that experienced on similar FERC projects of this size. A study plan recently submitted for the Eastman Falls Project (FERC No. 2457) on the Pemigewasset River in New Hampshire, which is utilizing a similar methodology, estimated that sampling a nine-mile-long impoundment with shocking and eel pots would cost $25,000. They estimated the effort to be two nights for the electrofishing survey. Given the much larger area that will need to be sampled under this request, we estimate moderate cost and effort will be required (20 days of shocking mainstem habitat plus another 5-10 days for tributaries and associated lake/pond habitat).

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Wilder Hydroelectric Project – FERC No. 1892-026
Bellows Falls Hydroelectric Project – FERC No. 1855-045
Vernon Hydroelectric Project – FERC No. 1904-073

***Study Request 16: Project effects on populations of tessellated darter,* Etheostoma olmstedi**

Goals and Objectives
The goal of this study is to evaluate the effects of project operations on populations of tessellated darter (*Etheostoma olmstedi*), a New Hampshire species of greatest conservation concern and known host species for the federally-endangered dwarf wedgemussel (*Alasmidonta heterodon*). The specific objectives of the study are to:

1. Determine the distribution and abundance of tessellated darter within project-affected areas; and
2. Determine the effects of project operations on the distribution and abundance of tessellated darter.

Resource Management Goals
The Agency's goals related to aquatic natural resources are to:

1. Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
3. Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the VTFWD's mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).

Two of the Department's planning goals are:

1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.
2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

Vermont Fish and Wildlife Department's Strategic Plan (2002 -2010) focuses towards four major areas of concern: resource conservation, fish and wildlife-based recreation and use, human health and safety, efficient operations, and effective management.

The tessellated darter is one of only three fish species in the Upper Connecticut River that serve as hosts for the glochidia of the federally-endangered dwarf wedgemussel, the others being the slimy sculpin (*Cottus cognatus*) and the Atlantic salmon (*Salmo salar*) (Wicklow 2005).

Tessellated darters may be the most important hosts for the dwarf wedgemussel in the Upper Connecticut for the following reasons:

- The USFWS has decided to end its program of stocking hatchery-reared salmon in the Connecticut River basin and accordingly it is unlikely that salmon parr will be available as potential hosts.
- The tessellated darter appears to be more widespread than the slimy sculpin in the Bellow Falls and Wilder project areas where the dwarf wedgemussel is known to exist. Yoder et. al. (2009) found the darter in the project areas upstream and downstream of both dams, while the sculpin was not found in either project area.

The dwarf wedge mussel is state and federally listed as endangered. Populations in the Upper Connecticut River are dependent on healthy tessellated darter populations, and therefore a better understanding of how dam operations affect the darter is crucial to the recovery of the dwarf wedgemussel.

A mission of both the New Hampshire Fish and Game Department and the Vermont Fish and Wildlife Department is to protect and conserve fish and wildlife and their habitats. Riverine fish species are an important component of the river's ecology. Tessellated darter is identified by New Hampshire as a Species of Greatest Concern.

Public Interest Consideration
The requestor is a resource agency.

Existing Information
In the Preliminary Application Documents (PADs)s for the Wilder, Bellows Falls, and Vernon projects, the applicant acknowledges that tessellated darter is one of the confirmed hosts of dwarf wedgemussel. It also identifies the occurrence of tessellated darter both upstream and downstream of each project. However, studies that specifically target small-bodied benthic species are lacking in project-affected areas. It is therefore likely that results of previous investigations are biased and underestimate true population size. An effective evaluation of project effects on a population will require robust, unbiased estimates of population parameters such as abundance or occupancy and similar estimates of population parameters under known conditions of low to no effect.

Existing literature indicates that tessellated darters may be found in a variety of habitats (Scott and Crossman 1979, Van Snik Gray and Stauffer 1999, Hartel 2002, Van Snik Gray et al. 2005, Henry and Grossman 2008), but these habitats are not necessarily equal in their ability to support the population or its function as host to dwarf wedgemussel. We cannot be certain that habitat use infers preference, nor that habitat use will be consistent from basin to basin. Therefore, habitat use within project-affected areas should be evaluated, and should be evaluated in concert with population parameters. By estimating population parameters (e.g., abundance, occupancy, extinction/colonization) as functions of habitat, we may determine whether habitat contributes to any differences in populations and if so, what specific habitat is preferred for stable and persistent populations.

Project Nexus
Operations at the Wilder, Bellows Falls, and Vernon projects alter natural river flow and consequently cause changes in the availability of instream habitat on which the tessellated darter and other lotic species depend. Habitat for tessellated darters is directly related to project operations in terms of flow (water depth and velocity, and their timing, duration, frequency, and rate of change) as well as the interactions of flow with other habitat variables such as substrata, vegetation, and cover. Operations both upstream (changes to the reservoir) and downstream (changes to the flow regime) may affect habitat, and may consequently lead to changes in the distribution, abundance, and behavior of tessellated darters that could in turn potentially affect the federally-endangered dwarf wedge mussel, for which the tessellated darter is a host species.

The information collected for this requested study will help determine whether project operations have a substantial effect on populations of tessellated darter, or whether population parameters are consistent with those of other populations in the region. If there is an effect of project operations on darter populations, study results will also permit identification of those habitat components related to operations that are most important for maintenance of stable and persistent populations of tessellated darter. This will in turn provide information that will assist the development of recommendations aimed to maintain populations of dwarf wedgemussel.

Proposed Methodology
Using an accepted and robust field sampling design (e.g., as described in Pollock et al. 2002 or MacKenzie et al. 2006) and accepted methods for collecting tessellated darters and other similar small-bodied fishes, conduct a field survey for tessellated darters within all project-affected areas from the headwaters of the Wilder pool downstream to the Vernon dam, as well as in selected areas outside of the project-affected areas with known stable populations of tessellated darter and/or dwarf wedgemussel. Such a sampling design should include replicate samples for estimation of species detection probability. For each replicate sample, collect and record data that may be important for describing differences in populations of tessellated darter, such as presence or abundance of other species (e.g., dwarf wedgemussel, slimy sculpin *Cottus cognatus*), depth, velocity, water temperature, substrata, time of day, presence of cover, proportion of vegetation cover, size of individuals collected (juveniles may select different habitat; larger individuals may outcompete smaller individuals for preferred habitat), and other factors as determined by a qualified biologist. Include also as covariates any relevant flow characteristics (Zimmerman 2006) that may differ among sites.

Using methods as described by Kery et al. (2005), MacKenzie et al. (2006), or Wenger and Freeman (2008), determine whether population estimates of tessellated darter are different in project-affected areas and, if so, which measured factors or flow characteristics are most important in describing these differences.

Level of Effort and Cost
The cost for collecting the data for this study is entirely dependent on the number of sites, number of sample replicates, and the extent of the covariate data that are measured, all of which and should be determined during the development of the study plan in consultation with fishery agencies and other parties, and may be adjusted during the course of field sampling. In general, if a species is common and easily captured, few replicates and many sites produce the best

estimates, whereas more replicates and fewer sites are preferable for rare species. In general, the more replicates added, the lower the errors in detection probability, and the more sites sampled, the lower the errors in population parameters. The number of people required in the field will be dependent on the sampling method that is selected, but should be at least two individuals. Provided the collected data are of high quality, analysis and synthesis should take at most 5-10 days.

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Wilder Hydroelectric Project – FERC No. 1892-026
Bellows Falls Hydroelectric Project – FERC No. 1855-045
Vernon Hydroelectric Project – FERC No. 1904-073

*Study Request 17: Assessment of adult sea lamprey (*Petromyzon marinus*) spawning within the project areas*

Goals and Objectives

The goal of this project is to assess the level of spawning activity by sea lamprey in the Wilder, Bellows Falls, and Vernon project areas and determine whether operations at these projects are affecting the success (i.e., survival to emergence) of lamprey spawning.

The objectives are:

Identify areas within the Wilder, Bellows Falls, and Vernon project areas where suitable spawning habitat exists for sea lamprey.

Conduct a telemetry study of sea lamprey during their upstream migration period in the spring, focusing on areas of suitable spawning habitat, and areas of known spawning.

Conduct spawning ground surveys to observe the utilization of this habitat for spawning purposes, and hence, confirm suitability.

Obtain data on redd characteristics including location, size, substrate, depth and velocity.

Determine if the operations at the Wilder, Bellows Falls and Vernon projects are adversely affecting these spawning areas (i.e. if flow alterations are causing dewatering and/or scouring of sea lamprey redds). If it is determined that the operations of the projects are adversely affecting the spawning success of sea lamprey, identify operational regimes that will reduce and minimize impacts to sea lamprey spawning habitat and spawning success within the project area.

Resource Management Goals

The Agency's goals related to aquatic natural resources are to:

1. Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
3. Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the

VTFWD's mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).

Two of the Department's planning goals are:

1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.
2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

Vermont Fish and Wildlife Department's Strategic Plan (2002 -2010) focuses towards four major areas of concern: resource conservation, fish and wildlife-based recreation and use, human health and safety, efficient operations, and effective management.

The sea lamprey (*Petromyzon marinus*), within the Connecticut River drainage, is one of New Hampshire and Vermont's Species of Greatest Conservation Need (SGCN). The conservation status of sea lamprey in New Hampshire is listed as "vulnerable." One of the threats identified in Vermont's Wildlife Action Plan (Kart et al. 2005) is degraded spawning habitat, which is second to habitat fragmentation.

As outlined in Vermont's Wildlife Action Plan (Kart et al. 2005), research and monitoring needs for SGCN include monitoring and assessing populations and habitats for current conditions and future changes, and identifying and monitoring problems for species and their habitats.

One of the conservation strategies identified in the Vermont Wildlife Action Plan, is protecting and restoring aquatic and riparian habitats through improved water quality; flow, water level and temperature regimes; sediment reduction; establishment of streamside buffers; and suitable aquatic habitat structure, diversity and complexity.

In support of conservation strategies and research needs listed above, identifying potential impacts that the Wilder, Bellows Falls, and Vernon Projects have on sea lamprey spawning is paramount. Results of the study will be used to develop flow-related license requirements and/or other mitigation measures that will optimize spawning habitat for a New Hampshire and Vermont SGCN.

Public Interest Consideration
The requestor is a state resource agency.

Existing Information
It is known that sea lamprey spawn in the Connecticut River main stem at least as far upstream as Wilder Dam, as well as tributary waters including the West, Williams, Black and White Rivers (Kart et al. 2005).

The PAD discusses sea lamprey distribution as: "FWS (2012) lists the current upstream extent of sea lamprey range as Bellows Falls Dam, noting, however, that reproduction has been documented as far north as the White River, Vermont, in the Wilder Project area. In certain years hundreds to thousands of sea lamprey have been recorded passing upstream of Bellow Falls dam, and in at least one year (2008) sea lamprey were documented passing upstream via the Wilder Dam fish ladder. In 2008 surveys, Yoder et al. (2009) documented sea lamprey just downstream of the confluence of the White River."

In 2012 at total of 99 sea lamprey were observed passing the Bellows Falls Dam, and a total of 696 sea lamprey were observed passing the Vernon Dam.

To date no studies have been conducted that aim to identify spawning habitat and spawning activity of sea lamprey within in the Wilder, Bellows Falls, and Vernon project areas and whether Project operations are affecting these activities.

Project Nexus

The operation of the Wilder, Bellows Falls and Vernon projects including minimum flows and large and rapid changes in flow releases from the dam have the potential to cause direct adverse effects on spawning habitat and spawning activity downstream of the dam. If adult sea lampreys are actively spawning in the project area, it is important to assess whether operations of the projects are having any adverse effects (i.e. dewatering and scouring) on these activities.

Proposed Methodology

Although a relatively new practice, the tagging and tracking of adult Pacific lamprey to determine final destination, has been successfully conducted in the Columbia River (Noyes et al. 2012). Similarly, from 2005-2009, radio telemetry was used to determine adult lamprey overwintering and spawning habitats, and spawn timing in the lower Deschutes River Subbasin (Fox et al. 2009).

In Vermont, factors affecting sea lamprey survival were examined (Smith and Marsden 2009). It was found that predation, water currents, and displacement of eggs from the nest, played a role in survival.

As part of the Wells Hydroelectric project (FERC No. 2149), Pacific lamprey spawning ground surveys were conducted to determine project effects on spawning success.

In 2010, redd surveys were completed in Shitike and Beaver Creeks to identify recent redds for placement of an experimental redd cap. The purpose of capping lamprey redds was to enumerate emerging larvae and to document timing of emergence with respect to estimated date of redd construction and water temperature (Fox et al. 2010). Therefore, to determine project effects on the spawning success of sea lamprey methods should follow Fox et al. (2010).

Level of Effort and Cost

The estimated level of effort and costs for this recommended study is expected to be moderate to high. The applicant did not propose any alternative studies in its PAD to address this specific issue.

Literature Cited

Fox, M. J.C. Graham, and S. Frank. 2009. Determining Adult Pacific Lamprey Abundance and Spawning Habitat in the Lower Dechutes River Sub-Basin, Oregon. Department of Natural Resources Confederated Tribes of the Warm Springs Reservation, Oregon

Fox, M. J.C. Graham, and S. Frank. 2010. Determining Adult Pacific Lamprey Abundance and Spawning Habitat in the Lower Dechutes River Sub-Basin, Oregon. Department of Natural Resources Confederated Tribes of the Warm Springs Reservation, Oregon

Kart, J., R. Regan, S.R. Darling, C. Alexander, K. Cox, M. Ferguson, S. Parren, K. Royar, B. Popp, editors. 2005. Vermont's Wildlife Action Plan. Vermont Fish & Wildlife Department. Waterbury, Vermont. http://www.vtfishandwildlife.com/swg_cwcs_report.cfm. (Accessed September 10, 2012).

Le, Bao and S. Kreiter. 2008. An assessment of Adult Pacific Lamprey Spawning within the Wells Project. Wells Hydroelectric Project NO. 2149.

Noyes, C.J., C.C. Caudill, T.S. Clabough, D.C. Joosten, E.L. Johnson, M.L. Keefer, and G.P. Naughton. 2011. Adult Pacific lamprey migration behavior and escapement in the Bonneville Reservoir and Lower Columbia River monitored using the juvenile salmonid acoustic telemetry system (JSATS). Technical Report 2012-4-Draft

Smith, S. J. and J. E. Marsden. 2009. Factors Affecting Sea Lamprey Egg Survival. North American Journal of Fisheries Management 29:859–868.

Vermont Fish and Wildlife Department . 2006. Vermont Fish and Wildlife Strategic Plan. http://www.vtfishandwildlife.com/library/reports_and_documents/Fish_and_wildlife/Strategic_Plan.pdf

Wilder Hydroelectric Project – FERC No. 1892-026
Bellows Falls Hydroelectric Project – FERC No. 1855-045
Vernon Hydroelectric Project – FERC No. 1904-073

Study Request 18: Impacts of impoundment water level fluctuations on resident fish spawning

Goals and Objectives

The goal of this study is to determine if the full range of water level fluctuations in the Vernon, Bellows Falls and Wilder Hydroelectric Projects negatively impact resident fish species (smallmouth bass, largemouth bass, yellow perch, black crappie, common sunfish, bluegill, chain pickerel, northern pike, golden shiner, common white sucker, spottail shiner, walleye and fallfish) in the impoundments, and if impacts are found to occur, to develop appropriate mitigation measures.

Specific objectives include:

1) Conduct field studies in the mainstem, tributaries and backwaters of project affected areas to assess timing and location of fish spawning. Nesting locations should be mapped.

2) Conduct field studies in the mainstem, tributaries and backwaters of project-affected areas to evaluate potential impacts of impoundment fluctuation on spawning habitat, nest abandonment, spawning fish displacement and egg dewatering. The study should also evaluate if changes in impoundment fluctuation range would mitigate for identified impacts and if other mitigative measures would lessen these impacts.

Resource Management Goals

The Agency's goals related to aquatic natural resources are to:

1. Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
3. Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the VTFWD's mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).

Two of the Department's planning goals are:

1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.
2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

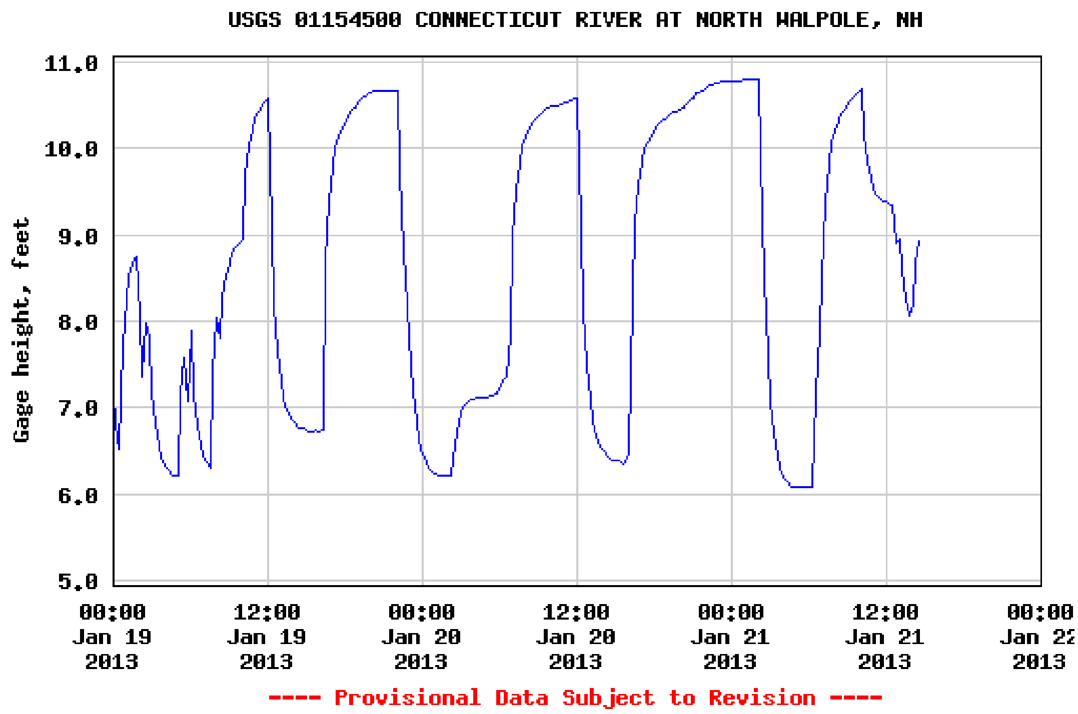
Vermont Fish and Wildlife Department's Strategic Plan (2002 -2010) focuses towards four major areas of concern: resource conservation, fish and wildlife-based recreation and use, human health and safety, efficient operations, and effective management.

Riverine fish species are an important component of the river's ecology and in some cases are the basis for a sport fishery. This requested study will help protect and conserve resident fish species by ensuring project operations do not negatively impact their spawning success.

Public Interest Consideration
The New Hampshire Fish and Game Department, the Vermont Fish and Wildlife Department, and the New Hampshire Department of Environmental Services are requesting this study. The requestors are state natural resource agencies.

Existing Information
To our knowledge, no information exists related to this requested study.

An example of the water level fluctuations that occur in the Lower Connecticut River due to hydropower generation is shown below.



Project Nexus
Project operations have the potential to impact fish species by influencing spawning success and spawning habitat quality and quantity. For example, water level changes due to project operations could create conditions where fish eggs are exposed to air, where quality spawning

habitat is dewatered, and/or where fish abandon nests containing eggs. The New Hampshire Fish and Game Department has received several calls in past springs regarding "acres" of yellow perch eggs being dewatered in the Bellows Falls Impoundment.

The projects operate within normal, permitted and flood-condition reservoir fluctuation limits that include during high flow events, the dropping of stanchion bays that cannot be raised without a subsequent drawdown of the impoundment beyond normal project operating ranges. The full range of reservoir fluctuations, including periodic drawdowns for stanchion bay replacement, need to be addressed in this study.

Proposed Methodology

Common tools to evaluate fish spawning and habitat would be used including, but not limited, electrofishing, visual observations, telemetry and habitat measurements. The study area for this request includes all impounded waters, including tributaries and backwaters, within the project-affected areas of the Vernon, Bellows Falls and Wilder Hydroelectric Projects. A second year of study may be required if first year data collection is limited due to environmental or other conditions, or if river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period.

Level of Effort and Cost

TransCanada does not propose any studies to meet this need. Estimated cost for the study is moderate to high but is dependent on the amount of field study that is needed.

Literature Cited

Kart, J., R. Regan, S.R. Darling, C. Alexander, K. Cox, M. Ferguson, S. Parren, K. Royar, B. Popp, editors. 2005. Vermont's Wildlife Action Plan. Vermont Fish & Wildlife Department. Waterbury, Vermont. http://www.vtfishandwildlife.com/swg_cwcs_report.cfm. (Access September 10, 2012).

Vermont Fish and Wildlife Department . 2006. Vermont Fish and Wildlife Strategic Plan. http://www.vtfishandwildlife.com/library/reports_and_documents/Fish_and_wildlife/Strategic_Plan.pdf

Turners Falls Hydroelectric Project – FERC No. 1889-081
Northfield Mountain Pumped Storage Project – FERC No. 2485-063

Study Request 18: Impacts of impoundment water level fluctuations on resident fish spawning

Goals and Objectives

The goal of this study is to determine if project operations and water level fluctuations in the Turners Falls Project impoundment negatively impact anadromous and resident fish species including but not limited, to sea lamprey, white sucker, fall fish, smallmouth bass, yellow perch, spottail shiners, bluegill, black crappie, chain pickerel, northern pike, common sunfish, and walleye, and if impacts are found to occur, to develop appropriate mitigation measures. This study complements a separate study requests specific to American shad spawning and also on habitats affected by water level manipulations. An additional instream flow study request will address fish habitat effects for species of concern downstream of the Turners Falls Dam.

Specific objectives include:

1. Conduct field studies in the main stem, tributaries and backwaters of project affected areas to assess timing and location of fish spawning.
2. Conduct field studies in the main stem, tributaries and backwaters of project affected areas to evaluate potential impacts of impoundment fluctuation on nest abandonment, spawning fish displacement and egg dewatering. The study should also evaluate if changes in impoundment fluctuation range would mitigate for identified impacts and if other mitigative measures would lessen these impacts.

A second year of study may be required should river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period (end of March through mid July). Similarly, water temperatures should be closely considered, to ensure representative conditions occurred to reduce bias in observations.

Resource Management Goals

The Agency's goals related to aquatic natural resources are to:

1. Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
3. Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the VTFWD's mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).

Two of the Department's planning goals are:

1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.
2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

Vermont Fish and Wildlife Department's Strategic Plan (2002 -2010) focuses towards four major areas of concern: resource conservation, fish and wildlife-based recreation and use, human health and safety, efficient operations, and effective management.

Riverine fish species are an important component of the river's ecology and in some cases are the basis for a sport fishery. This requested study will help protect and conserve resident fish species by ensuring Project operations do not negatively impact their spawning success and spawning habitats.

Public Interest Consideration

The requestor is a resource agency.

Existing Information

To our knowledge, no information exists related to this requested study. The Massachusetts Integrated List of Waters shows the Project Area from the VT/NH state line to the Turners Falls Dam impaired due to "other flow regime alterations."

Project Nexus

Project operations have the potential to impact fish species by influencing spawning success and spawning habitat quality and quantity. For example, water level changes due to Project operations could create conditions where fish eggs are exposed to air, where spawning habitat is dewatered, and/or where fish abandon nests containing eggs.

Proposed Methodology

Common tools to evaluate fish spawning would be used including visual observations of habitats and sampled fish (i.e., in spawning condition, coloration, gonads mature, and other external features that become developed with spawning) collected by gears such as electrofishing, seining and other net gears during defined environmental and or time windows for spawning activity. Project operation impacted areas, should be quantified to identify and define areas subject to dewatering and mapped relative to observations of fish nests, spawning fish, egg deposits. During identified spawning periods for these species, suitable spawning habitats subjected to daily project operational fluctuations will be surveyed to document the type and extent of project effects on nests or spawning habitat (fall fish nests, lamprey nests, bass and sunfish nests, white sucker eggs/larvae) and observable eggs or larvae, relative to water level and other environmental condition, including water temperature and water velocity in noted areas.

Level of Effort and Cost

FirstLight Power does not propose any studies to meet this need. Estimated cost for the study is moderate.

Literature Cited

Kart, J., R. Regan, S.R. Darling, C. Alexander, K. Cox, M. Ferguson, S. Parren, K. Royar, B. Popp, editors. 2005. Vermont's Wildlife Action Plan. Vermont Fish & Wildlife Department. Waterbury, Vermont. http://www.vtfishandwildlife.com/swg_cwcs_report.cfm. (Access September 10, 2012).

Vermont Fish and Wildlife Department . 2006. Vermont Fish and Wildlife Strategic Plan. http://www.vtfishandwildlife.com/library/reports_and_documents/Fish_and_wildlife/Strategic_Plan.pdf

Wilder Hydroelectric Project – FERC No. 1892-026
Bellows Falls Hydroelectric Project – FERC No. 1855-045
Vernon Hydroelectric Project – FERC No. 1904-073

Study Request 19: Impacts of project operations on tributary and backwater area access and habitats.

Goals and Objectives
One goal of this study is to determine if water level fluctuations from the Vernon, Bellows Falls and Wilder Hydroelectric Projects result in a barrier(s) to fish movement in and out of tributaries and backwaters to the impoundments and riverine reaches below dams.

A second goal is to determine if water level fluctuations in the Vernon, Bellows Falls and Wilder Project impoundments impact water levels, available fish habitat and water quality in tributaries and backwaters to the impoundments and riverine reaches below dams, and if impacts are found, to ascertain how spatially far reaching they are and develop mitigation measures.

Results of this study may also be used to help determine the adequacy of existing downstream minimum flow requirements.

Specific objectives include:
1) Conduct a field study of tributaries and backwaters, including water velocity and habitat data where appropriate, to evaluate potential impacts of impoundment fluctuation on fish access to tributaries and backwater areas. The study should also evaluate if changes in impoundment fluctuation range would mitigate for any identified impacts and if other mitigative measures would improve access.

2) Conduct a field study to examine potential impacts of impoundment fluctuations on water levels, available habitat and water quality in tributaries and backwaters. The evaluation should also evaluate if changes in impoundment fluctuation range would mitigate for identified impacts and if other mitigative measures would lessen these impacts.

Resource Management Goals
The Agency’s goals related to aquatic natural resources are to:
1. Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
3. Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the

VTFWD's mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).

Two of the Department's planning goals are:

1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.
2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

Vermont Fish and Wildlife Department's Strategic Plan (2002 -2010) focuses towards four major areas of concern: resource conservation, fish and wildlife-based recreation and use, human health and safety, efficient operations, and effective management.

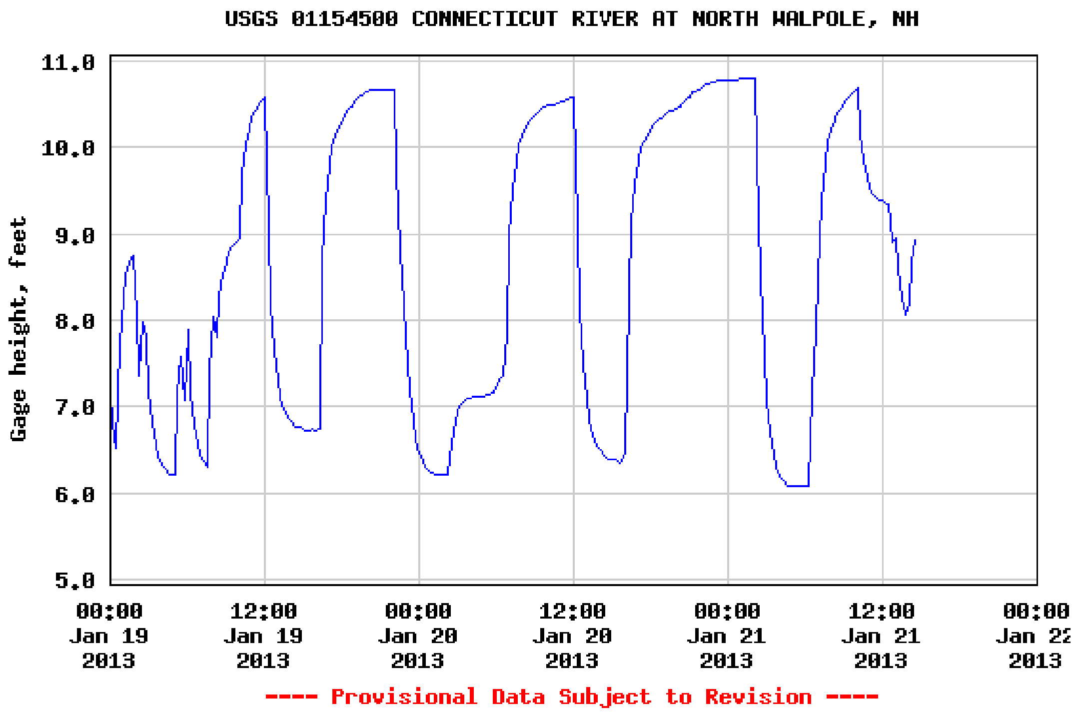
Diadromous and resident riverine fish species are an important component of the river's ecology and in some cases are the basis for a sport fishery. Furthermore, two of the states' Species of Greatest Conservation Need (SGCN) that would potentially be impacted have been documented in the project-affected areas.

This requested study will help promote tributary and backwater access and protect valuable fish habitat and maintain appropriate water quality conditions for diadromous and riverine fish species in project-affected areas. Maintaining connectivity between the mainstem of the Connecticut River and tributaries and backwaters is vital to the fish populations in these systems, as many fish species utilize these areas for spawning, rearing, refuge, and feeding.

Public Interest Consideration
The New Hampshire Fish and Game Department, the Vermont Fish and Wildlife Department, and the New Hampshire Department of Environmental Services are requesting this study. The requestors are state natural resource agency.

Existing Information
To our knowledge, no information exists related to this requested study.

An example of the water level fluctuations that occur in the Lower Connecticut River due to hydropower generation is shown below.



Project Nexus
Project operations have the potential to impact fish species life history requirements, biological interactions, and habitat quantity and quality. For example, water level changes due to project operations could create conditions that could impede free movement of fish between tributaries/backwaters and the mainstem of the Connecticut River, thus limiting access to spawning habitat and/or growth opportunities. Additionally, water level changes could also alter tributary and backwater fish habitat quality, quantity, and also water quality, thus decreasing productivity and available habitat. Furthermore, two of New Hampshire and Vermont's SGCN that could be impacted have been documented in the project-affected areas.

Proposed Methodology
Common tools to evaluate water level impacts would be used including: bathymetric mapping, substrate, depth and velocity measurements, and water quality information (dissolved oxygen, temperature, turbidity, and pH). Studies should be conducted throughout the year.

The study area for tributary and backwater fish sampling should cover all tributaries and backwaters within the project-affected areas of the Vernon, Bellows Falls and Wilder Hydroelectric Projects. A second year of study may be required if first year data collection is limited due to environmental or other conditions, or if river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period.

Level of Effort and Cost
TransCanada does not propose any studies to meet this need. Estimated cost for the study is relatively low.

Literature Cited

Kart, J., R. Regan, S.R. Darling, C. Alexander, K. Cox, M. Ferguson, S. Parren, K. Royar, B. Popp, editors. 2005. Vermont's Wildlife Action Plan. Vermont Fish & Wildlife Department. Waterbury, Vermont. http://www.vtfishandwildlife.com/swg_cwcs_report.cfm. (Access September 10, 2012).

Vermont Fish and Wildlife Department . 2006. Vermont Fish and Wildlife Strategic Plan. http://www.vtfishandwildlife.com/library/reports_and_documents/Fish_and_wildlife/Strategic_Plan.pdf

Turners Falls Hydroelectric Project – FERC No. 1889-081
Northfield Mountain Pumped Storage Project – FERC No. 2485-063

Study Request 19: Impacts of project operations on tributary and backwater area access and habitats.

Goals and Objectives
One goal of this study is to determine if water level fluctuations from the Turners Falls and Northfield Mountain Pumped Storage projects result in a barrier(s) to fish movement in and out of tributaries and backwaters to the impoundments and riverine reaches below dams.

A second goal is to determine if water level fluctuations in the Turners Falls and Northfield Mountain Pumped Storage project impoundments impact water levels, available fish habitat and water quality in tributaries and backwaters to the impoundments and riverine reaches below dams, and if impacts are found, to ascertain how spatially far reaching they are and develop mitigation measures.

Results of this study may also be used to help determine the adequacy of existing downstream minimum flow requirements.

Specific objectives include:
1) Conduct a field study of tributaries and backwaters, including water velocity and habitat data where appropriate, to evaluate potential impacts of impoundment fluctuation on fish access to tributaries and backwater areas. The study should also evaluate if changes in impoundment fluctuation range would mitigate for any identified impacts and if other mitigative measures would improve access.

2) Conduct a field study to examine potential impacts of impoundment fluctuations on water levels, available habitat and water quality in tributaries and backwaters. The evaluation should also evaluate if changes in impoundment fluctuation range would mitigate for identified impacts and if other mitigative measures would lessen these impacts.

Resource Management Goals
The Agency’s goals related to aquatic natural resources are to:
1. Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
3. Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the

VTFWD's mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).

Two of the Department's planning goals are:
1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.
2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

Vermont Fish and Wildlife Department's Strategic Plan (2002 -2010) focuses towards four major areas of concern: resource conservation, fish and wildlife-based recreation and use, human health and safety, efficient operations, and effective management.

This requested study will help promote tributary and backwater access and protect valuable fish habitat and maintain appropriate water quality conditions for diadromous and riverine fish species in project-affected areas. Maintaining connectivity between the mainstem of the Connecticut River and tributaries and backwaters is vital to the fish populations in these systems, as many fish species utilize these areas for spawning, rearing, refuge, and feeding.

Public Interest Consideration
The requestor is a state natural resource agency.

Existing Information
To our knowledge, limited information exists related to this requested study.

Project Nexus
Project operations have the potential to impact fish species life history requirements, biological interactions, and habitat quantity and quality. For example, water level changes due to project operations could create conditions that could impede free movement of fish between tributaries/backwaters and the mainstem of the Connecticut River, thus limiting access to spawning habitat and/or growth opportunities. Additionally, water level changes could also alter tributary and backwater fish habitat quality, quantity, and also water quality, thus decreasing productivity and available habitat.

Proposed Methodology
Common tools to evaluate water level impacts would be used including: bathymetric mapping, substrate, depth and velocity measurements, and water quality information (dissolved oxygen, temperature, turbidity, and pH). Studies should be conducted throughout the year.

The study area for tributary and backwater fish sampling should cover all tributaries and backwaters within the project-affected areas of the Turners Falls and Northfield Mountain Pumped Storage projects. A second year of study may be required if first year data collection is limited due to environmental or other conditions, or if river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period.

Level of Effort and Cost
First Light does not propose any studies to meet this need. Estimated cost for the study is moderate.

Literature Cited

Kart, J., R. Regan, S.R. Darling, C. Alexander, K. Cox, M. Ferguson, S. Parren, K. Royar, B. Popp, editors. 2005. Vermont's Wildlife Action Plan. Vermont Fish & Wildlife Department. Waterbury, Vermont. http://www.vtfishandwildlife.com/swg_cwcs_report.cfm. (Access September 10, 2012).

Vermont Fish and Wildlife Department . 2006. Vermont Fish and Wildlife Strategic Plan. http://www.vtfishandwildlife.com/library/reports_and_documents/Fish_and_wildlife/Strategic_Plan.pdf

Wilder Hydroelectric Project – FERC No. 1892-026
Bellows Falls Hydroelectric Project – FERC No. 1855-045
Vernon Hydroelectric Project – FERC No. 1904-073
Turners Falls Hydroelectric Project – FERC No. 1889-081
Northfield Mountain Pumped Storage Project – FERC No. 2485-063

Study Request 20: Evaluation of timing of downstream migratory movements of American eels on the mainstem Connecticut River

Goals and Objectives

The goal of this study is to better understand migration timing of adult, silver-phase American eels as it relates to environmental factors and operations of mainstem hydropower projects on the Connecticut River.

The objective of this study is to quantify and characterize the general migratory timing and presence of adult, silver-phase American eels in the Connecticut River relative to environmental factors and operations of mainstem river hydroelectric projects

Resource Management Goals

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the VTFWD's mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).

Two of the Department's planning goals are:

1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.
2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

Vermont Fish and Wildlife Department's Strategic Plan (2002 -2010) focuses towards four major areas of concern: resource conservation, fish and wildlife-based recreation and use, human health and safety, efficient operations, and effective management.

The Agency's goals related to aquatic natural resources are to:

1. Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
3. Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.

The American eel (*Anguilla rostrata*), is listed as one of both New Hampshire's and Vermont's Species of Greatest Conservation Need (SGCN). The status for conservation need in Vermont is listed as high priority (Kart et al. 2005), and the species is listed as "vulnerable" in New Hampshire. As identified in Vermont's Wildlife Action Plan (Kart et al. 2005), threats to the species include the construction of large dams on rivers which obstruct juvenile fish access to critical rearing habitats, as well as mortality associated with passing through hydroelectric facilities' turbines during their outmigration to sea.

As outlined in Vermont's Wildlife Action Plan (Kart et al. 2005), research and monitoring needs for this SGCN include determining their distribution and abundance, as the contribution of eels in northern regions to overall stock is unknown. One of the conservation strategies for this species is to support efforts to enhance access of American eels to Vermont waters by eliminating or minimizing impacts of dams and other obstructions along the Richelieu, St. Lawrence, and Connecticut Rivers.

The Atlantic States Marine Fisheries Commission has developed two documents related to the management of American eel:

1. <u>Interstate Fishery Management Plan for American Eel</u>. April 2000. Atlantic States Marine Fisheries Commission.
2. <u>Addendum II to the Fishery Management Plan for American Eel</u>. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

Objectives of the management plan include: (1) protect and enhance American eel abundance in all watershed where eel now occur; and (2) where practical, restore American eel to those waters where they had historical abundance but may now be absent by providing access to inland waters for glass eel, elvers, and yellow eel and adequate escapement to the ocean for pre-spawning adult eel.

Addendum II contains specific recommendations for improving upstream and downstream passage of American eel, including requesting that member states and jurisdictions seek special consideration for American eel in the FERC relicensing process.

The Connecticut River Atlantic Salmon Commission (CRASC) was established by Congress in 1983 (and reauthorized in 2002 for another 20 years) through the Connecticut River Atlantic Salmon Compact (Public Law 98-138). The Vermont Fish and Wildlife Department is a CRASC member agency, and a senior biologist from the department serves on the Technical Committee. In addition, the CRASC developed <u>A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin</u> in 2005. The goal of the plan is "to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem…" Management objectives in the plan include the following:

1. Protect and enhance eel populations where they currently exist;
2. Where practical, restore populations to waters where they had historical abundance;
3. Provide effective upstream and downstream fish passage around dams and other barriers within the species' range in the basin; and
4. Comply with all requirements of the Fishery Management Plan of the ASMFC.

Based on these plans, the Agency seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to downstream passage of American eel, the Agency goals are:

1. Minimize current and potential negative project operation effects that could hinder management goals and objectives.
2. Minimize project-related sources of downstream passage delay, injury, stress, and mortality in order to maximize the number of silver eels migrating to the spawning grounds.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), and the Federal Power Act (16 U.S.C. §791a, *et seq*.).

Public Interest Consideration
The requester is a state resource agency.

Existing Information
Data on timing of downstream migratory movements and rates of American eels in the mainstem Connecticut River are sparse and relatively incomplete. Preliminary data on presence of "eel-sized" acoustic targets have been collected (Haro et al. 1998) within the Turners Falls Project's Cabot Station forebay that were somewhat confirmed by video monitoring at the Cabot Station downstream fish bypass; however, these were short-term studies, with acoustic monitoring only performed from 17 September to 5 October and video monitoring only conducted between 18 September to 22 October.

Some daily monitoring of the downstream bypass at the Holyoke Dam (canal louver array) was performed in 2004 and 2005 (Kleinschmidt, Inc. 2005, 2006, Normandeau Associates 2007); these studies also were of relatively short duration (spanning from October 5 to November 10 in 2004 and September 9 to November 11 in 2005) and the sampler was only operated at night.

To date, no other directed studies of eel migratory movements have been conducted at any location on the Connecticut River mainstem. This information gap needs to be filled, as it relates directly to when downstream passage and protection measures need to be operated.

We also note that within the past seven years, the United States Fish and Wildlife Service (USFWS) has received two petitions to list the American eel under the Endangered Species Act. The first petition was received on November 18, 2004. On July 6, 2005 the USFWS issued a substantial 90-day finding on the petition and initiated a 12-month status review that concluded on February 2, 2007 with a finding that listing was not warranted. The second petition was filed on April 30, 2010 by the Council for Endangered Species Act Reliability. On September 29, 2011 the USFWS issued a substantial 90-day finding and initiated a 12-month status review. The USFWS is still accepting new American eel information for the ongoing status review. The USFWS also is currently in settlement negotiations with CESAR on their legal complaint that the USFWS failed to complete the 12-month finding within the statutory timeframe. Although the date for completion of the USFWS's 12-month finding on the latest petition is uncertain, it is likely that it will be made before any new licenses are issued for the projects.

Project Nexus

The timing of downstream migration of adult eels is poorly defined for the Connecticut River; therefore the general effects of hydroelectric project operations on eel survival to the ocean are unknown. Although separate study requests have been submitted to address project-specific downstream passage route selection, delays, and mortality of eels, general characteristics of river flow and environmental conditions may have significant relationships with project operation and eel migratory success and survival. For example, eels may tend to move immediately before or during periods of significant precipitation (or consequently river flow); times at which projects may be generating at maximum capacity or spilling, which may (or may not) present a higher passage risk to eels. Conversely, periods of low flow may be associated with a significant proportion of total river flow passing through turbine units, which present additional (or different) passage risk to eels. If discrete conditions which promote eel downstream migration are known, it may be possible to take actions with respect to project operations which reduce or minimize passage risk; i.e., operation of a bypass, reduction of intake approach velocities, directed spillage through a “safe” route, etc. These studies should provide baseline information on river-specific downstream migration to predict when silver-phase eels are expected to be migrating in the mainstem Connecticut River, from which project operations could be modified to minimize passage risks.

The studies are proposed for a single or multiple sites; the results will be relevant to all sites on the Connecticut River mainstem.

Proposed Methodology

Quantification of downstream movements of American eels in river systems requires systematic sampling of migrants throughout the migratory season. This can be accomplished with traditional active trapping methods; i.e., fyke or stow net sampling, weirs, or eel racks, but these methods are technically challenging on larger mainstem rivers, due to the scale of flows that need to be sampled, difficulties in operation throughout all flow conditions, and high debris loading during fall flows. Passive monitoring of migrant eels using hydroacoustic methods offers an alternative to active trapping. However, passive monitoring requires verification of potential acoustic targets with some level of active (collection) or visual (traditional optical or acoustic video) sampling.

Two potential locations offer opportunities to conduct simultaneous passive and active sampling: the Cabot Station (Turners Falls project) canal/forebay and the Holyoke Dam forebay and canal louver/bypass system. Each location possesses a route of downstream passage which conducts a significant proportion of river flow (Cabot canal and Holyoke forebay or canal), and each has a proximal bypass equipped with a sampler so that fish can be concentrated/collected from the passage route and identified to species. Project operations do influence the relative proportion of flow (and thus numbers of downstream migrant eels) in each passage route, so numbers of eels sampled in each route represent only a proportion of the total number of eels migrating downstream within the entire river. Because the absolute proportion of eels using a specific route at any one time is unknown, numbers of eels quantified within a route must serve as a relative index of the degree of migratory movement.

This study shall quantify eel movements in either one, or preferably both, locations for two consecutive years (since environmental conditions strongly influence migratory timing of eels, which can vary significantly from year to year; Haro 2003). Eels will be quantified using methods similar to Haro et al. (1999), by continuously monitoring a fixed location at the projects with hydroacoustics. Because eels tend to concentrate in areas of dominant flow (Brown et al. 2009, EPRI 2001), the zone to be monitored should pass a dominant proportion of project flow throughout most periods of operation (i.e., forebay intake area). Hydroacoustic monitoring shall encompass the entire potential migratory season, beginning in mid-August and ending in mid-December, and shall operate 24 hours per day. Data will be recorded for later processing and archiving.

Systematic active quantification of eels at downstream bypass samplers shall be performed simultaneously with passive hydroacoustic monitoring, to verify presence of eels and relative abundance of eel-sized hydroacoustic targets from the hydroacoustic data. Although daily operation of the bypass sampler could be performed, a more comprehensive technique is to monitor eels entering the bypass with an acoustic camera (i.e. DIDSON, BlueView, etc.). The acoustic camera will afford positive visual identification of eels as they enter the bypass, which is a concentration point for migrating eels. Acoustic camera monitoring will also allow monitoring to be performed 24 hours a day, and will be relatively unaffected by water turbidity (which influences effectiveness of traditional optical video monitoring). The acoustic camera system will be operated during the same time period as acoustic monitoring, and images will be recorded for later processing and archiving.

Data analyses of hydroacoustic, acoustic camera, bypass sampling, and environmental/ operational data will follow standard methodology.

Project operation (flows, levels, gate openings, number of units operating and operation level) and environmental conditions (river flow, temperature, turbidity, air temperature, precipitation) will be monitored regularly (hourly measurements if possible) throughout the duration of the studies.

These methodologies are consistent with accepted practice.

Level of Effort and Cost

The level of cost and effort for the downstream migrant eel migratory timing study would be moderate, given the level of cost for instrumentation, deployment, and data review/analysis. Cost is estimated at $50,000 per year for the study.

The applicant did not propose any studies to meet this need in the PAD.

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Wilder Hydroelectric Project – FERC No. 1892-026
Bellows Falls Hydroelectric Project – FERC No. 1855-045
Vernon Hydroelectric Project – FERC No. 1904-073

Study Request 21: Downstream American eel passage

Goals and Objectives

The goal of this study is to determine the impact of three hydroelectric projects on the outmigration of silver eels in the Connecticut River. Entrainment at the conventional turbines at the Vernon, Bellows Falls, and Wilder projects can result in mortality or injury. It is important to understand the passage routes at each project and the potential for delay, injury, and mortality to assess alternative management options to increase survival.

The objectives of this study are:

1. Quantify the movement rates (including delays) and relative proportion of eels passing via various routes at the projects (i.e. through the turbines, through the downstream bypasses; spilled at the dams, etc.).
2. Evaluate instantaneous and latent mortality and injury of eels passed via each potential route.

Resource Management Goals

The Agency's goals related to aquatic natural resources are to:

1. Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
3. Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the VTFWD's mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).

Two of the Department's planning goals are:

1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.
2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

Vermont Fish and Wildlife Department's Strategic Plan (2002 -2010) focuses towards four major areas of concern: resource conservation, fish and wildlife-based recreation and use, human health and safety, efficient operations, and effective management.

The American eel (*Anguilla rostrata*), is listed as one of both New Hampshire's and Vermont's Species of Greatest Conservation Need (SGCN). The status for conservation need in Vermont is listed as high priority (Kart et al. 2005), and the species is listed as "vulnerable" in New Hampshire. As identified in Vermont's Wildlife Action Plan (Kart et al. 2005), threats to the species include the construction of large dams on rivers which obstruct juvenile fish access to critical rearing habitats, as well as mortality associated with passing through hydroelectric facilities' turbines during their outmigration to sea.

As outlined in Vermont's Wildlife Action Plan (Kart et al. 2005), research and monitoring needs for this SGCN include determining their distribution and abundance, as the contribution of eels in northern regions to overall stock is unknown. One of the conservation strategies for this species is to support efforts to enhance access of American eels to Vermont waters by eliminating or minimizing impacts of dams and other obstructions along the Richelieu, St. Lawrence, and Connecticut Rivers.

The Atlantic States Marine Fisheries Commission has developed two documents related to the management of American eel:

1. <u>Interstate Fishery Management Plan for American Eel</u>. April 2000. Atlantic States Marine Fisheries Commission.
2. <u>Addendum II to the Fishery Management Plan for American Eel</u>. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

Objectives of the management plan include: (1) protect and enhance American eel abundance in all watershed where eel now occur; and (2) where practical, restore American eel to those waters where they had historical abundance but may now be absent by providing access to inland waters for glass eel, elvers, and yellow eel and adequate escapement to the ocean for pre-spawning adult eel.

Addendum II contains specific recommendations for improving upstream and downstream passage of American eel, including requesting that member states and jurisdictions seek special consideration for American eel in the FERC relicensing process.

The Connecticut River Atlantic Salmon Commission (CRASC) was established by Congress in 1983 (and reauthorized in 2002 for another 20 years) through the Connecticut River Atlantic Salmon Compact (Public Law 98-138). The Vermont Fish and Wildlife Department is a CRASC member agency, and a senior biologist from the department serves on the Technical Committee. The CRASC developed <u>A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin</u> in 2005. The goal of the plan is "to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem…" Management objectives in the plan include the following:

1. Protect and enhance eel populations where they currently exist;
2. Where practical, restore populations to waters where they had historical abundance;

3. Provide effective upstream and downstream fish passage around dams and other barriers within the species' range in the basin; and
4. Comply with all requirements of the Fishery Management Plan of the ASMFC.

Based on these plans, the Agency seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to downstream passage of American eel, the Agency's goals are:

1. Minimize current and potential negative project operation effects that could hinder management goals and objectives.
2. Minimize project-related sources of downstream passage delay, injury, stress, and mortality in order to maximize the number of silver eels migrating to the spawning grounds.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), and the Federal Power Act (16 U.S.C. §791a, *et seq*.).

Public Interest Consideration

The requester is a state resource agency.

Existing Information

The PAD contains information on the biology and life history of the American eel. It also summarizes eel collection data within the Vernon and Bellows Falls project areas. Eels have been collected both upstream and downstream of the Vernon Project and also have been counted passing the upstream anadromous fish ladder. Eels also have been documented upstream of the Bellows Falls and Wilder projects.

To date, no directed studies of eel entrainment or mortality have been conducted at any of the projects. These information gaps need to be filled so resource agencies can assess the relative and cumulative impact of project operations on outmigrating eels and develop adequate passage and protection measures to meet management goals and objectives.

We also note that within the past seven years, the USFWS has received two petitions to list the American eel under the Endangered Species Act. The first petition was received on November 18, 2004. On July 6, 2005 the USFWS issued a substantial 90-day finding on the petition and initiated a 12-month status review that concluded on February 2, 2007 with a finding that listing was not warranted. The second petition was filed on April 30, 2010 by the Council for

Endangered Species Act Reliability (CESAR). On September 29, 2011 the USFWS issued a substantial 90-day finding and initiated a 12-month status review. The USFWS is still accepting new American eel information for the ongoing status review. The USFWS also is currently in settlement negotiations with CESAR on their legal complaint that the USFWS failed to complete the 12-month finding within the statutory timeframe. Although the date for completion of the USFWS's 12-month finding on the latest petition is uncertain, it is likely that it will be made before any new licenses are issued for the projects.

Project Nexus

The Vernon, Bellows Falls, and Wilder projects operate as peaking facilities, except during periods when inflow exceeds the hydraulic capacities of the stations. Silver eels outmigrate during the mid- summer through late fall, a time of year when flows are generally within the operating capacities of the stations. Therefore, the projects would be expected to spill infrequently during the silver eel outmigration.

The project configurations present problems with respect to providing safe, timely and effective passage for outmigrating eels. The intakes likely are deep and, while no specification for the trashracks were provided in the PADs, it is unlikely that they would prevent impingement and/or entrainment of eels. Existing anadromous downstream passage facilities at the projects also would not be expected to be effective for eels; the target anadromous species are surface-oriented, while eels tend to move much deeper in the water column. Eels are known to occur upstream of the dams; therefore, it is necessary to understand how eels move through the projects and the level of injury or mortality caused by entrainment through the projects' turbines.

Proposed Methodology

In order to understand the movements of outmigrating silver eels as they relate to operations at the Vernon, Bellows Falls, and Wilder projects, radio telemetry technology should be utilized. Radio telemetry is an accepted technology that has been used for a number of studies associated with hydropower projects, including at the Muddy Run Project (FERC No. 2355).

Studies should be designed to investigate route selection (i.e., entrainment vs. spill) independently from estimation of mortality/injury, because these metrics require different telemetric methodologies. Studies also will likely benefit from data collected over both study years (especially route selection studies, which may be more significantly affected by environmental conditions during a given season that mortality/injury studies). It is also envisioned that results from route selection studies can guide design of turbine mortality studies. Therefore, it is proposed, at a minimum, that route selection studies be conducted in multiple years, but mortality/injury studies may be conducted after the first year of route selection studies has been completed.

1. **Objective 1: Route Selection**
   This study will involve systematic releases of radio-tagged silver phase eels at strategic points above areas of interest, to assess general routes of passage (i.e., via spill, bypass, or turbines). Active downstream migrants should be collected within-basin if possible (i.e., Cabot or Holyoke bypass samplers), but fish sourced from out of basin may be

acceptable to meet sample size demands. Experimental fish must meet morphometric (e.g. eye diameter relative to body size) criteria to ensure they are migrant silver phase. Collections should be made within the migratory season (late Aug to mid Oct), and eels should be tagged and released within 21 days after capture, but preferably within seven days (particularly if the test eels are from out-of-basin).

All telemetered eels will be radio and passive integrated transponder (PIT) tagged. PIT antennas will be installed at bypasses at Vernon and Bellows Falls and monitored continuously to verify passage of eels via bypass channels.

Vernon Project Route Selection Study:
A minimum number of 50 telemetered eels (e.g., 5 separate groups of approximately 10 eels each) will be required to maximize the data return. Tagged eels should be released at least 5 km upstream of the Vernon project. Groups of eels should be released during spill and non-spill periods if possible. Telemetry receivers and antennas should be located to assess passage via the following potential routes: Vernon spillway; Fishway attraction water intake (if operational); Vernon downstream bypasses; and Vernon Station turbines.

Eels from the Bellows Falls route studies migrating to the Vernon Dam may be used to supplement (but not serve in lieu of) these release groups.

Bellows Falls Dam Route Selection Study:
A minimum number of 50 telemetered eels (e.g., 5 separate groups of approximately 10 eels each) will be required to maximize the data return. Groups of eels should be released during spill (if any) and non-spill and during periods of low, moderate, and high generation conditions, if possible. Tagged eels should be released at least 5 km upstream of the Bellows Falls Dam. If significant spillage occurs during releases, up to 50 additional eels should be released in the upper canal and allowed to volitionally descend through the canal to assure that sufficient number of eels are exposed to canal and powerhouse intake conditions. Telemetry receivers and antennas should be located upstream and downstream of the spillway, at the canal entrance, within the canal, in the fish downstream fish bypass entrance and turbine intakes and in mainstem below Bellows Falls Station to assess passage via the following potential routes: entrainment into the canal; passage over the spillway; into the upstream fishway attraction water intake (this should operate during the study to assess its use by eels as it may be operational in the future for riverine or eel passage as addressed in the Resident Fish Passage study request); the downstream fish bypass; and station turbines.

Eels from the Wilder route study migrating to the Bellow Falls Project may be used to supplement (but not serve in lieu of) these release groups.

Wilder Project Route Selection Study:
A minimum number of 50 telemetered eels (e.g., 5 separate groups of approximately 10 eels each) should be required to maximize the data return.

Tagged eels should be released at least 5 km upstream of the Wilder Project. Groups of eels should be released during spill and non-spill periods if possible. Telemetry receivers and antennas should be located to assess passage via the following potential routes: Wilder spillway; Fishway attraction water intake (if operational); Wilder downstream bypasses; and Wilder Station turbines.

Mobile tracking (i.e., via boat) in river reaches between release sites and several km downstream of Vernon Station will be performed at regular intervals during and after releases to confirm routes and fates of passed fish, or fish lost to follow-up.

Movement rates (time between release and detection at radio antenna locations, and between radio antenna locations) of eels passing the projects by various routes will also be quantified.

The route selection portion of this study should occur in both study years.

2. **Objective 2: Spill, Bypass, and Turbine Mortality/Injury Studies**

Spill, bypass, and turbine mortality will be assessed using a radio-telemetric balloon tag method. A minimum number of 50 tagged eels (e.g., 5 separate groups of approximately 10 eels each) will be required at each location (dam spillways, downstream bypasses, and station turbines) to maximize the data return.

For spill mortality sites (dam spillways and downstream bypasses), tagged eels will be injected or released into spill flow at points where water velocity exceeds 10 ft/sec, to minimize the possibility of eels swimming upstream into the headpond or canal. Passed balloon-tagged eels will be recovered below areas of spill and held for 48 hours in isolated tanks for observation of injury and latent mortality; unrecovered balloon-tagged eels will be censored from the data.

For turbine mortality sites (Vernon, Bellows Falls, and Wilder stations), tagged eels will be injected into intakes of units operating at or near full generation at points where intake water velocity exceeds 10 ft/sec, to minimize the possibility of eels swimming back upstream through the intakes. Passed balloon-tagged eels will be recovered in the tailrace and held for 48 hours in isolated tanks for observation of injury and latent mortality; unrecovered balloon-tagged eels will be censored from the data.

If the balloon tag mortality component of the study occurs in Study Year 1 then all possible route selection sites would need to be evaluated. If the balloon tag mortality component of the study occurs in Study Year 2, then results from the route selection study (Year 1) could be used to inform which sites need to be evaluated for mortality.. Eels recovered from balloon tag studies should not be used for route selection studies.

Data analyses of route selection and turbine mortality (instantaneous and latent) will follow standard methodology.

Project operation (flows, levels, gate openings, number of units operating and operation level) and environmental conditions (river flow, temperature, turbidity, air temperature, precipitation) will be monitored regularly (hourly measurements if possible) throughout the duration of the studies.

These methodologies are consistent with accepted practice.

Level of Effort and Cost

The level of cost and effort for the downstream eel passage study would be moderate to high; silver eels would need to be collected, tagged, and released in several locations over the course of the migration season. Antennas and receivers would need to be installed at the intakes of all stations as well as at the dam spillways and Station bypasses, and monitored regularly. Data would need to be retrieved periodically, then analyzed. A multi-site route selection study conducted by the USGS Conte Lab on the Shetucket River in Connecticut cost approximately $75,000 for the first year of study. Costs are estimated at $100,000 per year for the Route Selection studies and $75,000 per year for the Spill, Bypass, and Turbine Mortality/Injury Studies, for each project.

The applicant did not propose any studies to meet this need in the PAD.

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Turners Falls Hydroelectric Project – FERC No. 1889-081
Northfield Mountain Pumped Storage Project – FERC No. 2485-063

Study Request 21: Downstream American eel passage

Goals and Objectives

The goal of this study is to determine the impact of two hydroelectric projects on the outmigration of silver eels in the Connecticut River. Entrainment of eels at the Northfield Mountain Pumped Storage Station (NFMPS) removes eels from the river, effectively extirpating them from the population. Entrainment at the conventional turbines at Station 1 and Cabot Station of the Turners Falls Project can result in mortality or injury. It is important to understand the passage routes at each project and the potential for mortality to assess alternative management options to increase survival.

The objectives of this study are:

1. Quantify the movement rates (including delays) and relative proportion of eels passing via various routes at the projects; i.e. for NFMPS, the proportion entrained into the intake; for Turners Falls Dam, the proportion entrained into the power canal and spilled via bascule and Tainter gates; for the Cabot Canal, proportion of fish passing via spillways, turbines, and the downstream bypass.
2. Evaluate instantaneous and latent mortality and injury of eels passed via the Turners Falls Dam routes, including bascule and Tainter gates, spillways, turbines, and the downstream bypass.

Resource Management Goals

The Agency's goals related to aquatic natural resources are to:

1. Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
3. Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.
4.

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the VTFWD's mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).

Two of the Department's planning goals are:

1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.

2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

Vermont Fish and Wildlife Department's Strategic Plan (2002 -2010) focuses towards four major areas of concern: resource conservation, fish and wildlife-based recreation and use, human health and safety, efficient operations, and effective management.

The American eel (*Anguilla rostrata*), is listed as one of both New Hampshire's and Vermont's Species of Greatest Conservation Need (SGCN). The status for conservation need in Vermont is listed as high priority (Kart et al. 2005), and the species is listed as "vulnerable" in New Hampshire. As identified in Vermont's Wildlife Action Plan (Kart et al. 2005), threats to the species include the construction of large dams on rivers which obstruct juvenile fish access to critical rearing habitats, as well as mortality associated with passing through hydroelectric facilities' turbines during their outmigration to sea.

As outlined in Vermont's Wildlife Action Plan (Kart et al. 2005), research and monitoring needs for this SGCN include determining their distribution and abundance, as the contribution of eels in northern regions to overall stock is unknown. One of the conservation strategies for this species is to support efforts to enhance access of American eels to Vermont waters by eliminating or minimizing impacts of dams and other obstructions along the Richelieu, St. Lawrence, and Connecticut Rivers.

The Atlantic States Marine Fisheries Commission has developed two documents related to the management of American eel:
1. <u>Interstate Fishery Management Plan for American Eel</u>. April 2000. Atlantic States Marine Fisheries Commission.
2. <u>Addendum II to the Fishery Management Plan for American Eel</u>. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

Objectives of the management plan include: (1) protect and enhance American eel abundance in all watershed where eel now occur; and (2) where practical, restore American eel to those waters where they had historical abundance but may now be absent by providing access to inland waters for glass eel, elvers, and yellow eel and adequate escapement to the ocean for pre-spawning adult eel.

Addendum II contains specific recommendations for improving upstream and downstream passage of American eel, including requesting that member states and jurisdictions seek special consideration for American eel in the FERC relicensing process.

In addition, the Connecticut River Atlantic Salmon Commission (CRASC) developed <u>A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin</u> in 2005. The goal of the plan is "to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem…" Management objectives in the plan include the following:
1. Protect and enhance eel populations where they currently exist;

2. Where practical, restore populations to waters where they had historical abundance;
3. Provide effective upstream and downstream fish passage around dams and other barriers within the species' range in the basin; and
4. Comply with all requirements of the Fishery Management Plan of the ASMFC.

Based on these plans, the Agency seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:
1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to downstream passage of American eel, the Agency's goals are:
1. Minimize current and potential negative project operation effects that could hinder management goals and objectives.
2. Minimize project-related sources of downstream passage delay, injury, stress, and mortality in order to maximize the number of silver eels migrating to the spawning grounds.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), and the Federal Power Act (16 U.S.C. §791a, *et seq*.).

Public Interest Consideration

The requester is a resource agency.

Existing Information

The PAD contains information on the biology, life history, and regulatory status of American eel. It also discusses 2-D and 3-D telemetry studies that were conducted at Cabot Station in 1996, 1997, 2002 and 2003. Results of those studies indicate that a significant proportion of eels entering the Cabot forebay become entrained (90% in 2002, 100% in 2003; Brown 2005, Brown et al. 2009). The PAD notes that the study done in 2003 determined that 15 of the 29 test eels were detected at the Hadley Falls Station. However, that study was not designed to assess turbine mortality.

To date, no directed studies of eel mortality at Cabot Station or eel entrainment or mortality at either Station 1 or the NFMPS facility have been conducted. These information gaps need to be filled so resource agencies can assess the relative and cumulative impact of project operations on outmigrating eels and develop adequate passage and protection measures to meet management goals and objectives.

We also note that within the past seven years, the USFWS has received two petitions to list the American eel under the Endangered Species Act. The first petition was received on November

18, 2004. On July 6, 2005 the USFWS issued a substantial 90-day finding on the petition and initiated a 12-month status review that concluded on February 2, 2007 with a finding that listing was not warranted. The second petition was filed on April 30, 2010 by the Council for Endangered Species Act Reliability (CESAR). On September 29, 2011 the USFWS issued a substantial 90-day finding and initiated a 12-month status review. The USFWS is still accepting new American eel information for the ongoing status review. The USFWS also is currently in settlement negotiations with CESAR on their legal complaint that the USFWS failed to complete the 12-month finding within the statutory timeframe. Although the date for completion of the USFWS's 12-month finding on the latest petition is uncertain, it is likely that it will be made prior to any new licenses are issued for the projects.

Project Nexus

The Turners Falls Project operates as a peaking facility, except during periods when inflow exceeds the hydraulic capacity of Cabot Station and Station 1. Silver eels outmigrate during the mid- summer through late fall, a time of year when flows are generally near the maximum operating capacity of the stations. Therefore, the project would be expected to spill infrequently during the silver eel outmigration beyond the nominal amount required in the bypass reach.

Racks at Cabot Station, Station 1, and NFMPS facility are not designed to protect eels from entrainment. At Cabot, the racks have one-inch clear spacing on the top 11-feet, with five-inch clear spacing on the bottom 20 feet of racks. The approach velocity at the racks is approximately 2.0 feet per second at maximum hydraulic capacity. At Station 1, the racks have 2.6-inch clear spacing and an approach velocity of 1.2 feet per second. Eels can readily pass through a 2.6-inch clear space. NFMPS has 48-foot-deep trashracks with six-inch clear spacing over the intake and an approach velocity of 3.5 feet per second at full pumping capacity (15,000 cfs).

As mentioned above, previous studies conducted at Cabot Station documented eel entrainment. Cabot Station has existing downstream passage facilities designed for anadromous species, but studies have documented few eels utilizing the surface bypass (likely because Cabot has a relatively deep, wide intake area). Station 1 has no passage and protection facilities. NFMPS has a seasonally-deployed barrier net to minimize entrainment of Atlantic salmon smolts, but it is only operated from April through June 15 annually. While no studies have been conducted at Station 1 or NFMPS facility, the rack spacing is wide enough to allow for entrainment.

Proposed Methodology

In order to understand the movements of outmigrating silver eels as they relate to operations at the Northfield Mountain Pump Storage Facility, Station 1, and Cabot Station, radio telemetry technology should be utilized. Radio telemetry is an accepted technology that has been used for a number of studies associated with hydropower projects, including at the Muddy Run Project (FERC No. 2355).

Studies should be designed to investigate route selection (i.e., entrainment vs. spill) independently from estimation of mortality/injury, because these metrics require different telemetric methodologies. Studies also will likely benefit from data from several seasons (especially route selection studies, which may be more significantly affected by environmental conditions during a given season that mortality/injury studies). It is also envisioned that results from route selection studies can guide design of turbine mortality studies. Therefore, it is proposed, at a minimum, that route selection studies be conducted in multiple years, but mortality/injury studies may be conducted after the first year of route selection studies have been completed.

1. Objective 1: Route Selection

This study will involve systematic releases of radio-tagged silver phase eels at strategic points above areas of interest, to assess general routes of passage (i.e., via spill, bypass, or turbines). Active downstream migrants should be collected within-basin if possible (i.e., Cabot or Holyoke bypass samplers), but fish sourced from out of basin may be acceptable to meet sample size demands. Experimental fish must meet morphometric (e.g. eye diameter relative to body size) criteria to ensure they are migrant silver phase. Collections should be made within the migratory season (late Aug to mid Oct), and eels should be tagged and released within 7 days of collection.

NFMPS Route Selection Study:

A minimum number of 50 telemetered eels (e.g., 5 separate groups of approximately 10 eels each) will be required to maximize the data return. Eels will be released at least 5 km upstream of the NFMPS project; releases should be timed so that there is a significant probability that migrating eels will encounter NFMPS during the pumping stage. Radio telemetry antennas will be strategically placed to determine times eels are present within the river reach in the vicinity of the NFMPS intakes, within the intakes themselves, and whether they are entrained into the upper reservoir.

Turners Falls Dam Route Selection Study:

A minimum number of 50 telemetered eels (e.g., 5 separate groups of approximately 10 eels each) will be required to maximize the data return. Groups of eels should be released during spill and non-spill periods if possible. Tagged eels will be released at least 3 km upstream of the Turners Falls dam but several km below the intake to NFMPS. Telemetry receivers and antennas will be located above and below the dam to assess passage via the following potential routes: entrainment into power canal; passage via spill over the bascule gates; passage via spill through the Tainter gates.

Eels from the NFMPS route study not entrained into the NFMPS intake and migrating to the Turners Falls Dam may be used to supplement (but not serve in lieu of) these release groups.

Turners Falls Project – Canal Route Selection Study:

A minimum number of 50 telemetered eels (e.g., 5 separate groups of approximately 10 eels each) will be required to maximize the data return. Groups of eels should be released during periods of low, moderate, and high generation conditions if possible. Eels will be released in the upper canal (ideally just downstream of the Gatehouse), and allowed to volitionally descend through the canal. Telemetry receivers and antennas will be located within the canal, bypass, channel, and mainstem below Cabot Station to assess passage via the following potential routes: Spillway Fishway attraction water intake (if operational); Station 1 turbines; Cabot Station spillway; Cabot Station bypass; Cabot Station turbines

Eels from the NFMPS and Turners Falls Dam Route Studies not entrained into the NFMPS intake and migrating into the Turners Falls Canal may be used to supplement (but not serve in lieu of) these release groups.

Mobile tracking (i.e., via boat) in river reaches between release sites and several km downstream of Cabot Station will be performed at regular intervals during and after releases to confirm routes and fates of passed fish, or fish lost to follow-up.

Movement rates (time between release and passage) of eels passing the projects by various routes will also be quantified.

The route selection portion of this study should occur in both study years.

2. Objective 2: Spill, Bypass, and Turbine Mortality/Injury Studies
Spill, bypass, and turbine mortality will be assessed using a radio-telemetric balloon tag method. A minimum number of 50 tagged eels (e.g., 5 separate groups of approximately 10 eels each) will be required at each location (dam bascule gate, dam Tainter gate, Cabot Station spillway, Cabot Station bypass, Station 1 and Cabot Station) to maximize the data return. Turbine mortality studies are not required at NFMPS because it is assumed that all entrained fish (including eels) are lost to the Connecticut River system.

For spill mortality sites (dam bascule gate, dam Tainter gate, Cabot spillway, Cabot Station bypass), tagged eels will be injected or released into spill flow at points where water velocity exceeds 10 ft/sec, to minimize the possibility of eels swimming upstream into the headpond or canal. Passed balloon-tagged eels will be recovered below areas of spill and held for 48 hours in isolated tanks for observation of injury and latent mortality; unrecovered balloon-tagged eels will be censored from the data.

For turbine mortality sites (Station 1 and Cabot Station), tagged eels will be injected into intakes of units operating at or near full generation at points where intake water velocity exceeds 10 ft/sec, to minimize the possibility of eels swimming back upstream through the intakes. Passed balloon-tagged eels will be recovered in the tailrace and held for 48 hours in isolated tanks for observation of injury and latent mortality; unrecovered balloon-tagged eels will be censored from the data.

Mobile tracking (i.e., via boat) in river reaches between release sites and several km downstream of Cabot Station will be performed at regular intervals after releases to confirm routes and fates of passed fish, or fish lost to follow-up.

The turbine mortality component of the study should occur in Study Year 2.

Data analyses of route selection and turbine mortality (instantaneous and latent) will follow standard methodology.

Project operation (flows, levels, gate openings, number of units operating and operation level) and environmental conditions (river flow, temperature, turbidity, air temperature, precipitation) will be monitored regularly (hourly measurements if possible) throughout the duration of the studies.

These methodologies are consistent with accepted practice.

Level of Effort and Cost

The level of cost and effort for the downstream eel passage study would be moderate to high; silver eels would need to be collected, tagged, and released in several locations over the course of the migration season. Antennas and receivers would need to be installed at the intakes to all stations as well as at the Turners Falls dam spillway and Cabot Station bypass, and monitored regularly. Data would need to be retrieved periodically, then analyzed. A multi-site route selection study conducted by the USGS Conte Lab on the Shetucket River in Connecticut cost approximately $75,000 for the first year of study. Cost are estimated at $100,000 per year for the Route Selection studies and $75,000 per year for the Spill, Bypass, and Turbine Mortality/Injury Studies.

In the PAD, the applicant has identified the need to assess issues related to downstream passage for American eels at the project, but indicates that it intends to rely on information from previously conducted studies and ongoing studies. The USFWS is not aware of any previously conducted or ongoing studies related to downstream eel passage.

Literature Cited

Brown, L.S. 2005. Characterizing the downstream passage behavior of silver phase American eels at a small hydroelectric facility. M.Sc. Thesis, Department of Natural Resource Conservation, University of Massachusetts, Amherst, Massachusetts. 110 pp.

Brown, L., A. Haro, and T. Castro-Santos. 2009. Three-dimensional movement of silver-phase American eels in the forebay of a small hydroelectric facility. Pages 277-291in: J. Casselman et al. editors. Eels at the Edge: Science, Status, and Conservation Concerns. American Fisheries Society, Bethesda, MD.

EPRI (Electric Power Research Institute). 2001. Review and documentation of research and technologies on passage and protection of downstream migrating catadromous eels at hydroelectric facilities. EPRI Technical Report No. 1000730, Palo Alto, California 270 pp.

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Vermont Fish and Wildlife Department . 2006. Vermont Fish and Wildlife Strategic Plan. http://www.vtfishandwildlife.com/library/reports_and_documents/Fish_and_wildlife/Strategic_Plan.pdf

Wilder Hydroelectric Project – FERC No. 1892-026
Bellows Falls Hydroelectric Project – FERC No. 1855-045
Vernon Hydroelectric Project – FERC No. 1904-073

Study Request 22: Upstream American eel passage assessment

Goals and Objectives

This study has two objectives:

1. Conduct systematic surveys of eel presence/abundance at tailrace and spillway locations at the Vernon, Bellows Falls, and Wilder projects to identify areas of concentration of eels staging in pools or attempting to ascend wetted structures that would potentially establish the most effective locations to place upstream eel passage facilities.
2. Collect eels with temporary trap/pass devices from areas identified from surveys as potential locations of eel concentration to assess whether eels can be collected/passed in substantial numbers, and whether locations are viable sites for permanent eel trap/pass structures.

Resource Management Goals

The American eel (*Anguilla rostrata*), is also one of New Hampshire and Vermont's Species of Greatest Conservation Need (SGCN). The status for conservation need in Vermont is listed as high priority (Kart et al. 2005), and the species is listed as "vulnerable" in New Hampshire. As identified in Vermont's Wildlife Action Plan (Kart et al. 2005), threats to the species include the construction of large dams on rivers which obstruct juvenile fish access to critical rearing habitats, as well as mortality associated with passing through hydroelectric facilities' turbines during their outmigration to sea.

As outlined in Vermont's Wildlife Action Plan (Kart et al. 2005), research and monitoring needs for this SGCN include determining their distribution and abundance, as the contribution of eels in northern regions to overall stock is unknown. One of the conservation strategies for this species is to support efforts to enhance access of American eels to Vermont waters by eliminating or minimizing impacts of dams and other obstructions along the Richelieu, St. Lawrence, and Connecticut Rivers.

The Atlantic States Marine Fisheries Commission has developed two documents related to the management of American eel:

1. <u>Interstate Fishery Management Plan for American Eel</u>. April 2000. Atlantic States Marine Fisheries Commission.
2. <u>Addendum II to the Fishery Management Plan for American Eel</u>. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

In addition, the Connecticut River Atlantic Salmon Commission (CRASC) developed the draft document: <u>A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin</u> in 2005. The goal of the plan is "to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem…" Management objectives in the plan include the following:

1. Protect and enhance eel populations where they currently exist;
2. Where practical, restore populations to waters where they had historical abundance;
3. Provide effective upstream and downstream fish passage around dams and other barriers within the species' range in the basin; and
4. Comply with all requirements of the Fishery Management Plan of the ASMFC.

Based on these plans, the Agency seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the three projects. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to upstream passage of American eel, the Agency's goals are:

1. Minimize current and potential negative project operation effects that could hinder management goals and objectives.
2. Minimize project-related sources of upstream passage delay, injury, and stress in order to facilitate access to historical rearing habitat.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), and the Federal Power Act (16 U.S.C. §791a, *et seq*.).

Public Interest Consideration

The requester is a resource agency.

Existing Information

The PAD contains no information relative to areas where eels seeking to move upstream concentrate downstream of the three dams, or annual numbers of eels attempting to ascend past the dams. While eels have been known to ascend the Vernon and Bellows Falls fish ladders, their efficiency for passing eels is unknown, and they are only operated during the American shad passage season (from April 15 through July 15). Eels are currently able to pass Vernon, Bellows Falls, and Wilder dams (as evidenced by documented presence of eels upstream), but the total number of eels attempting to pass all three dams and the proportion successfully passing each project is unknown (but suspected to be low). The downstream Holyoke Project has operated upstream eel passage facilities since 2004. Last year these facilities passed over 40,000 juvenile eels. While the next dam upstream (the Turners Falls Project; FERC No. 1889) has no dedicated upstream eel passage facilities, eels have been known to ascend the Cabot Station fish ladder (A. Haro, U.S. Geological Survey, pers. comm.). Although there is rearing habitat in between the Turners Falls and Vernon dams, some eels will attempt to continue upstream, and passage needs to be provided so these fish can access historical habitat.

These information gaps need to be filled so resource agencies can determine the best locations to site upstream eel passage facilities and assess whether operating the existing anadromous ladders would be an effective mechanism to move juvenile eels upstream past the projects.

We also note that within the past seven years, the USFWS has received two petitions to list the American eel under the Endangered Species Act. The first petition was received on November 18, 2004. On July 6, 2005 the USFWS issued a substantial 90-day finding on the petition and initiated a 12-month status review that concluded on February 2, 2007 with a finding that listing was not warranted. The second petition was filed on April 30, 2010 by the Council for Endangered Species Act Reliability (CEASAR). On September 29, 2011 the USFWS issued a substantial 90-day finding and initiated a 12-month status review. The USFWS is still accepting new American eel information for the ongoing status review. The USFWS also is currently in settlement negotiations with CESAR on their legal complaint that the USFWS failed to complete the 12-month finding within the statutory timeframe. Although the date for completion of the USFWS's 12-month finding on the latest petition is uncertain, it is likely that it will be made before any new licenses are issued for the projects.

Project Nexus

The three projects generate hydropower on the head created by the Vernon, Bellows Falls, and Wilder dams. These dams create barriers to upstream migrating eels. While some eels are able to pass dams, some are not, and the passability of a given dam depends on factors such as its height, hydraulics, presence of climbable surfaces, presence of predators, risk of exposure to heat or drying while climbing a dam, etc. All three dams are high (Vernon: 58 ft. high; Bellows Falls: 30 ft. high; and Wilder: 60 ft. high), and the majority of the dam faces are dry during most of the upstream eel passage season. Design of the dams is not currently amenable to passage of eels by climbing. As mentioned earlier, the existing anadromous passage facilities are not designed to pass eels, and even if some eels are able to ascend the ladders, they may incur delays (in attraction or passage rates), be size-selective (e.g. velocity barrier for small eels presented by ~8 ft/sec flow through weirs and orifices), present a potential predation risk (predators in or near the fishways), and are not operated throughout the upstream eel passage season.

Proposed Methodology

Objective 1: Systematic Surveys

Surveys of eel presence and relative abundance should be conducted at regular intervals throughout the eel upstream migratory season (~1 May to ~15 October, or when river temperatures exceed 10 C). Surveys should consist of visual inspection and trapping in likely areas where eels may concentrate as they attempt to climb structures wetted by significant spill or leakage flow below the dams and associated structures. These locations include: the upstream fish ladders at all three projects (dewatered state) and leakage or overflow points along the downstream faces of all three dams, including spillways. Methods should include visual surveys (on foot, from a boat, or snorkeling) and trapping using small mesh (< 1/8” clear opening) baited eel pots. Visual surveys should be performed once per week, at night, preferentially during precipitation events. Trap sets should be performed once per week, with an overnight soak time. Recorded data should include location, observation of eels (presence, absence, relative numbers, relative sizes, behaviors, time/date of observation), and survey method.

Objective 2: Trap/Pass Collections

Areas identified from Systematic Surveys as having significant number of eels present should be targeted as potential areas for permanent eel trap/passes, and should be initially assessed using temporary/portable trap passes. At a minimum (regardless of survey results), temporary trap passes should be installed at stilling basins and/or lower sections of fishways supplied with minimal attraction flow (0.5-1.0 cfs) during dewatered conditions at all three projects , as these locations may be supplemented with additional attraction flow and have high potential for being concentration points for upstream migrant eels. Similarly, traps should also be placed at spillway or bypass channel locations where eels have a potential to climb wetted (e.g., via leakage) flow zones, at the highest points where eels are able to climb to, or where otherwise feasible. Temporary trap/passes should be purpose-designed and built for each location, and operated throughout the eel upstream migratory season (~1May to 15 October, or when river temperatures exceed 10° C). Ramp-type traps with supplementary attraction flow are preferred temporary trap/pass designs. Traps should operate daily, with catches quantified every 2-3 days. Recorded data should include location, trapping interval, absolute numbers of eels trapped, relative eel sizes, and hydraulic and environmental conditions during the trapping period.

All collected eels from surveys should be released at their point of capture; those eels collected from trap/pass collections should be transported to and released into the headponds upstream of where they were collected.

These methodologies are consistent with accepted practice.

Level of Effort and Cost

The level of cost and effort for the survey component of the study would be low for each individual project (moderate for all three projects combined); a minimal number of personnel may be able to conduct the weekly surveys. The trap/pass component would require low to moderate cost and effort. We estimate $40,000 per project to conduct this study.

The Agency is not aware of any previously conducted or ongoing studies related to upstream eel passage. The applicant did not propose any studies to meet this need in the PAD.

Literature Cited

Kart, J., R. Regan, S.R. Darling, C. Alexander, K. Cox, M. Ferguson, S. Parren, K. Royar, B. Popp, editors. 2005. Vermont's Wildlife Action Plan. Vermont Fish & Wildlife Department. Waterbury, Vermont. http://www.vtfishandwildlife.com/swg_cwcs_report.cfm. (Accessed September 10, 2012).

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Turners Falls Hydroelectric Project – FERC No. 1889-081

Study Request 22: Upstream American eel passage assessment

Goals and Objectives

This study has two objectives:

1. Conduct systematic surveys of eel presence/abundance at Cabot Station discharge, Station #1 discharge, canal discharges, and Turners Falls Dam to identify areas of concentration of eels staging in pools or attempting to ascend wetted structures that would potentially establish the most effective locations to place upstream eel passage facilities.
2. Collect eels with temporary trap/pass devices from areas identified from surveys as potential locations of eel concentration to assess whether eels can be collected/passed in substantial numbers, and whether locations are viable sites for permanent eel trap/pass structures.

Resource Management Goals

The Agency's goals related to aquatic natural resources are to:

1. Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
3. Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the VTFWD's mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).

Two of the Department's planning goals are:

1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.
2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

Vermont Fish and Wildlife Department's Strategic Plan (2002 -2010) focuses towards four major areas of concern: resource conservation, fish and wildlife-based recreation and use, human health and safety, efficient operations, and effective management.

The American eel (*Anguilla rostrata*), is listed as one of both New Hampshire's and Vermont's Species of Greatest Conservation Need (SGCN). The status for conservation need in Vermont is listed as high priority (Kart et al. 2005), and the species is listed as "vulnerable" in New Hampshire. As identified in Vermont's Wildlife Action Plan (Kart et al. 2005), threats to the species include the construction of large dams on rivers which obstruct juvenile fish access to critical rearing habitats, as well as mortality associated with passing through hydroelectric facilities' turbines during their outmigration to sea.

As outlined in Vermont's Wildlife Action Plan (Kart et al. 2005), research and monitoring needs for this SGCN include determining their distribution and abundance, as the contribution of eels in northern regions to overall stock is unknown. One of the conservation strategies for this species is to support efforts to enhance access of American eels to Vermont waters by eliminating or minimizing impacts of dams and other obstructions along the Richelieu, St. Lawrence, and Connecticut Rivers.

The Atlantic States Marine Fisheries Commission has developed two documents related to the management of American eel:

1. Interstate Fishery Management Plan for American Eel. April 2000. Atlantic States Marine Fisheries Commission.
2. Addendum II to the Fishery Management Plan for American Eel. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

The Connecticut River Atlantic Salmon Commission (CRASC) was established by Congress in 1983 (and reauthorized in 2002 for another 20 years) through the Connecticut River Atlantic Salmon Compact (Public Law 98-138). The Vermont Fish and Wildlife Department is a CRASC member agency, and a senior biologist from the department serves on the Technical Committee. In addition, the Connecticut River Atlantic Salmon Commission (CRASC) developed A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin in 2005. The goal of the plan is "to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem…" Management objectives in the plan include the following:

1. Protect and enhance eel populations where they currently exist;
2. Where practical, restore populations to waters where they had historical abundance;
3. Provide effective upstream and downstream fish passage around dams and other barriers within the species' range in the basin; and
4. Comply with all requirements of the Fishery Management Plan of the ASMFC.

Based on these plans, the Agency seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to upstream passage of American eel, the Agency's goals are:

1. Minimize current and potential negative project operation effects that could hinder management goals and objectives.

2. Minimize project-related sources of upstream passage delay, injury, and stress in order to facilitate access to historical rearing habitat.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), and the Federal Power Act (16 U.S.C. §791a, *et seq*.).

Public Interest Consideration

The requester is a resource agency.

Existing Information

The PAD contains no information relative to areas where eels seeking to move upstream concentrate downstream of the dam, or annual numbers of eels attempting to ascend past Turners Falls Dam. While eels have been known to ascend the Cabot Station ladder (A. Haro, U.S. Geological Survey, pers. comm.), its efficiency is unknown, and it is only operated during the American shad passage season (from April 1 through July 15). Eels are currently able to pass the Turners Falls Dam complex (as evidenced by documented presence of eels upstream), but the total number of eels attempting to pass Turners Falls and the proportion successfully passing the project is unknown (but suspected to be low). The downstream Holyoke Project has operated upstream eel passage facilities since 2004. Last year these facilities passed over 40,000 juvenile eels. While there is rearing habitat in between the Holyoke and Turners Falls dams, some eels will attempt to continue upstream, and passage needs to be provided so these fish can access historical habitat.

These information gaps need to be filled so resource agencies can determine the best locations to site upstream eel passage facilities and assess whether operating the existing anadromous ladders would be an effective mechanism to move juvenile eels upstream past the project.

We also note that within the past seven years, the USFWS has received two petitions to list the American eel under the Endangered Species Act. The first petition was received on November 18, 2004. On July 6, 2005 the USFWS issued a substantial 90-day finding on the petition and initiated a 12-month status review that concluded on February 2, 2007 with a finding that listing was not warranted. The second petition was filed on April 30, 2010 by the Council for Endangered Species Act Reliability (CESAR). On September 29, 2011 the USFWS issued a substantial 90-day finding and initiated a 12-month status review. The USFWS is still accepting new American eel information for the ongoing status review. The USFWS also is currently in settlement negotiations with CESAR on their legal complaint that the USFWS failed to complete the 12-month finding within the statutory timeframe. Although the date for completion of the USFWS's 12-month finding on the latest petition is uncertain, it is likely that it will be made before any new licenses are issued for the projects.

Project Nexus

The project generates hydropower on the head created by the Turners Falls dam. This dam creates a barrier to upstream migrating eels. While some eels are able to pass dams, some are not, and the passability of a given dam depends on factors such as its height, hydraulics, presence of climbable surfaces, presence of predators, risk of exposure to heat or drying while climbing a dam, etc. The Turners Falls dam is high (35 feet above bedrock), and the majority of the dam face is dry during most of the upstream eel passage season. Design of the dam is not currently amenable to passage of eels by climbing. While flow is released to the bypass reach via a bascule gate (typically the one closest to the gatehouse), this would not facilitate eel passage, as bascule gates open outward and downward (i.e., requiring the eels to essentially swim nearly upside down to get over the gate). As mentioned earlier, the existing anadromous passage facilities are not designed to pass eels, and even if some eels are able to ascend the ladders, they may incur delays (in attraction or passage rates), be size-selective (e.g. velocity barrier for small eels presented by ~8 ft/sec flow through weirs and orifices), present a potential predation risk (predators in or near the fishways), and are not operated throughout the upstream eel passage season.

Proposed Methodology

Objective 1: Systematic Surveys

Surveys of eel presence and relative abundance should be conducted at regular intervals throughout the eel upstream migratory season (~1 May to ~15 October, or when river temperatures exceed 10 C). Surveys should consist of visual inspection and trapping in likely areas where eels may concentrate as they attempt to climb structures wetted by significant spill or leakage flow in the Turners Falls dam complex area. These locations include: Cabot Station downstream bypass outfall, Cabot Station spillway (including attraction water stilling basin), Cabot Fishway (dewatered state), USGS Conte Lab flume outfall, Number One Station outfall, various small turbine and process water outfalls from the Cabot Canal, Spillway Fishway attraction water stilling basin, and leakage points along the downstream face of Turners Falls Dam (bascule and Tainter gates). Methods should include visual surveys (on foot, from a boat, or snorkeling) and trapping using small mesh (< 1/8" clear opening) baited eel pots. Visual surveys should be performed once per week, at night, preferentially during precipitation events. Trap sets should be performed once per week, with an overnight soak time. Recorded data should include location, observation of eels (presence, absence, relative numbers, relative sizes, behaviors, time/date of observation), and survey method.

Objective 2: Trap/Pass Collections

Areas identified from Systematic Surveys as having significant number of eels present should be targeted as potential areas for permanent eel trap/passes, and should be initially assessed using temporary/portable trap passes. At a minimum (regardless of survey results), temporary trap passes should be installed at the following locations: Cabot Fishway attraction flow stilling basin (during dewatered fishway period), Number One Station outfall, and Spillway Fishway attraction flow stilling basin (during watered and dewatered fishway period), as these locations may be supplemented with additional attraction flow and have high potential for being concentration points for upstream migrant eels. Temporary trap/passes should be purpose-designed and built for each location, and operated throughout the eel upstream migratory season (~1May to 15 October, or when river temperatures exceed 10 C). Ramp-type traps with supplementary attraction flow are preferred temporary trap/pass designs. Traps should operate daily, with catches quantified every 2-3 days. Recorded data should include location, trapping interval, absolute numbers of eels trapped, relative eel sizes, and hydraulic and environmental conditions during the trapping period.

All collected eels from surveys should be released at their point of capture; those eels collected from trap/pass collections should be transported to and released above the dam in the Turners Falls Pool.

These methodologies are consistent with accepted practice.

Level of Effort and Cost

The level of cost and effort for the survey component of the study would be low; a minimal number of personnel may be able to conduct the weekly surveys. The trap/pass component would require low to moderate cost (estimated at $40,000) and effort.

In the PAD, the applicant has identified the need to assess issues related to upstream passage for American eels at the project, but indicates that it intends to rely on information from previously conducted studies and ongoing studies. The USFWS is not aware of any previously conducted or ongoing studies related to upstream eel passage.

Wilder Hydroelectric Project – FERC No. 1892-026
Bellows Falls Hydroelectric Project – FERC No. 1855-045
Vernon Hydroelectric Project – FERC No. 1904-073

Study Request 23: Impingement and entrainment of resident fish species at project intakes

Goals and Objectives

The goal of this study is to assess the adequacy of the intakes at Bellows Falls, Wilder, and Vernon projects to minimize fish mortality resulting from impingement and entrainment of fishes residing in the Connecticut River, and to recommend appropriate mitigative measures as necessary.

Specific objectives include:

- Describe the configuration of the intake at each project, including the forebay characteristics, size of the intakes, trashrack spacing and extent of coverage if the intakes, approach velocities and the influence of trashrack debris and cleaning protocols.
- Estimate the mortality rates for resident fish species and life stages that may result from impingement on project trashracks.
- Estimate the mortality rates for resident fish species and life stages that may result from entrainment and passage through the project turbines. Review existing Vermont Fish and Wildlife Department’s (VTFWD) fish passage data to increase sample size and gain a better understanding of temporal variability.
- Determine structural and operational measures that could be reduce fish mortality.

Resource Management Goals

Vermont Water Quality Standards (VWQS) seek to provide high quality aquatic habitat necessary to support healthy aquatic communities and the associated uses such as fishing.

The Agency’s goals related to aquatic natural resources and pertinent to this study request are to:

1. Provide for healthy, self-sustaining fish communities.
2. Minimize the potential negative effects of project operation on resident fish populations, and mitigate for losses.

Public Interest Consideration

The requestor is a state fish and wildlife agency.

Existing Information

The Connecticut River and the project impoundments support a variety of resident fish species as well as angling. However, there is no information about fish mortality and the population effects resulting from project impingement and entrainment. The project PADs contain almost no information about the project trashracks. During the ILP site visits held in October 2012 the Agency was informed that the rack spacing was in most cases four inches (on center) and as much as six inches in some cases. Further, these trashracks do not cover the entire intake area in all cases. No information on approach velocities has been provided. Mortality rates of fish passing through the turbines are not known.

Project Nexus

The Bellows Falls, Wilder and Vernon dams span across the Connecticut River, acting as a physical impediment to fish passage. Fishes living in the impoundments will at times enter project forebays and come in close proximity to project intakes. Impingement or entrainment is certainly occurring but the extent of this impact is unknown. The wide rack spacing is likely to result in entrainment.

The projects include downstream fish passage facilities but their use and effectiveness for resident fish species is unknown. These facilities are operated seasonally and therefore will not mitigate impingement and entrainment at all times.

Proposed Methodology

Impingement, entrainment and turbine mortality studies have been conducted at numerous other hydropower projects and can be used to assess potential fish mortality based on results from other projects with similar configurations.
Approach velocities can be calculated and actual measurements can be taken to quantify variability by location and verify calculated results.
Turbine mortality should be assessed by releasing tagged fish for downstream recovery. The details of this type of study should be addressed during the study plan stage.
The contribution of existing fish passage facilities to reducing impingement and entrainment of resident fishes should also be assessed.

Level of Effort and Cost

The expected level of effort and anticipated costs will be comparable or less than those experienced on similar FERC projects of this size.

Wilder Hydroelectric Project – FERC No. 1892-026
Bellows Falls Hydroelectric Project – FERC No. 1855-045
Vernon Hydroelectric Project – FERC No. 1904-073

Study Request 24: Determine upstream passage needs for riverine fish species at project fishways

Goals and Objectives
The goal of this study is to determine the adequacy of the existing Bellows Falls, Wilder, and Vernon fish ladders in passing riverine species and determine the appropriate operation period for these fishways to pass riverine and diadromous fish.
Specific objectives include:

- Identify the utilization and temporal distribution, of passage through the Bellows Falls, Wilder, and Vernon fishways by riverine and diadromous fish species
- Review existing Vermont Fish and Wildlife Department's (VTFWD) fish passage data to increase sample size and gain a better understanding of temporal variability.
- Operate and monitor the fishways year-round (or until otherwise infeasible) to assess fishway use over a longer period than the fishways have traditionally been operated to:

    1. Determine the appropriate operating windows of the fishways for riverine species

    2. Determine the appropriate operating windows of the fishways for diadromous species such as American eel and sea lamprey.

Resource Management Goals
The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the VTFWD's mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).

Two of the Department's planning goals are:

1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.
2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

Vermont Fish and Wildlife Department's Strategic Plan (2002 -2010) focuses towards four major areas of concern: resource conservation, fish and wildlife-based recreation and use, human health and safety, efficient operations, and effective management.

A mission of the New Hampshire Fish and Game Department (NHFGD) is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats.

Three of the NHFGD's goals are to ensure:
1. New Hampshire has a wide range of naturally occurring habitats and health, functioning ecosystems.
2. New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.
3. New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.

In order to be consistent with both Department's missions and goals, and to promote healthy fish populations, connectivity within a river system is important. By allowing fish to move through the fishway during different times of the year, and during different life history stages, access to available riverine aquatic habitat is increased. Fish are able to seek the best available habitat and food resources, as well as avoid predator interactions. Furthermore, movement within a river system promotes genetic diversity. Currently upstream resident fish passage at the Bellows Falls, Wilder, and Vernon dams is precluded most of the year due to fishway closure.

Public Interest Consideration
The requestor is a state natural resource agency.

Existing Information
No such information exists that will allow for a comprehensive assessment of existing year round fishway utilization by resident species. The VTFWD has several years (2007-2012) of seasonal passage data that have not yet been analyzed. These data are in the form of .avi files, but only include the spring and summer months (typically May- July).
The PAD acknowledges that "Resident species have also been recorded using the Bellows Falls and Wilder fish ladder". Those data are available from the Vermont Fish & Wildlife Department. Fish passage video data that have been processed should be available for distribution in the future (Lael Will, Vermont Fish & Wildlife, personal communication)". Although not comprehensive, analysis of these data would assist in filling this data gap.

In 2012, VTFWD staff documented resident species passage at the Vernon fishway. Species observed utilizing the fishway included bluegill (N = 555), common carp (N = 209), channel catfish (N = 37), trout sp. (N = 2), walleye (N = 54), white sucker (N = 102), and American eel (N =262). However, these analyses were conducted during one year and did not include any monitoring outside of the spring spawning run.

Project Nexus
The Bellows Falls, Wilder and Vernon dams span across the Connecticut River, acting as a physical impediment to fish passage. Therefore, the project has a direct impact on fish passage and limits fish from accessing available aquatic habitat located upstream of the dam.
The PAD acknowledges that "river fragmentation can reduce or obstruct fish and aquatic community connectivity and therefore genetic diversity and stock structure. However, those impacts are reduced by the provision of fish passage and the length of the impoundment. Upstream and downstream fish passages, designed for Atlantic salmon, are likely used by other migratory and resident species, providing connectivity; however, fish counts are limited,

unknown or unavailable for resident species". In fact, it is known that riverine and diadromous species use the fishways, but there has been limited analysis of this data and fishway monitoring was limited to spring period.

Therefore, in order to determine the level of riverine fish passage through the existing fishways, and the appropriate operation period for the fishway , review of existing data and , further monitoring of the fishways is warranted.

Proposed Methodology

Fishway monitoring has been conducted annually by VTFWD dating back to 1985. Monitoring was focused on Atlantic salmon, American shad and American eel. Resident species were recorded periodically, but were not monitored outside the spring anadromous fish migration period

Fishway monitoring has been used to assess existing and proposed project operations, and to develop appropriate operating windows for fisheries resources.

In addition to fish window count data, monitoring should include monitoring of the hydraulic conditions in the fishways and fishway entrances, and periodic fish observations should be made over the length of the fishways. If count data or observations of the fishways indicate the need for fishway operation changes or for more specific information on fish movement through the fishways, changes to the monitoring plan for year 2 monitoring would need to be implemented.

Level of Effort and Cost

This study will require video monitoring equipment, appropriate software (e.g. salmon soft), and personal to read to files, and manage the equipment. Some information already exists in the form of .avi files and past count data and are readily available from VTFWD. No other tool (e.g. radio telemetry) is more appropriate or cost effective for these types of assessments. Cost is relatively low.

Literature Cited

Kart, J., R. Regan, S.R. Darling, C. Alexander, K. Cox, M. Ferguson, S. Parren, K. Royar, B. Popp, editors. 2005. Vermont's Wildlife Action Plan. Vermont Fish & Wildlife Department. Waterbury, Vermont. http://www.vtfishandwildlife.com/swg_cwcs_report.cfm. (Accessed September 10, 2012).

Vermont Fish and Wildlife Department . 2006. Vermont Fish and Wildlife Strategic Plan. http://www.vtfishandwildlife.com/library/reports_and_documents/Fish_and_wildlife/Strategic_Plan.pdf

Wilder Hydroelectric Project – FERC No. 1892-026

Study Request 25: Impact of impoundment water level fluctuations on wetlands

Goals and Objectives

The goal of this study is to determine the impacts to wetlands from daily and seasonal water level fluctuation in the impoundment and downstream from the Wilder Hydroelectric Project to the head of the Bellows Falls impoundment.

The objectives of this study are to:

1. Identify all wetlands types, natural communities, and invasive species within the impoundment and downstream, and determine the proportion of wetlands and wetland type (i.e. emergent, shrub, forested) that are impacted by daily and seasonal water level fluctuations from project operations.
2. Determine the ratios of wetland types in the project area should be compared to previous national wetland inventory maps, and/or to reference conditions to determine if wetland types or natural communities within the project impoundment or downstream are being altered by project operations.
3. Determine how project operations are affecting the wetland plant community composition, including promoting the spread of invasive species or affecting rare, threaten, and endangered species.

Resource Management Goals

The Agency's goals related to aquatic natural resources are to:

1. Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
3. Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the VTFWD's mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).

Two of the Department's planning goals are:

1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.
2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

The goal of the Vermont Agency of Natural Resources is to identify and protect significant wetlands and the values and function which they ensure that there is no net loss of such wetlands and their function are achieved. Vermont classifies wetlands that are adjacent to streams, rivers, and open water that contain woody or persistent non-woody vegetation as Class II significant wetlands.

Public Interest Consideration
The requestor is a state natural resource agency.

Existing Information
The PAD does not address how wetlands type or wetland community composition that could be impacted by daily and seasonal water level fluctuations within the impoundment.

Project Nexus
The project impoundment extends 45 miles upstream from the dam. The project currently operates in a peaking mode, with allowable impoundment fluctuations of up to 5 feet, with proposals to continue as such. Wetlands can be affected by the operations of the hydropower project depending on frequency, timing, amplitude and duration of impoundment fluctuations. The PAD provides limited information on how project operations affect wetlands and the plant community composition within the project impoundment and downstream. Operations of the project must conform to Vermont goal of protecting significant wetlands and the values and function which they ensure that there is no net loss of such wetlands. The Agency requests a study to determine the impacted by normal daily and seasonal operations of the project on wetland communities.

Proposed Methodology
The widely accepted methodology in the Federal Manual for Identifying and Delineating Jurisdictional Wetlands, as amended and supplemental guidance documents issued by the U.S. Army Corps of Engineers is recommended for identifying wetlands. The Vermont classification system for natural communities should be used to classify community type (See Appendix A). The general community composition should be recorded as well as any rare, threaten or endangered plant species or invasive species. The proportion of wetlands that are impacted by project operations should be compared to reference wetlands communities to evaluate how plant species composition has been altered by project operations. The frequency, timing, amplitude, and duration of reservoir fluctuations on impacted wetlands and natural communities should be recorded throughout the year. The ratio of wetland types presently identified in the project boundaries should be compared to national wetland inventory maps to address if project operations have altered wetlands.

Level of Effort and Cost
The cost and effort of this study will be moderate, but is important to document the potential impact operations have on wetlands within the vicinity of the project to determine if Vermont’s wetland management goals are being met.

Bellows Falls Hydroelectric Project – FERC No. 1855-045

Study Request 25: Impact of impoundment water level fluctuations on wetlands

Goals and Objectives

The goal of this study is to determine the impacts to wetlands from daily and seasonal water level fluctuation in the impoundment and downstream from the Bellows Falls Hydroelectric Project to the head of the Vernon impoundment.

The objectives of this study are to:

1. Identify all wetlands types, natural communities, and invasive species within the impoundment and downstream, and determine the proportion of wetlands and wetland type (i.e. emergent, shrub, forested) that are impacted by daily and seasonal water level fluctuations from project operations.
2. Determine the ratios of wetland types in the project area should be compared to previous national wetland inventory maps, and/or to reference conditions to determine if wetland types or natural communities within the project impoundment or downstream are being altered by project operations.
3. Determine how project operations are affecting the wetland plant community composition, including promoting the spread of invasive species or affecting rare, threaten, and endangered species.

Resource Management Goals

The Agency's goals related to aquatic natural resources are to:

1. Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
3. Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the VTFWD's mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).

Two of the Department's planning goals are:

1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.
2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

The goal of the Vermont Agency of Natural Resources is to identify and protect significant wetlands and the values and function which they ensure that there is no net loss of such wetlands and their function are achieved. Vermont classifies wetlands that are adjacent to streams, rivers, and open water that contain woody or persistent non-woody vegetation as Class II significant wetlands.

Public Interest Consideration
The requestor is a state natural resource agency.

Existing Information
The PAD does not address how wetlands type or wetland community composition that could be impacted by daily and seasonal water level fluctuations within the impoundment.

Project Nexus
The project impoundment extends 26 miles upstream from the dam. The project currently operates in a peaking mode, with allowable impoundment fluctuations of up to 3 feet, with proposals to continue as such. Wetlands can be affected by the operations of the hydropower project depending on frequency, timing, amplitude and duration of impoundment fluctuations. The PAD provides limited information on how project operations affect wetlands and the plant community composition within the project impoundment and downstream. Operations of the project must conform to Vermont goal of protecting significant wetlands and the values and function which they ensure that there is no net loss of such wetlands. The Agency requests a study to determine the impacted by normal daily and seasonal operations of the project on wetland communities.

Proposed Methodology
The widely accepted methodology in the Federal Manual for Identifying and Delineating Jurisdictional Wetlands, as amended and supplemental guidance documents issued by the U.S. Army Corps of Engineers is recommended for identifying wetlands. The Vermont classification system for natural communities should be used to classify community type (See Appendix A). The general community composition should be recorded as well as any rare, threaten or endangered plant species or invasive species. The proportion of wetlands that are impacted by project operations should be compared to reference wetlands communities to evaluate how plant species composition has been altered by project operations. The frequency, timing, amplitude, and duration of reservoir fluctuations on impacted wetlands and natural communities should be recorded throughout the year. The ratio of wetland types presently identified in the project boundaries should be compared to national wetland inventory maps to address if project operations have altered wetlands.

Level of Effort and Cost
The cost and effort of this study will be moderate, but is important to document the potential impact operations have on wetlands within the vicinity of the project to determine if Vermont's wetland management goals are being met.

Vernon Hydroelectric Project – FERC No. 1904-073

Study Request 25: Impact of impoundment water level fluctuations on wetlands

Goals and Objectives
The goal of this study is to determine the impacts to wetlands from daily and seasonal water level fluctuation in the impoundment and downstream from the Vernon Hydroelectric Project to the head of the Turner Falls impoundment.

The objectives of this study are to:
1. Identify all wetlands types, natural communities, and invasive species within the impoundment and downstream, and determine the proportion of wetlands and wetland type (i.e. emergent, shrub, forested) that are impacted by daily and seasonal water level fluctuations from project operations.
2. Determine the ratios of wetland types in the project area should be compared to previous national wetland inventory maps, and/or to reference conditions to determine if wetland types or natural communities within the project impoundment or downstream are being altered by project operations.
3. Determine how project operations are affecting the wetland plant community composition, including promoting the spread of invasive species or affecting rare, threaten, and endangered species.

Resource Management Goals
The Agency's goals related to aquatic natural resources are to:
1. Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
3. Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.
4.

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the VTFWD's mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).

Two of the Department's planning goals are:
1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.
2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

The goal of the Vermont Agency of Natural Resources is to identify and protect significant wetlands and the values and function which they ensure that there is no net loss of such wetlands and their function are achieved. Vermont classifies wetlands that are adjacent to streams, rivers, and open water that contain woody or persistent non-woody vegetation as Class II significant wetlands.

Public Interest Consideration
The requestor is a state natural resource agency.

Existing Information
The PAD does not address how wetlands type or wetland community composition that could be impacted by daily and seasonal water level fluctuations within the impoundment.

Project Nexus
The project impoundment extends 26 miles upstream from the dam. The project currently operates in a peaking mode, with allowable impoundment fluctuations of up to 8 feet, with proposals to continue as such. Wetlands can be affected by the operations of the hydropower project depending on frequency, timing, amplitude and duration of impoundment fluctuations. The PAD provides limited information on how project operations affect wetlands and the plant community composition within the project impoundment and downstream. Operations of the project must conform to Vermont goal of protecting significant wetlands and the values and function which they ensure that there is no net loss of such wetlands. The Agency requests a study to determine the impacted by normal daily and seasonal operations of the project on wetland communities.

Proposed Methodology
The widely accepted methodology in the Federal Manual for Identifying and Delineating Jurisdictional Wetlands, as amended and supplemental guidance documents issued by the U.S. Army Corps of Engineers is recommended for identifying wetlands. The Vermont classification system for natural communities should be used to classify community type (See Appendix A). The general community composition should be recorded as well as any rare, threaten or endangered plant species or invasive species. The proportion of wetlands that are impacted by project operations should be compared to reference wetlands communities to evaluate how plant species composition has been altered by project operations. The frequency, timing, amplitude, and duration of reservoir fluctuations on impacted wetlands and natural communities should be recorded throughout the year. The ratio of wetland types presently identified in the project boundaries should be compared to national wetland inventory maps to address if project operations have altered wetlands.

Level of Effort and Cost
The cost and effort of this study will be moderate, but is important to document the potential impact operations have on wetlands within the vicinity of the project to determine if Vermont's wetland management goals are being met.

Wilder Hydroelectric Project – FERC No. 1892-026
Bellows Falls Hydroelectric Project – FERC No. 1855-045
Vernon Hydroelectric Project – FERC No. 1904-073

Study Request 26: Impacts of water level fluctuations on aquatic vegetation, including invasive species, in project impoundments

Goals and Objectives

The goal of this study is to determine if the full range of water level fluctuations from the Vernon, Bellows Falls and Wilder Hydroelectric Projects negatively impact emergent aquatic vegetation (EAV) and submerged aquatic vegetation (SAV) and their habitats in the impoundments and riverine reaches below the dams.

The objective is to conduct field studies in mainstem littoral zones, tributaries and backwaters to determine if EAV and SAV species distribution and abundance, and their habitats, are impacted by current water level fluctuations permitted under the TransCanada Projects' licenses and whether aquatic vegetation and its habitats can be enhanced by modifications to project operations or other mitigation measures and whether there is any unique or important shoreline or aquatic habitats that should be protected. Results of this study may also be used to help determine the adequacy of existing downstream minimum flow requirements.

The specific objectives of the field study, at a minimum, include:

- Quantitatively describe and map wetland types within 200 feet of the shoreline, and describe associated wildlife;
- Delineate, quantitatively describe, and map all wetland types including invasive species and wildlife observed (e.g., bald eagle nesting, water fowl nesting) within 200 feet of the shoreline, and the extent of this habitat if it extends beyond 200 feet; and
- Quantitatively describe (e.g., substrate composition, vegetation type and abundance) and map shallow water aquatic habitat types subject to project operation inundation and exposure, noting and describing additional areas where water depths at lowest operational range are wetted to a depth less than one foot (flats, near shore areas, gravel bars, with very slight bathymetric change);

A second year of study may be required should river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period.

The field study should produce a habitat inventory report that includes:

- The results of the field study in the form of maps and descriptions;
- An assessment of project effects on wetland, riparian, littoral zone vegetation and shallow water habitats, invasive plant species, and wildlife habitat at the project; and
- Recommendations for any necessary plant, habitat type, or wildlife, protection and/or invasive species control measures.

Resource Management Goals

The Agency's goals related to aquatic natural resources are to:

1. Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
3. Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the VTFWD's mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).

Two of the Department's planning goals are:

1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.
2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

Vermont Fish and Wildlife Department's Strategic Plan (2002 -2010) focuses towards four major areas of concern: resource conservation, fish and wildlife-based recreation and use, human health and safety, efficient operations, and effective management.

Riverine fish species are an important component of the river's ecology and in some cases are the basis for a sport fishery. Aquatic vegetation is crucial fish habitat as the majority of fish in the project impoundments utilize EAV and SAV at some point during their life history. This requested study will help enhance EAV and SAV in the project impoundments.

Public Interest Consideration

The New Hampshire Fish and Game Department, the Vermont Fish and Wildlife Department, and the New Hampshire Department of Environmental Services are requesting this study. The requestors are state natural resource agencies.

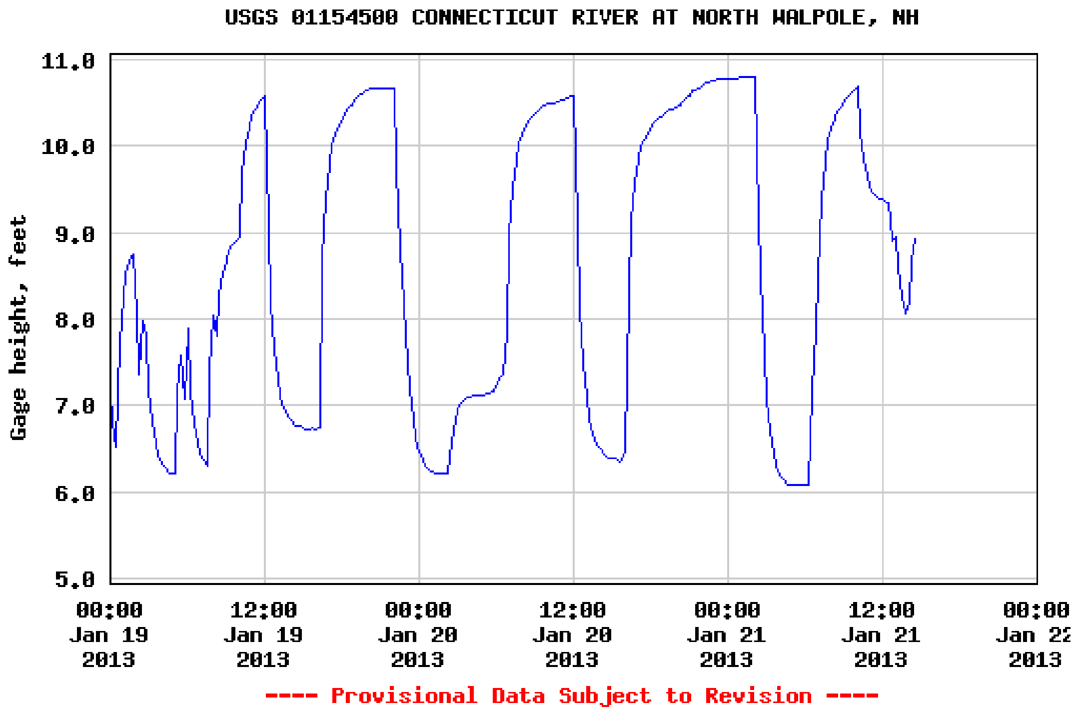
Existing Information

Existing information in the PADs does not quantify EAV and SAV. However, the applicant acknowledges that water level fluctuations caused by the project have the potential to affect fringing wetland and littoral areas:

> "*The average daily water level fluctuation of 2.5 vertical feet has resulted in a zone of sparse vegetation along most of the shorelines of the impoundment. Wetland and littoral resources in this zone are limited by the frequent wetting and drying*." (Wilder PAD, p.3-

104, see also similar language in the Bellows Falls PAD p. 3-115 and the Vernon PAD p. 3-143)

An example of the water level fluctuations that occur in the Lower Connecticut River due to hydropower generation is shown below.



Project Nexus

Water level fluctuations due to project operations have the potential to influence fish species life history requirements, biological interactions, and habitat quantity and quality by impacting EAV and SAV. For example, water level changes due to project operations could create conditions where EAV and SAV abundance is diminished, thus negatively impacting a habitat used by riverine fish for spawning, rearing, feeding, and cover. Additionally, water level fluctuations due to project operations could influence EAV and SAV habitat in the project impoundments and promote invasive plants over native species. This study needs to take into account existing and potential future limits on impoundment level fluctuations intended to limit recreation impacts, and the interactions of any changes in pond level fluctuation range or frequency and discharge changes.

Proposed Methodology

Vegetation mapping and mapping of littoral zones in relation to water level fluctuations are common tools for identifying EAV and SAV that may be impacted by changes in water levels. The study should include field surveys designed to describe the characteristics of each mapped wetland, riparian, littoral and shallow water habitat including plant species composition, relative abundance/density, habitat quality, and land use. These surveys should be conducted to describe these habitats at the lowest water level operational range permitted on a daily operation schedule, under low flow conditions. Information collected should include:

- Plant species composition, and their relative abundance/density and condition/structure (e.g., seedlings)
- Surveying for the federally Endangered Northeastern bulrush (*Scirpus ancistrochaetus*);
- Structured data, including estimates of average heights and aerial cover of each vegetation layer (specifically denoting invasive species);
- Aquatic habitat substrate composition, quantity (i.e., percent types and area), wood structure (relative abundance measure applied by area), water depths (inundated, exposed, and water less than one foot);
- Predominate land use(s) associated with each cover type;
- Wildlife sightings should be noted;
- Field verified wetland, riparian, and littoral and shallow water habitats and invasive species occurrences, should be geo-referenced as polygons and overlain on orthophoto at a suitable scale.

Bathymetric mapping of the littoral zone will be needed to model the extent of this zone that will be affected by different water fluctuation scenarios.

The study area is from the most upstream area influenced by the Wilder Dam to the most downstream area influenced by the Vernon Dam. Water level fluctuations caused by the projects may affect not only the impoundments, but also the downstream river reaches below the dams. Studies would occur in the main river littoral zone and in backwater areas during spring, summer and fall. A second year of study may be required if first year data collection is limited due to environmental or other conditions, or if river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period.

Level of Effort and Cost
Although the PAD's acknowledge that project operations have the potential to impact littoral resources, TransCanada did not propose any studies concerning aquatic vegetation. Analysis as described above is needed to understand potential impacts of the projects on these resources. Estimated cost for the study is moderate due to the need for field assessment.

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Kart, J., R. Regan, S.R. Darling, C. Alexander, K. Cox, M. Ferguson, S. Parren, K. Royar, B. Popp, editors. 2005. Vermont's Wildlife Action Plan. Vermont Fish & Wildlife Department. Waterbury, Vermont. http://www.vtfishandwildlife.com/swg_cwcs_report.cfm. (Access September 10, 2012).

Vermont Fish and Wildlife Department . 2006. Vermont Fish and Wildlife Strategic Plan. http://www.vtfishandwildlife.com/library/reports_and_documents/Fish_and_wildlife/Strategic_Plan.pdf

Turners Falls Hydroelectric Project – FERC No. 1889-081
Northfield Mountain Pumped Storage Project – FERC No. 2485-063

Study Request 26: Impacts of water level fluctuations on aquatic vegetation, including invasive species, in project impoundment

Goals and Objectives

The goal of this study is to obtain baseline information on riparian, wetland, Emergent Aquatic Vegetation (EAV), Submerged Aquatic Vegetation (SAV), littoral zone and shallow water aquatic habitats (subject to operational inundation and exposure to near exposure) known to occur in the project area. Information would be used to determine whether riparian, wetland, EAV and SAV, littoral, and shallow water (e.g., mid river bars and shoals) habitats are impacted by current water level fluctuations permitted under the Turners Falls and Northfield projects' licenses and whether these vegetation types and shallow water habitats can be protected and restored by modifications to project operations or other mitigation measures. This analysis needs to take into account existing and potential future limits on pond level fluctuations intended to limit recreation impacts, and the interactions of any changes in pond level fluctuation range or frequency and discharge changes under a new licenses of the Turners Falls and upstream projects. This information is needed to determine whether the projects operation affects plants, habitat, and wildlife in the project area, whether aquatic vegetation and its habitats can be enhanced by modifications to project operations or other mitigative measures, and whether there is any unique or important shoreline or aquatic habitats that should be protected.

The specific objectives of the field study, at a minimum, include:

- Quantitatively describe and map wetland types within 200 feet of the shoreline, and describe associated wildlife;
- Delineate, quantitatively describe, and map all wetland types including invasive species and wildlife observed (e.g., bald eagle nesting, water fowl nesting) within 200 feet of the shoreline, and the extent of this habitat if it extends beyond 200 feet; and
- Quantitatively describe (e.g., substrate composition, vegetation type and abundance) and map shallow water aquatic habitat types subject to project operation inundation and exposure, noting and describing additional areas where water depths at lowest operational range are wetted to a depth less than one foot (flats, near shore areas, gravel bars, with very slight bathymetric change);

A second year of study may be required should river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period.

The field study should produce a habitat inventory report that includes:

- The results of the field study in the form of maps and descriptions;
- An assessment of project effects on wetland, riparian, littoral zone vegetation and shallow water habitats, invasive plant species, and wildlife habitat at the project; and
- Recommendations for any necessary plant, habitat type, or wildlife, protection and/or invasive species control measures.

Resource Management Goals

The Agency's goals related to aquatic natural resources are to:

1. Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
3. Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the VTFWD's mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).

Two of the Department's planning goals are:

1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.
2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

Vermont Fish and Wildlife Department's Strategic Plan (2002 -2010) focuses towards four major areas of concern: resource conservation, fish and wildlife-based recreation and use, human health and safety, efficient operations, and effective management. The Agency aims to protect and restore native riparian, wetland, EAV, SAV, littoral and shallow water habitat (i.e., spawning and or nursery areas for aquatic organisms) in the project reservoir.

Public Interest Consideration

The requestor is a resource agency.

Existing Information

Existing information in the PAD does not quantify EAV and SAV in this area, or other shallow aquatic habitat types and physical features (e.g., depths, substrates, wood structure) that are the environment for aquatic biota in the project area. The PAD does provide some limited monitoring data for 2012 (2 locations) on water surface elevations that show daily fluctuations, in the upper third of this impoundment, that varied over 4 feet on a daily cycling frequency, with fluctuations generally in the 2 foot range in low flow months for the data provided in the PAD. The current license does permit a greater pool elevation operational fluctuation, up to a 9 foot change in elevation, based on the Turners Falls Dam water elevation. In the PAD it is noted these operational fluctuations under most circumstances at the Turners Falls Dam are within 3.5 feet.

In the PAD it is noted that FLP would like to expand its NMPS upper reservoir capacity (by up to 24%), how this may affect project operations and the habitats noted in this request is unknown. It is also noted that water is typically pumped to the upper reservoir in evening and generation back to the river occurs once to twice daily, in daytime hours, based upon power needs and power value. Under current license conditions, provided set thresholds for minimum flow and Turners Dam current license elevations are met, the NMPS may operate with no restriction in timing, frequency, or magnitude for pumping or generation. No data were provided on the operation of the NMPS plant over time relative to data on pumping and generation on an hourly basis, averaged values were provided over monthly periods. It is unclear what the actual timing, frequency and magnitude of these NMPS operations are over the course of a year and how that relates to; aquatic plant species establishment, growth, survival, littoral zone or other shallow water habitat fish spawning periods and their effects on these fishes (reproduction success and subsequent recruitment, e.g., bass and fall fish nests) in available and utilized habitat, and how the quantity and quality of these shallow water habitats are effected by project operational manipulation/alteration, as currently permitted or proposed.

The PAD provides lists of plant and wildlife species whose native ranges overlap with the project area, but it does not provide any baseline information on known occurrences of these species in the wetlands, riparian, littoral and shallow water habitats, within or adjacent to, the project area. Plant and wildlife occurring in these habitats may benefit from protection, mitigation, and enhancement (PMEs) measures, given the potential effects of continuing the current semiautomatic peaking operating regime. In addition, a large scale sediment discharge from NMPS resulted in regulatory actions by FERC, the EPA and MADEP in 2010. Continuing and as yet unresolved management plan measures relative to sediment and NMPS project operations, are further concerns for shallow water, littoral zone, and wetland habitats.

The Atlantic States Marine Fisheries Commission, Atlantic Coast Diadromous Fish Habitat: A Review of utilization, threats, recommendations for conservation, and research needs (ASMFC 2009), contains a review of habitat information for these species. Recommendations in this report include: Maintain water quality and suitable habitat for all life stages of diadromous species in all rivers with populations of diadromous species.

Project Nexus

Water level fluctuations due to project operations could affect EAV and SAV habitat as well as the quantity and quality littoral and shallow water habitat. These operational water level fluctuation effects are expected to impact fish species use of these habitats and may affect spawning fishes reproductive success and subsequent population recruitment including but not limited to American shad, blueback herring, sea lamprey, fall fish, and bluegill, which spawn in mid to late spring through early summer in areas subject to daily or more frequent water level fluctuations.

The current operating mode, as well as the unknowns with proposed upper reservoir expansion, may affect wetland riparian, littoral and other shallow water habitats and promote the introduction and expansion of invasive plant species through fluctuating water levels. A study that explains the relationship between the proposed mode of operation and the type and quantity or wetland, riparian, littoral, shallow water habitats, and invasive species affected would help inform a decision on the need for protection and/or control of these resources in the license.

Proposed Methodology

The PAD currently contains maps portraying general wetland types from the Cabot Station tailrace upstream to the Vernon Dam. In addition, the Service understands that the detailed bathymetry exists for the Turners Falls impoundment. The proposed study should utilize this existing information in conjunction with field surveys designed to describe the characteristics of each mapped wetland, riparian, littoral and shallow water habitat including plant species composition, relative abundance/density, habitat quality, and land use. These surveys should be conducted to describe these habitats at the lowest water level operational range permitted on a daily operation schedule, under low flow conditions. Information collected should include:

- Plant species composition, and their relative abundance/density and condition/structure (e.g., seedlings);
- Structured data, including estimates of average heights and aerial cover of each vegetation layer (specifically denoting invasive species);
- Aquatic habitat substrate composition, quantity (i.e., percent types and area), wood structure (relative abundance measure applied by area), water depths (inundated, exposed, and water less than one foot);
- Predominate land use(s) associated with each cover type;
- Wildlife sightings should be noted;
- Field verified wetland, riparian, and littoral and shallow water habitats and invasive species occurrences, should be geo-referenced as polygons and overlain on orthophoto at a suitable scale.

Level of Effort and Cost

In the PAD, First Light identified impacts of the project operations on wetlands, riparian and littoral zone habitat as a potential issue to be addressed in relicensing, and proposed wetland vegetation mapping. However, additional analysis as described above is needed to understand the impacts of the project on these resources and habitats.

A wetlands, riparian, littoral/shallow water, invasive species inventory, of the scope envisioned, would likely require 6-8 months to complete and cost $40,000 to $50,000.

Literature Cited

Atlantic States Marine Fisheries Commission. 2009. Atlantic coast diadromous fish habitat: A review of utilization, threats, recommendations, for conservation, and research needs. Habitat Management Series #9. Washington, D.C.

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Wilder Hydroelectric Project – FERC No. 1892-026
Bellows Falls Hydroelectric Project – FERC No. 1855-045

*Study Request 27: Project effects on the dwarf wedgemussel (***Alasmidonta heterodon***)*

Goals and Objectives

It has been well documented that the damming of rivers can have detrimental impacts on the mussel communities that inhabit areas both upstream and downstream of dams (Watters 1999, Layzer et. al. 1993, Moog 1993). The goal of this study is to evaluate the effects that the Wilder, and Bellows Falls hydroelectric projects have on populations of the federally-endangered dwarf wedgemussel (*Alasmidonta heterodon*). In addition, the results of the study can be used to develop measures to minimize adverse impacts to the dwarf wedgemussel in the future.

The specific objectives of the study are as follows:

1. Conduct an initial survey of the free flowing stretch of the Connecticut River from the Wilder Dam to the upstream end of the Bellows Falls impoundment to determine the distribution of the dwarf wedgemussel in this reach.
2. Determine the best sites for intensive quantitative sampling of mussel communities, with emphasis on the dwarf wedgemussel. Data will be collected to estimate density (mussels per unit area) and age class structure for all species.
3. Lay the groundwork for a long-term monitoring program.
4. Document instream behavior of mussels during varying flow conditions.
5. Determine how availability and persistence of dwarf wedgemussel habitat changes with water level and flow fluctuations.

Resource Management Goals

The dwarf wedgemussel is a federally- and state-endangered species. As such, this study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures and protection, mitigation, and enhancement measures for the species pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), and Vermont's Endangered Species Law (10 V.S.A. section 5401 et. seq.).

The Agency of Natural Resources conservation goals for endangered species are:

1. Maintain or increase populations of rare, threatened, and endangered species in the town or area of interest.
2. Maintain, restore, provide stewardship for, and conserve habitats and natural communities that support rare, threatened, and endangered species.

The Connecticut River dwarf wedgemussel population is one that must be demonstrated to be viable in order before the species can be down listed to threaten. The Upper Connecticut metapopulation is likely the largest remaining population in the world (USFWS 2007), and so its protection is essential to the recovery of the species as a whole.

Public Interest Consideration
The requestor is a state natural resource agency

Existing Information
In 2011, Biodrawversity, LLC conducted a freshwater mussel survey throughout the Vernon, Bellows Falls, and Wilder project areas (Biodrawversity and LBG 2012). This survey was semi-quantitative (i.e. timed searches were used) and the main goal was to assess the distribution, abundance, demographics, and habitat of the dwarf wedgemussel in the project areas. Dwarf wedgemussel were found in the Wilder impoundment (all within a 14-mile stretch of the river beginning 27 miles upstream of the Wilder Dam) and Bellows Falls impoundment (located sporadically in the upper 17 miles of the impoundment); none were found in the Vernon project-affected area. These results corroborate the results of other studies performed in the past in these areas (Nedeau 2006a, Nedeau 2006b).

The 2011 survey did not include the 17-mile free flowing stretch of the Connecticut River downstream of Wilder Dam. The dwarf wedgemussel has, in the past, been found within this river reach, although overall there has been limited survey work in the area. A better understanding of the distribution and abundance of the dwarf wedgemussel in this stretch of the river is required before an evaluation of how the dam affects this species can be made. **This need is represented in Objective 1**.

Since the 2011 survey was semi-quantitative, it cannot be used as a basis for determining population estimates or trends (Wicklow 2005). In fact, few if any of the past surveys performed in the project-affected areas have employed quantitative methodology. In addition, there is little quantitative information regarding the age class structure, and therefore recruitment, of the mussel communities in the area. In order to demonstrate that a dwarf wedgemussel population is viable according to the Dwarf Wedgemussel Recovery Plan (USFWS 1993), it must have a large and dense enough population to maintain genetic variability and annual recruitment must be adequate to maintain a stable population. Thus, knowledge of population size and density as well as a better understanding of age class structure is a necessary step in determining the baseline status of dwarf wedgemussel populations. The 2011 survey and other surveys can be used to determine the best sites for implementing a monitoring program. **This need is represented in Objective 2**.

Once this baseline is established, it will be important to monitor the sites so that biologists can estimate and track changes to dwarf wedgemussel populations and/or evaluate any project-related population impacts. Therefore, there is a need to develop long-term monitoring plots that will be surveyed at regular intervals using methodology that is repeatable and yields quantitative, statistically valid results. **This need is represented in Objective 3**.

Flow conditions that result from dam operations may alter the behavior of individual dwarf wedgemussels or individuals of other species. Dam operations affect streamflow, temperature, and dissolved oxygen, and changes to these variables can often be rapid. It is not known how these rapid changes affect various aspects of a mussel’s biology, including lure display, shell position (open/closed), siphoning rate, and vertical migration. **This need is represented in Objective 4**.

Dam operations can also affect the availability of habitat for mussels, and this availability can change quickly as water levels fluctuate under peaking operations. The persistence of habitat is a key element to the long-term success of sedentary lotic organisms such as the dwarf wedgemussel (Maloney et. al. 2012), which is unable to quickly move in response to rapid changes in its environment and can thus become stranded in areas of unsuitable habitat; however, there is currently no information concerning the relation of project operations to habitat persistence within the Wilder and Bellows project-affected areas. **This need is represented in Objective 5**.

Project Nexus
The dwarf wedgemussel is known to occur within the Wilder and Bellows Falls project areas and operations of these two dams may affect the viability of this species in the Connecticut River. This study plan will allow for a better understanding of how sub-daily flow and water level fluctuations influence dwarf wedgemussel abundance, available habitat, and behavior. This information can be used to inform the development of license requirements that can ensure the continued existence of this species within the project-affected areas.

Additionally, a long-term monitoring program of important dwarf wedgemussel sites within the project areas is necessary to evaluate any project-related population and/or behavioral impacts that may occur. This information can be used to inform decision makers in the future.

Proposed Methodology
A survey of the 17-mile reach between the Bellows Falls impoundment and the Wilder Dam is the logical first step of the study plan, and this can be done in well less than one field season. This may be treated as an extension of the Biodrawversity and LBG (2012) survey and the same semi-quantitative methodology may be used. Once completed, this survey will help fill in the knowledge gap that exists in the distribution of the dwarf wedgemussel within this reach of the Connecticut River. **This proposed methodology corresponds to Objective 1**.

Next, quantitative study plots should be established at sites throughout the two project-affected areas that are known to support the dwarf wedgemussel. Plots should be set up and surveyed using methodology that will allow for the estimation of population density and size. Smith et. al. (2001) have developed such a methodology, which is also outlined in Strayer and Smith (2003). It is based on a double-sampling design (visual inspection of the substrate surface plus excavation of a random subset of quadrats) using 0.25 m^2 quadrats that are placed systematically with multiple random starts. This protocol has been used to monitor dwarf wedgemussel populations at two sites on the Ashuelot River in Keene, NH (Nedeau 2004). A number of other recent studies have also made use of this protocol for different species of mussels (Fulton et. al. 2010, Crabtree & Smith 2009, Bradburn 2009).

Data to determine age class structure should also be collected at these selected sites. This would involve measuring the length and estimating the age (through external annuli counts) of each mussel sampled within a quadrat. Based on this information, an analysis of recruitment can be made. This field work and analysis was performed on the mussel community inhabiting the lower Osage River in Missouri as part of the relicensing process of the Osage Hydroelectric

Project (FERC no. 459) (ESI 2003). The work done on the Osage can be used as a template for this study. Depending on how many plots are chosen, this phase of the study could take one or two field seasons. **This proposed methodology corresponds to Objective 2**.

The sites surveyed to meet Objective 2 should be resurveyed using the same methodology at regular intervals in the future so that any changes over time and/or over varied flow regimes can be evaluated. In addition, a mark-recapture pilot study should be initiated to evaluate the potential for using this methodology for long-term monitoring of dwarf wedgemussel abundance and survival. Mark-recapture methods provide statistically robust estimates of population parameters that are superior to simple count estimates in cases where it is not practicable to count all individuals in a population. Methods should be similar to those in Peterson et al. (2011), Meador et al. (2011), and Villella et al. (2004), but should focus on differences among sampled sites. Sites should be selected based on those sampled to meet Objective 2, but should also include sites outside of the project area to fully evaluate project effect and to account for any natural variability that may be independent of project effect.

A long-term mussel monitoring program was devised as part of the study plan for the relicensing of the Lake Blackshear Hydroelectric Project (FERC no. 659) on the Flint River in Georgia. According to the monitoring plan (Lake Blackshear Project 2009), three surveys will be conducted five years apart, beginning five years after issuance of the FERC license. Surveys will be quantitative (there is a qualitative aspect to the Lake Blackshear mussel monitoring plan that can be ignored) and will focus on evaluating changes in recruitment and population size of the purple bankclimber (*Elliptoideus sloatianus*), a federally-listed species. A similar protocol should be used to monitor dwarf wedgemussel populations in the project-affected areas of the Connecticut River post-license, although the number of surveys and the time between surveys may require some research and discussion. **This proposed methodology corresponds to Objective 3**.

In order to investigate the effects that the hydropower projects have on mussel behavior, individual mussels should be observed as flow fluctuates as a result of dam operations. Researchers should measure changes in shell position (open/closed), siphoning rate, lure display, horizontal migration (movement across the substrate), and vertical migration (burrowing). Past studies have quantified changes in vertical migration due to flow fluctuations (Saha & Layzer 2008, DiMaio & Corkum 1997). This phase of the study will likely take two field seasons in order to maximize the number of behavioral observations so that any trends can be identified and evaluated. **This proposed methodology corresponds to Objective 4**.

At these same sites, an evaluation of flow fluctuations on dwarf wedgemussel habitat persistence should be conducted following methods similar to those of Maloney et. al. (2012). This will include the development of a two-dimensional hydrodynamic model based on modeled depth, velocity, Froude number, shear velocity, and shear stress. This model will be used to quantify suitable dwarf wedgemussel habitat and its persistence over a range of flows, including flows typically experienced under peaking operations. These methods are being employed to evaluate persistence of dwarf wedgemussel habitat on the Delaware (Maloney et. al. 2012) and Susquehanna (T. Moburg, The Nature Conservancy, personal communication) rivers. Depending on how many plots are chosen, this phase of the study could take one or two field seasons. **This proposed methodology corresponds to Objective 5**.

Level of Effort and Cost
The cost for collecting the data for this study is entirely dependent on the number of study sites selected, as well as how frequently surveys will be conducted as part of the long-term monitoring plan. The expected level of effort and anticipated costs will be comparable to that of similar FERC relicensing projects of this size.

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Wilder Hydroelectric Project – FERC No. 1892-026

Study Request 28: Assess the impact of project operations on state-listed rare, threatened and endangered plant species and significant natural communities

Goals and Objectives

The goal of this study is to determine the potential impact of water fluctuations downstream and within the impoundment from project operations on state listed rare, threaten, and endangered plant species (S1 & S2) and significant natural communities. The survey should encompass all areas from the head of the impoundment, downstream to the start of the next projects impoundment.

The objectives of this study are:

- Identify rare and state listed plants and significant natural communities that might be affected by an altered hydrological regime.
- Determine mitigation in operations that might be appropriate to ameliorate any adverse impacts.

Resource Management Goals

Vermont threatened and endangered species are protected by Vermont's Endangered Species Law (10 V.S.A. section 5401 et. seq.). The Agency of Natural Resources conservation goals for endangered species are:

1. Maintain or increase populations of rare, threatened, and endangered species in the town or area of interest.
2. Maintain, restore, provide stewardship for, and conserve habitats and natural communities that support rare, threatened, and endangered species.

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the Vermont Fish and Wildlife Department mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).

Two of the Department's planning goals are:

1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.
2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

Public Interest Consideration

The requestor is a state natural resource agency.

Existing Information

The PAD indicates that there are many state listed rare, threaten, and endangered plant species occur within project area. A rare plant and community survey was conducted in summer 2012 to document the presence or absence of rare species, identify additional locations of rare species, and to evaluate the potential for project impacts on rare species. The PAD indicates that the detailed results of this survey would be available in late 2012, but at the time of filing this study request, the report was not available for Agency review to confirm the appropriate methodology was used and conclusions in the PAD.

Project Nexus

The project impoundment extends 45 miles upstream from the dam. The project currently operates in a peaking mode, with allowable impoundment fluctuations of up to 5 feet, with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (675 cfs), but can increase rapidly during times of power generation. Rare plants and natural communities can be affected by the operations of the hydropower project depending on frequency, timing, amplitude and duration of impoundment fluctuations. The PAD provides limited information on how project operations affect the rare plant communities' composition within the project impoundment. Operations of the project must conform to protect state listed plant species and natural communities. The Agency requests a study to determine the impacted by normal daily and seasonal operations of the project on state listed rare, threaten, and endangered plant species (S1 & S2) and significant natural communities.

Proposed Methodology

To assess the adverse impact of project operations on state listed plants and natural communities a survey of the impoundment and downstream of the project should be conducted. The survey should survey all that could potentially be affected by project operations. This survey should extend to cover the 100 year floodplain. A precise elevation should be recorded with a GPS unit to determine the proximity to project operations. An assessment of the plants and natural community overall health and condition should be determined to assess whether project operations are negatively impacting the community. State listed or natural communities deemed to be impacted by project operations; mitigation in operational procedures should be explored. Mitigation of the project operations on plants and natural communities should take into account the physical and biological requirements and whether there are certain times that the plants and/or community are more sensitive to project operations.

Level of Effort and Cost

The cost and effort of this study will be moderate, but is important to document the potential impact operations have on state listed plants and significant natural communities within the vicinity of the project to determine if Vermont's natural resource management goals are being met.

Bellows Falls Hydroelectric Project – FERC No. 1855-045

Study Request 28: Assess the impact of project operations on state-listed rare, threatened and endangered plant species and significant natural communities

Goals and Objectives

The goal of this study is to determine the potential impact of water fluctuations downstream and within the impoundment from project operations on state listed rare, threaten, and endangered plant species (S1 & S2) and significant natural communities. The survey should encompass all areas from the head of the impoundment, downstream to the start of the next projects impoundment.

The objectives of this study are:

- Identify rare and state listed plants and significant natural communities that might be affected by an altered hydrological regime.
- Determine mitigation in operations that might be appropriate to ameliorate any adverse impacts.

Resource Management Goals

Vermont threatened and endangered species are protected by Vermont's Endangered Species Law (10 V.S.A. section 5401 et. seq.). The Agency of Natural Resources conservation goals for endangered species are:

1. Maintain or increase populations of rare, threatened, and endangered species in the town or area of interest.
2. Maintain, restore, provide stewardship for, and conserve habitats and natural communities that support rare, threatened, and endangered species.

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the Vermont Fish and Wildlife Department mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).

Two of the Department's planning goals are:

1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.
2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

Public Interest Consideration

The requestor is a state natural resource agency.

Existing Information

The PAD indicates that there are many state listed rare, threaten, and endangered plant species occur within project area. A rare plant and community survey was conducted in summer 2012 to document the presence or absence of rare species, identify additional locations of rare species, and to evaluate the potential for project impacts on rare species. The PAD indicates that the detailed results of this survey would be available in late 2012, but at the time of filing this study request, the report was not available for Agency review to confirm the appropriate methodology was used and conclusions in the PAD.

Project Nexus

The project impoundment extends 26 miles upstream from the dam. The project currently operates in a peaking mode, with allowable impoundment fluctuations of up to 3 feet, with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (1080 cfs), but can increase rapidly during times of power generation. Rare plants and natural communities can be affected by the operations of the hydropower project depending on frequency, timing, amplitude and duration of impoundment fluctuations. The PAD provides limited information on how project operations affect the rare plant communities' composition within the project impoundment. Operations of the project must conform to protect state listed plant species and natural communities. The Agency requests a study to determine the impacted by normal daily and seasonal operations of the project on state listed rare, threaten, and endangered plant species (S1 & S2) and significant natural communities.

Proposed Methodology

To assess the adverse impact of project operations on state listed plants and natural communities a survey of the impoundment and downstream of the project should be conducted. The survey should survey all that could potentially be affected by project operations. This survey should extend to cover the 100 year floodplain. A precise elevation should be recorded with a GPS unit to determine the proximity to project operations. An assessment of the plants and natural community overall health and condition should be determined to assess whether project operations are negatively impacting the community. State listed or natural communities deemed to be impacted by project operations; mitigation in operational procedures should be explored. Mitigation of the project operations on plants and natural communities should take into account the physical and biological requirements and whether there are certain times that the plants and/or community are more sensitive to project operations.

Level of Effort and Cost

The cost and effort of this study will be moderate, but is important to document the potential impact operations have on state listed plants and significant natural communities within the vicinity of the project to determine if Vermont's natural resource management goals are being met.

Vernon Hydroelectric Project – FERC No. 1904-073

Study Request 28: Assess the impact of project operations on state-listed rare, threatened and endangered plant species and significant natural communities

Goals and Objectives

The goal of this study is to determine the potential impact of water fluctuations downstream and within the impoundment from project operations on state listed rare, threaten, and endangered plant species (S1 & S2) and significant natural communities. The survey should encompass all areas from the head of the impoundment, downstream to the start of the next projects impoundment.

The objectives of this study are:

- Identify rare and state listed plants and significant natural communities that might be affected by an altered hydrological regime.
- Determine mitigation in operations that might be appropriate to ameliorate any adverse impacts.

Resource Management Goals

Vermont threatened and endangered species are protected by Vermont's Endangered Species Law (10 V.S.A. section 5401 et. seq.). The Agency of Natural Resources conservation goals for endangered species are:

1. Maintain or increase populations of rare, threatened, and endangered species in the town or area of interest.
2. Maintain, restore, provide stewardship for, and conserve habitats and natural communities that support rare, threatened, and endangered species.

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the Vermont Fish and Wildlife Department mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).

Two of the Department's planning goals are:

1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.
2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

Public Interest Consideration

The requestor is a state natural resource agency.

Existing Information
The PAD indicates that there are many state listed rare, threaten, and endangered plant species occur within project area. A rare plant and community survey was conducted in summer 2012 to document the presence or absence of rare species, identify additional locations of rare species, and to evaluate the potential for project impacts on rare species. The PAD indicates that the detailed results of this survey would be available in late 2012, but at the time of filing this study request, the report was not available for Agency review to confirm the appropriate methodology was used and conclusions in the PAD.

Project Nexus
The project impoundment extends 26 miles upstream from the dam. The project currently operates in a peaking mode, with allowable impoundment fluctuations of up to 8 feet, with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (1250 cfs), but can increase rapidly during times of power generation. Rare plants and natural communities can be affected by the operations of the hydropower project depending on frequency, timing, amplitude and duration of impoundment fluctuations. The PAD provides limited information on how project operations affect the rare plant communities' composition within the project impoundment. Operations of the project must conform to protect state listed plant species and natural communities. The Agency requests a study to determine the impacted by normal daily and seasonal operations of the project on state listed rare, threaten, and endangered plant species (S1 & S2) and significant natural communities.

Proposed Methodology
To assess the adverse impact of project operations on state listed plants and natural communities a survey of the impoundment and downstream of the project should be conducted. The survey should survey all that could potentially be affected by project operations. This survey should extend to cover the 100 year floodplain. A precise elevation should be recorded with a GPS unit to determine the proximity to project operations. An assessment of the plants and natural community overall health and condition should be determined to assess whether project operations are negatively impacting the community. State listed or natural communities deemed to be impacted by project operations; mitigation in operational procedures should be explored. Mitigation of the project operations on plants and natural communities should take into account the physical and biological requirements and whether there are certain times that the plants and/or community are more sensitive to project operations.

Level of Effort and Cost
The cost and effort of this study will be moderate, but is important to document the potential impact operations have on state listed plants and significant natural communities within the vicinity of the project to determine if Vermont's natural resource management goals are being met.

Wilder Hydroelectric Project – FERC No. 1892-026
Bellows Falls Hydroelectric Project – FERC No. 1855-045
Vernon Hydroelectric Project – FERC No. 1904-073

Study Request 29: Survey the number, species and behavior of adult dragonflies and emerging nymphs within the project areas

Goals and Objectives

The goal of this study is to conduct an inventory to detect and gather information on known and new odonate populations classified as Species of Greatest Conservation Need (SGCN) along the Connecticut River throughout the project area to assess the potential impact of project operations on dragonflies species habitat and survival.

The objectives of this study are:

Obtain information on the habitats of each species collected, in particular the riparian zone vegetation cover, river substrate and water quality.

Obtain information on the life cycle of each species present and most importantly, the hatching period and number per year of nymphs.

Obtain baseline distributional and relative abundance data for all odonate species by conducting surveys throughout the project areas.

Assess the vulnerability of nymphs of each species to disturbances such as water level fluctuation during nymph hatching, flow fluctuations, changes in vegetation or exposed hard substrate in the riparian area.

Determine if Project operations are adversely affecting the survival success of emerging nymphs (i.e. if flow alterations are causing mortality prior to hardening off).

If it is determined that the Project operations are adversely affecting survival, identify operational regimes that will reduce and minimize impacts odonates and odonate habitat within the project area.

Resource Management Goals

The Agency’s goals related to aquatic natural resources are to:

1. Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
3. Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the VTFWD's mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).

Two of the Department's planning goals are:

1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.

2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

Three odonate species within the lower Connecticut River drainage are listed as Vermont Species of Greatest Conservation Need (SGCN) within the River/Stream odonates group.

Conversion of habitat, habitat alteration and sedimentation are all identified in the Vermont Wildlife Action Plan (VWAP) as current problems facing odonates.

A high priority strategy in the VWAP for odonate management is the acquisition or easements on high priority SGCN odonate riverine sites.

Protecting and restoring aquatic and riparian habitats through improved water quality; flow, water level and temperature regimes; sediment reduction; establishment of streamside buffers; and suitable aquatic habitat structure, diversity and complexity is a conservation strategy identified in the VWAP for aquatic species.

Results of the survey will be used to develop flow-related license requirements and/or other mitigation measures that will optimize habitat for these Vermont SGCN.

Public Interest Consideration
The requestor is a state resource agency.

Existing Information
At least nine odonate species are known to inhabit the Connecticut River valley in Vermont, the habitat requirements of which vary within the general rivers/streams category. Most species have not been assigned state status ranks, due to incomplete distribution and abundance information.[2]

A total of 18 dragonfly species have been documented in the Connecticut River valley in Massachusetts just south of the Vernon project area, including 8 that are listed by the state of Massachusetts as Species of Special Concern, Threatened, or Endangered, including some known Vermont species. [1]. However, their existence above the Vernon dam is unknown.

Odonates emerge from the water as nymphs and shed their pupal skins at or very close to the first vertical surface they encounter. Dragonflies are soft for the first half-hour after emerging from their skins and are at risk of being injured or killed by waves from passing boats and rapidly fluctuating water levels. Until their bodies harden and their wings dry, they cannot move further up the bank. Dragonflies that emerge at or very close to the waterline are therefore at significantly higher risk of injury or death.[1]

To date no studies have been conducted above the Vernon Dam to identify odonate populations within the three project areas and whether project operations are affecting these populations.

Project Nexus

The Wilder Project impounds 45 miles of river that would otherwise be free flowing. The project currently operates in a peaking mode, with allowable impoundment fluctuations of up to 5 feet, with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (675 cfs), but can increase rapidly during times of power generation.

The Bellows Falls Project impounds 26 miles of river that would otherwise be free flowing. The project currently operates in a peaking mode, with allowable impoundment fluctuations of up to 3 feet, with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (1083 cfs), but can increase rapidly during times of power generation.

The Vernon Project impounds 26 miles of river that would otherwise be free flowing. The project currently operates in a peaking mode, with allowable impoundment fluctuations of up to 8 feet, with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (1250 cfs), but can increase rapidly during times of power generation.

Operations at the three projects have the potential to cause direct adverse effects to odonate habitat within the project area, and effect survival of during emergence. The Agency requests a study assess whether project operations are having any adverse effects to these populations.

Proposed Methodology

Study methods similar to those from Morrison, F., McLain, D., and Sanders, L. 2006. *A Survey of Dragonfly Emergence Patterns Based on Exuvia Counts and the Results of River Bottom Transects at Selected Sites in the Turners Falls Pool of the Connecticut River, 2006 Field Season* This would provide valley wide consistency in methodology.

Level of Effort and Cost

The estimated level of effort and costs for this recommended study is expected to be moderate. The applicant did not propose any alternative studies in its PAD to address this specific issue.

Literature Cited

[1]Dragonfly Studies
http://www.restoreconnriver.org/dragonfly_studies.php
© 2007 Franklin Regional Council of Governments, 425 Main Street, Suite 20, Greenfield, MA 01301-3313 Ph: 413-774-3167 | Email: info@frcog.org

[2]Vermont's Wildlife Action Plan. 2005. Vermont Fish & Wildlife Department. Waterbury, Vermont. http://www.vtfishandwildlife.com/swg_cwcs_report.cfm.

Wilder Hydroelectric Project – FERC No. 1892-026
Bellows Falls Hydroelectric Project – FERC No. 1855-045
Vernon Hydroelectric Project – FERC No. 1904-073

Study Request 30: Survey for new and existing populations of adult Cobblestone and Puritan tiger beetle populations within the project areas

Goals and Objectives

The goal of this study is to conduct a survey to detect and gather information on known and new Cobblestone and Puritan tiger beetle populations along the Connecticut River throughout the project area (including the impoundments and downstream in the free flowing reaches), and to determine the potential impact from project operations on tiger beetles.

The objectives of this study are:

- Obtain baseline distributional and abundance data and map occurrences of Cobblestone and Puritan tiger beetle populations along the Connecticut River throughout the three project areas.
- Define the particular habitat requirements of each species.
- Assess the vulnerability of each species to disturbances such as siltation, flow fluctuations, and changes in shoreline composition and vegetation.
- Identify areas within the project areas where suitable habitat may exist for tiger beetles and the portion affected by project operations.
- Determine if project operations are adversely affecting the survival success of tiger beetle and beetle larva.
- If it is determined that the project operations are adversely affecting survival, identify operational regimes that will reduce and minimize impacts to tiger beetle and tiger beetle habitat within the project area.

Resource Management Goals

Vermont threatened and endangered species are protected by Vermont's Endangered Species Law (10 V.S.A. section 5401 et. seq.). The Agency of Natural Resources conservation goals for endangered species are:

1. Maintain or increase populations of rare, threatened, and endangered species in the town or area of interest.
2. Maintain, restore, provide stewardship for, and conserve habitats and natural communities that support rare, threatened, and endangered species.

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the VTFWD's mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).

Two of the Department's planning goals are:

1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.
2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

Two tiger beetle species within the Connecticut River drainage are listed as Vermont's Species of Greatest Conservation Need (SGCN), the Cobblestone tiger beetle (state-threatened species) and the Puritan tiger beetle (federally-threatened species). [1]

Conversion of habitat, habitat alteration, habitat succession, inadequate disturbance regime and sedimentation are all identified in the Vermont Wildlife Action Plan (VWAP) as current problems facing tiger beetles. [1]

A high priority strategy in the VWAP for tiger beetle management is easement acquisition of high priority SGCN tiger beetle riverine sites. [1]

Protecting and restoring aquatic and riparian habitats through improved water quality; flow, water level and temperature regimes; sediment reduction; establishment of streamside buffers; and suitable aquatic habitat structure, diversity and complexity is a conservation strategy identified in the VWAP for aquatic species. [1]

Results of the survey will be used to develop flow-related license requirements and/or other mitigation measures that will optimize habitat for these Vermont SGCN.

Public Interest Consideration
The requestor is a state resource agency.

Existing Information
The Puritan tiger beetle (*Cicindela puritana*) is a federally threatened species only known historically from a single Vermont site, although other historic sites were known along the New Hampshire side of the river. [1]

Impoundments along the Connecticut River likely caused the extirpation of this species. Other habitat losses may have also been a factor. Reintroduction could be considered if sufficient habitat improvements are made. Riverside recreational use has had a significant impact on populations at other New England sites. Historically found along lower portion of Connecticut River in Hartland, VT and nearby NH sites, this species prefers wide sand deposits along big rivers or narrow beaches along rivers with clay banks.[1]

The Cobblestone tiger beetle (*Cicindela marginipennis*) is a state-threatened species and has been studied in Vermont to a greater degree than other *Cicindela* species. Habitat losses along the Connecticut River and possibly other rivers have been significant due to impoundments. *C.*

marginipennis is found in the lower Connecticut River, White River, West River, and single Winooski River, Southern Vermont Piedmont and Northern Green Mountains. [1]

The Cobblestone tiger beetle is in extremely restricted habitat, being found on cobble beaches of shores and islands of large rivers. Adults inhabit areas of cobble and sand where vegetation is very sparse. Larvae occupy burrows in the sand along the edges of cobblestones. [1]

Project Nexus

The project impounds several miles of river that otherwise would be free flowing. Currently the projects operate in a peaking (daily run-of-river) mode resulting in large and rapid changes in flow below the dams. Rapid changes in flow and water level have the potential to cause direct adverse effects to tiger beetle habitat within the three project areas. If tiger beetles inhabit the project areas, it is important to assess whether project operations are having any adverse effects to these populations. The Agency request a study to determine the effects of project operations on cobblestone and puritan tiger beetles.

Proposed Methodology

The methodology should be similar to that used by Brust, M. L., Hoback , W. W. and Johnson, J. J., *Fishing for Tigers: A Method for Collecting Tiger Beetle Larvae Holds Useful Applications for Biology and Conservation*, 2010, The Coleopterists Bulletin 64(4):313-318.

Results should include presence, relative abundance, evidence of reproduction, and available habitat. Additionally, the methodology should collect information on habitat used by each species of tiger beetles and identify potential habitat. The portion of habitat that is affected by project operations should also be determined, and the frequency of inundation of each site.

Level of Effort and Cost

The estimated level of effort and costs for this recommended study is expected to be moderate. The applicant did not propose any alternative studies in its PAD to address this specific issue.

Literature Cited

[1]Vermont's Wildlife Action Plan. 2005. Vermont Fish & Wildlife Department. Waterbury, Vermont. http://www.vtfishandwildlife.com/swg_cwcs_report.cfm.

Wilder Hydroelectric Project – FERC No. 1892-026
Bellows Falls Hydroelectric Project – FERC No. 1855-045
Vernon Hydroelectric Project – FERC No. 1904-073

*Study Request 31: Survey the distribution, population size and habitat conditions of Fowler's Toad (*Bufo fowleri*) within the project areas*

Goals and Objectives

The goal of this study is to conduct a survey to obtain baseline distributional and abundance data on Fowler's Toads along the Connecticut River throughout the project areas to determine the potential impacts of project operations.

The objectives of the study are:
Survey for and map occurrences of Fowler's Toads and suspected hybrids with American Toads.

Define the preferred habitat requirements of the species.

Document and map current and suitable habitat, including connectivity of patches.[1]

Assess the vulnerability of Fowler's Toads to project operations such as flow fluctuations, siltation, and changes in shoreline composition and vegetation.

Determine if Project operations are adversely affecting the survival success of Fowler's Toads (i.e. if flow alterations are impacting breeding habitat).

If it is determined that the Project operations are adversely affecting survival, identify operational regimes that will reduce and minimize impacts on Fowler's Toads and Fowler's Toad habitat within the project area.

Resource Management Goals

The Agency's goals related to aquatic natural resources are to:

1. Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by project operations.
3. Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the VTFWD's mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005).

Two of the Department's planning goals are:

1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.
2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

Fowler's Toad populations have been documented within the Connecticut River drainage in the Project area.[1]

The Fowler's Toad is a Vermont's Species of Greatest Conservation Need (SGCN). It is currently being considered for recommendation as an endangered species by the Vermont Endangered Species Committee (See Appendix B). It is ranked as an S1, Very Rare species.[1]

Fowler's Toads breed in Vermont in shallow pools along the disturbed shoreline of the Connecticut River and perhaps its larger tributaries. It forages and overwinters primarily in well-drained sites, particularly floodplain forests and sandy deciduous woodlands along shorelines and river valleys, but may also occupy gardens, lawns, and fields.[1].

Fowler's Toads have specialized breeding habitat requirements that benefit from shoreline disturbance as a result of flooding and wave action. They also undergo regular short-term population fluctuations. Any habitat conversion, alteration, or fragmentation that disrupts the species' ability to move between breeding and terrestrial sites as well as recolonize appropriate habitat may have negative effects.[1]

Conversion of habitat, habitat alteration, and habitat fragmentation are all identified in the Vermont Wildlife Action Plan (VWAP) as current problems facing Fowler's Toads.[1] In addition, a lack of flood events that would deposit sand and gravel along the shoreline of the Connecticut River and clean away vegetation, will limit appropriate breeding habitat.

A strategy in the VWAP for Fowler's Toad management is to protect currently known breeding sites and adjacent terrestrial habitat through easement or purchase.[1]

Protecting and restoring aquatic and riparian habitats through improved water quality; flow, water level and temperature regimes; sediment reduction; establishment of streamside buffers; and suitable aquatic habitat structure, diversity and complexity is a conservation strategy identified in the VWAP for aquatic species.[1]

Results of the survey will be used to develop flow-related license requirements and/or other mitigation measures that will optimize habitat for this Vermont SGCN.

Public Interest Consideration
The requestor is a state resource agency.

Existing Information

To date no studies have been conducted to identify Fowler's Toad populations within the three project areas and whether Project operations are affecting these populations.

Project Nexus

The Wilder Project impounds 45 miles of river that would otherwise be free flowing. The project currently operates in a peaking mode, with allowable impoundment fluctuations of up to 5 feet, with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (675 cfs), but can increase rapidly during times of power generation.

The Bellows Falls Project impounds 26 miles of river that would otherwise be free flowing. The project currently operates in a peaking mode, with allowable impoundment fluctuations of up to 3 feet, with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (1080 cfs), but can increase rapidly during times of power generation.

The Vernon Project impounds 26 miles of river that would otherwise be free flowing. The project currently operates in a peaking mode, with allowable impoundment fluctuations of up to 8 feet, with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (1250 cfs), but can increase rapidly during times of power generation.

Project operations have the potential to cause direct adverse effects to Fowler's Toad habitat within the three Project areas. Releases that mimic natural flood events would probably benefit this species by creating and maintaining breeding habitat. Since Fowler's Toads are known to inhabit the project areas, it is important to assess whether Project operations are having any adverse effects to their populations.

Proposed Methodology

Adapt methods below to river shores:
Amphibian Calling Surveys, Author: Sam Droege, USGS Patuxent Wildlife Research Center, 12100 Beech Forest Rd., Laurel, MD 20708, frog@usgs.gov, 301-497-5840.
http://www.pwrc.usgs.gov/monmanual/techniques/amphibcallingsurveys.htm

Improving calling surveys for detecting Fowler's toad, Bufo fowleri, *in southern New England, USA*, Todd A. Tupper, Robert P. Cook, Brad C. Timm, and Amy Goodstine
http://www.nps.gov/caco/naturescience/upload/Bufo_fowleri_Poster_Tupper.pdf

May also include nighttime wet road surveys, near-shore boat surveys, the use of FrogLoggers and environmental DNA sampling.

Level of Effort and Cost

The estimated level of effort and costs for this recommended study is expected to be moderate. The applicant did not propose any alternative studies in its PAD to address this specific issue.

Literature Cited

[1]Vermont's Wildlife Action Plan. 2005. Vermont Fish & Wildlife Department. Waterbury, Vermont. http://www.vtfishandwildlife.com/swg_cwcs_report.cfm.

Wilder Hydroelectric Project – FERC No. 1892-026
Bellows Falls Hydroelectric Project – FERC No. 1855-045
Vernon Hydroelectric Project – FERC No. 1904-073

Study Request 32: Recreational survey and enhancement study

Goals and Objectives
The goal of this study is to identify opportunities for improving recreational opportunities at project facilities and on project lands, including new or improved recreational facilities and changes in project operations.

The objectives are to:

- Survey recreational users and potential users to identify to what extent existing recreational opportunities are being utilized by the public within the project boundaries and why potential recreational users are not using the resource.
- Identify any safety issues to recreational users from project operations, how project operations impacting recreational users and how operations could be modified to improve recreational opportunities.
- Identify how recreational opportunities in the vicinity of the project could be developed to enhance future recreational opportunities, including, but not limited to, river access points, primitive camping sites, improvement in portage trails, etc.

Resource Management Goals
The 1993 Vermont Recreation Plan (Vermont Department of Forests, Parks and Recreation), through extensive public involvement, identified water resources and access as top priority issues. The planning process disclosed that recreational use of surface waters is increasing, resulting in greater concern about water quality, public access to Vermont's waters, and shoreland development. The plan's Water Resources and Access Policy states:

> It is the policy of the State of Vermont to protect the quality of the rivers, streams, lakes, and ponds with scenic, recreational, cultural and natural values and to increase efforts and programs that strive to balance competing uses. It is also the policy of the State of Vermont to provide improved public access through the acquisition and development of sites that meet the needs for a variety of water-based recreational opportunities.

Another priority issue identified in the Recreation Plan is the loss or mismanagement of scenic resources. The plan notes "[t]he protection of the scenic and visual resources in Vermont is paramount if Vermont is to maintain its renowned charm and character."

The Connecticut River is considered Class B waters. Vermont Water Quality Standards require that Class B waters be managed to provide full support for all recreational uses, including swimming and other primary contact forms of recreation and boating, fishing and other recreational uses.

Public Interest Consideration
The requestor is a state natural resource agency.

Existing Information

The PAD provides information on the existing recreational resources, but does not provide information on how project operations adversely affect recreational opportunities or perceptions of recreational users utilizing opportunities in the project areas.

Project Nexus

These projects affect the Connecticut River from the vicinity of Wells River, Vermont to the Massachusetts boundary. Recreational opportunities on these public waters are affected by the presence of the projects and their operation. The Agency requests a recreational assessment that can be used to inform the development of recreational plans for the projects.

Proposed Methodology

The proposed study methodology should include an inventory of all the recreational facilities and opportunities within the project boundary, and a determination of the number of recreational users utilizing the resources. The study should include a component to survey an equal proportion of recreational users utilizing different activities to determine how project operations affect their recreational use and experience, and identify any safety issues associated with project operations or current recreational facilities. Potential recreational users in the area should be identified to determine why potential recreational users do not use the resource. An analysis of the recreational facilities should be conducted to identify future projects that could improve the recreational resources and/or the need to improve existing recreational facilities or access to the resource.

The approach used during the relicensing of TransCanada's Fifteen Mile Falls Project can serve as a model.

Level of Cost and Effort

The cost and effort of this study will be moderate, but it will provide essential information for certification and licensing of the projects.

Wilder Hydroelectric Project – FERC No. 1892-026
Bellows Falls Hydroelectric Project – FERC No. 1855-045
Vernon Hydroelectric Project – FERC No. 1904-073

Study Request 33: Assess the amount of development within the floodplain of the lower Connecticut River

Goals and Objectives
The goal of this study is to determine the number of developments within the 100 year floodplain to determine if river profile operations during high flow events, aimed to reduce overland flow and contain flows to the channel, are necessary to protect public or community economic investments.

The objectives of this study are:
- Determine the number of public and community development within the 100 year floodplain in New Hampshire and Vermont.
- Determine if river profile operations could be modified in locations to allow over land flow in the floodplains where waters would not cause damage or endanger public safety and community investments.

Resource Management Goals
The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota, wildlife or habitat.

Under Act 138 (Sec. 9. 10 V.S.A. § 1427) – River Corridor and Floodplain Management, the Agency is responsible for identifying where the sensitivity of a river poses a probable risk of harm to life, property, or infrastructure, and to develop recommended best management practices for the management of river corridors, floodplains, and buffers.

Public Interest Consideration
The requestor is a state natural resource agency.

Existing Information
The PAD does not provide any information on this topic.

Project Nexus
The PAD indicates that at all three projects have river profile operations during high flow events. The PAD states that during high flows the dams operate with the goal to reduce overland flow and contain flow to the channel. During river profile operations the impoundments are drawn down prior to high flow events to allow inflows to stay within the channel and reduce the flow entering the river floodplain communities. The Agency requests a study to determine if river profile operations are necessary to protect public safety, community or public economic investment.

Proposed Methodology

The Agency recommends that the Licensee use the latest Flood Insurance Studies to determine the number of residents, commercial buildings or other infrastructure within the 100 year floodplain. If a recent Flood Insurance Study has not been completed, aerial photos could be used with the 100 year floodplain for the Lower Connecticut River overlaid to complete the study.

Level of Effort and Cost

The effort and cost of this study is expected to be relatively low, but is important to document the potential impact operations have on floodplain communities and whether river profile operations are necessary to protect public safety and investments.

Bellows Falls Hydroelectric Project – FERC No. 1855-045

Study Request 34: Bellows Falls aesthetic flow study

Goal and Objective
The goal of this study is to determine the flow required at Bellows Falls dam and bypass reach to support aesthetics under the Vermont Water Quality Standards.

Resource Management Goals
The Connecticut River is considered a Class B waters. Good aesthetic values are a management objective for Class B waters in Vermont. Vermont's Water Quality Standards provide that waters shall be of a quality that consistently exhibits good aesthetic values, including water character, flows, water level, bed and channel characteristics.

Public Interest Consideration
The requestor is a state resource agency.

Existing Information
The PAD provides limited information on this issue, only briefly indicating that during flows that exceed project capacity that the excess is spilled over the dam into the bypass reach. During other times of year no minimum flow is required in the bypass reach, and the amount of flow present is determined by the amount of spillage.

Project Nexus
Flow over the dam and in the bypass reach directly impacts aesthetics, which must be supported to conform to Vermont Water Quality Standards. The Agency requests a study of alternate spillage flows at the facility. This information will be needed before the Agency can certify that the project meets Vermont Water Quality Standards.

Proposed Methodology
A range of alternate spillages can be videotaped and qualitatively analyzed, or a demonstration study can be arranged for direct observation of flows by a team for subjective grading. If the latter approach is used, the flows should be documented using both still photographs and videotaping. Typically, a range of flows are observed from several vantage points. If direct observation is used, a rating form is employed to provide a structure for the individual observations.

Level of Effort and Cost
The effort and cost would be determined by the approach used. Under appropriate conditions, one day of field work should be required.

Vermont Agency of Natural Resources

Study Requests for Wilder, Bellows Falls and Vernon Projects

Appendix A

Natural Community Survey Form

NATURAL COMMUNITY SURVEY FORM

Natural Heritage Inventory (NHI)

Vermont Fish and Wildlife Department

Revised: October 16, 2012

Contact Eric Sorenson with questions about natural communities or this form: 802-476-0126; eric.sorenson@state.vt.us

Natural Community Type: Click here to enter text.

Natural Community Variant Name (if applicable): Click here to enter text.

Association Name (NHI office only): Click here to enter text.

Is this an update of an existing NHI record? (NHI office only) Yes ☐ No ☐

Site Name: Click here to enter text.

Site Location Road Address: Click here to enter text.

Town: Click here to enter text.

Surveyor(s): Click here to enter text.

Mailing Address: Click here to enter text.

Phone: Click here to enter text.

E-mail: Click here to enter text.

Survey Date(s): Click here to enter text.

Owner(s) of Natural Community: Name(s): Click here to enter text.

Address: Click here to enter text.

Phone: Click here to enter text.

E-mail: Click here to enter text.

GENERAL DESCRIPTION OF THE SITE

Briefly describe the natural and man-made features of the site and setting in which the natural community occurs, including topography, size of the contiguous forested area, other natural community types present, surface waters and drainage patterns, and land use history and land management.

Click here to enter text.

NATURAL COMMUNITY INFORMATION

Concisely describe the natural community, including canopy cover, dominant species, the physical setting, evidence of human and natural disturbance, forest community age, woody debris abundance, and presence of invasive species.

Click here to enter text.

Elevation (feet): minimum: Click here to enter text. **maximum**: Click here to enter text.

Slope (degrees): Click here to enter text.

Aspect (degrees or cardinal direction): Click here to enter text.

Bedrock geologic type (2012 VT bedrock geology map): Click here to enter text.

Soil type (Natural Resources Conservation Service) or description: Click here to enter text.

Vegetation Description: To be applied to a representative area of the community large enough to capture most species.

Total Canopy Cover: Click here to enter text.% Total Shrub Cover: Click here to enter text.%

	Trees			Shrubs				
	T1Emergent	T2 Canopy	T3 Subcanopy	S1 Tall (> 4 ft.)	S2 Short (<4 ft.)	H Herbaceous	N Nonvascular	V Vine
Height (ft.)								
% Cover								

Dominant Species and their cover for each stratum (T1- emergent, T2-main canopy, T3-subcanopy, S1-tall shrub, S2-short shrub, H-herb, N-nonvascular, V-vine). Give average DBH (inches) for trees. For each species estimate actual percent cover or use one of the cover class categories below. Use the species list table below or attach a separate sheet.

Stratum	Species	DBH	Cover	Stratum	Species	Cover

Cover Classes	
r	**< 1% rare**
+	**< 1% occs**
1	**1-5 %**
2	**6-25 %**
3	**26-50 %**
4	**51-75 %**
5	**76-100 %**

OR

Cover Classes	
D	**Dominant; cover > 50%**
C	**Common; 6 to 50 % or numerous individuals**
O	**Occasional; 1 to 5% or scattered individuals**
R	**Rare; < 1% or one to a few individuals**

Provide ages for representative trees in the community (optional).

Tree Species	DBH	Age

Comments about the natural community that do not fit in another field:

Click here to enter text.

NATURAL COMMUNITY MAPPING

Attach GIS shapefiles (preferred) or digital or paper map of the natural community boundaries with labeled polygons.

Estimate percent of mapped polygon occupied by the natural community: >95%☐; 80-95%☐; 20-80%☐; 0-20%☐
Explain if <95%, explain what other communities are present: Click here to enter text.

Indicate type and scale of Base Map used to map the natural community: Click here to enter text.

Confidence in the Extent of the Natural Community as Mapped (check one)

☐ Confident that the full extent is known and mapped:

☐ Full extent is not known:

☐ Uncertain if full extent is known:

Comments: (If the natural community extends off the subject property, explain, and estimate total area of community.)

Click here to enter text.

COMMUNITY OCCURRENCE RANKING: a range of ranks may be used (such as AB)

Using **VT NHI ranking specifications** (if available)*: OR Using **Generic ranking specifications** (provided below):

	Rank (A-D)	**Comments**
Current Condition		Click here to enter text.
Landscape Context		Click here to enter text.
Size (acres)		Community size and how determined: Click here to enter text.
Overall Rank		Click here to enter text.

* Available for some natural communities from Eric Sorenson (eric.sorenson@state.vt.us) or 802-476-0126.

Generic ranking specifications

Use the following guidelines to fill in the grid above if VT NHI ranking specifications are not yet available for the community type.

Current Condition

A: mature example of the community type (forests with trees generally >150 years old); natural processes intact; no exotics
B: some minor alteration of vegetation structure and composition, such as by selective logging; minor alterations in ecological processes; exotics species present in low abundance
C: significant alteration of vegetation structure and composition, such as by heavy logging; alteration of ecological processes are significant, but community recovery/restoration is likely; exotic species are abundant and control will take significant effort

D: ecological processes significantly altered to the point where vegetation composition and structure are very different from A-ranked condition and restoration/recovery is unlikely; exotic species are abundant or control will be difficult

Landscape Context

A: highly connected; area around EO (>1,000acres) is largely intact natural vegetation, with species interactions and natural processes occurring across communities; surrounding matrix forest meets at least B specifications for Condition.
B: moderately connected; area around EO (>1,000acres) is moderately intact natural vegetation, with species interactions and some natural processes occurring across many communities, although temporary disturbances such as logging have reduced condition of the landscape; surrounding matrix forest meets at least C specifications for Condition

C: moderately fragmented; area around EO is largely a combination of cultural and natural vegetation with barriers to species interactions and natural processes across communities; surrounding land is a mix of fragmented forest, agriculture, and rural development

D: highly fragmented; area around EO is entirely, or almost entirely, surrounded by agriculture or urban development

Size

No Generic ranking applicable. Please provide size of community in grid above.

Overall Rank (based on best judgment)

A: excellent estimated viability

B: good estimated viability

C: fair estimated viability

D: poor estimated viability

NATURAL COMMUNITY MANAGEMENT

Discuss management needs and plans for this natural community, including need for invasive species monitoring and control. If the natural community requires a buffer with specific management, describe and map the buffer width and specifically explain the ecological need for the buffer:

Click here to enter text.

ADDITIONAL INFORMATION; (none required) (check those that are attached):

☐ Additional plant species list attached

☐ Plot form(s) attached

☐ Animal list attached

Please send completed form and GIS shapefiles to Eric Sorenson:

eric.sorenson@state.vt.us

or

Eric Sorenson

Natural Heritage Inventory

Vermont Fish and Wildlife Department

5 Perry Street, Suite 40

Barre, Vermont 05641

Vermont Agency of Natural Resources

Study Requests for Wilder, Bellows Falls and Vernon Projects

Appendix B

Documentation for the listing of the Fowler's Toad as an endangered species in Vermont

SPECIES STATUS REVIEW

STATE OF VERMONT
ENDANGERED SPECIES COMMITTEE

Common Name: **Fowler's Toad**	Current Status: **None** (Special Concern by SAG - Reptiles & Amphibians, S1 Vermont Heritage Rank, and high priority SGCN)
Scientific Name: ***Anaxyrus fowleri*** **(Previously** ***Bufo fowleri*****)**	Recommended Status: **Endangered**
Scientific Advisory Group Chair: James S. Andrews	Endangered Species Committee Chair: Sally Laughlin
Date:	Date:

Wildlife and plant species are added to or removed from the list of endangered and threatened species by action of the Secretary of the Agency of Natural Resources, upon recommendation of the Vermont Endangered Species Committee, according to 10 V.S.A., Chapter 123. The Vermont Endangered Species Committee is advised by scientific advisory groups on vascular plants, non-vascular plants, invertebrates, fish, reptiles and amphibians, birds, and mammals.

DEFINITIONS

ENDANGERED: A species that normally occurs in the State and whose continued existence as a viable component of the State's wild fauna or flora is in jeopardy, or a species determined to be an endangered species under the Federal Endangered Species Act. [V.S.A. Title 10, Chapter 123, Sections 5401(6) & 5402(b).]
THREATENED: A species whose numbers are significantly declining because of loss of habitat or human disturbance and unless protected will become an endangered species, or a species determined to be a threatened species under the Federal Endangered Species Act. [V.S.A. Title 10, Chapter 123, Section 5401(7) & 5402(c).]

GUIDELINES FOR LISTING AS ENDANGERED OR THREATENED

1. Species (including subspecies and varieties) which may be listed include all wild and free-ranging or naturally-occurring mammals, birds, amphibians, reptiles, fish, invertebrates, vascular and non-vascular plants.
2. Species which may be listed include those native to the State or known to exist as viable, naturalized populations in Vermont.
3. Species which may be listed must have spent at least some portion of their life cycle in Vermont on a sustained basis, breeding or otherwise.
4. Species listed by the Secretary of the Interior as endangered or threatened in the U.S., if occurring as historical or current residents or transients in Vermont, shall be listed in their respective categories.
5. Attached to this review shall be a SPECIES DOCUMENTATION including the best scientific information available with sources cited.
6. The Endangered Species Committee and its scientific advisory groups shall consider the CATEGORIES and CRITERIA FOR LISTING when recommending species for listing or delisting, using the best scientific information available and their best expert judgments.
7. Specific numbers cited in the Primary Criteria of the CRITERIA FOR LISTING are guidelines only, and are to be interpreted with respect to the biology of the species. Definitions of terms such as *population* and *reproductive potential* for each species shall be provided by the appropriate scientific advisory groups according to accepted practices in their field of biology.

(Guidelines continued on page 2)

CRITERIA FOR LISTING AS ENDANGERED OR THREATENED

1.0 **ENDANGERED**

____ 1.1 The species is known to have occurred historically in Vermont but has not been documented in the last 25 years; OR

__X__ 1.2 The species meets at least one of the following primary criteria of rarity:

- __X__ 1.2.1 There are estimated to be three or fewer viable, reproducing populations separated by unfavorable habitat in Vermont; OR
- __X__ 1.2.2 There are estimated to be fewer than 100 reproducing individuals in Vermont; OR
- ____ 1.2.3 The species is known in the last 25 years from 20 or fewer sites throughout its global range;

AND one of the following secondary criteria:

- ____ 1.2.4 The species has declined overall or noncyclically throughout a significant portion of its global range; OR
- ____ 1.2.5 The species is restricted to localities within or immediately adjacent to Vermont; OR
- __X__ 1.2.6 One or more special factors cause the species to be vulnerable to extirpation:
  - ____ 1.2.6.1 The species is in danger of exploitation or is threatened with disturbance; OR
  - __X__ 1.2.6.2 The species occurs in rare or specialized habitat that is vulnerable to loss, modification, or variations in quality; OR
  - ____ 1.2.6.3 The species has low reproductive potential or is experiencing reduced reproductive success; OR
  - __X__ 1.2.6.4 The species has other factors that render it vulnerable to extirpation (*list*).
    This species was last documented from Vermont in 2007. Since known populations have declined precipitously, there are clearly factors or combinations of factors that occur (or did occur) that render it vulnerable to extirpation. However, it is unclear exactly what factors or combination of factors brought about the current decline. In addition to habitat loss, habitat modification, and habitat fragmentation as listed above, this species has also shown sensitivity to lowered pH, herbicides, pesticides, some metals, road mortality, disease, parasites, and weather extremes such as those that could bring about mortality as a result of freezing (cold weather and lack of snow) or dehydration (drought). In addition, the cyclical nature of these populations in itself renders this species more vulnerable as it requires repopulation across an increasingly fragmented landscape. These threats are all discussed in greater detail in the species documentation.

Fowler's Toad (*Anaxyrus fowleri*)
Narrative Summary
December 18, 2012

The Endangered Species Committee recommends to the Secretary of Natural Resources that the Fowler's Toad (*Anaxyrus fowleri*) be listed as Endangered.

Fowler's Toad (*Anaxyrus fowleri*, previously *Bufo fowleri*) is a close relative of the more common American Toad (*Anaxyrus americanus*). The Fowler's Toad is an edge of range species that seems to have always been limited in distribution in Vermont. The Fowler's Toad was last documented in Vermont in 2007. We do not know what has caused this recent decline.

We have very little historical data on some of our rare reptiles and amphibians in Vermont. For example the Four-toed Salamander (*Hemidactylium scutatum*) was first documented in Vermont in 1960 and our only known large population of Spotted Turtles (*Clemmys guttata*) was not discovered until 2010. Both of these species are presumed to have existed in Vermont for hundreds if not thousands of years prior to our discovery of their presence.

Fowler's Toad was first reported and photographed in Vermont in 1983 in White River Junction (town of Hartford; Andrews, 2011) where it was reported as numerous. They have been reported from three other sites in the Connecticut River Valley of Vermont. A population in Vernon was well documented from 1994 through 2007.

Breeding choruses took place along the shores of the Connecticut River in Vernon and its islands (NH). Despite general herpetological survey efforts and multiple targeted surveys covering Windham County, no additional Fowler's Toads have been seen. Repeated (26 visits) and targeted surveys in 2008 by a graduate student from Antioch New England, did not locate any Fowler's Toads in the Vernon area or any surrounding areas including south of the Massachusetts border. Disturbed river-shore seems to be the primary breeding habitat used by this species in Vermont.

Species whose habitat needs are more restrictive and whose numbers are limited are at a heightened risk from anthropogenic and natural events. Since we have been unable to locate this species in Vermont since 2007, there are clearly factors or combinations of factors that occur (or did occur) that render it vulnerable to extirpation. However, it is unclear exactly what factors or combination of factors brought about the current low population levels. Controlling flooding along the lower Connecticut River may be limiting the creation of appropriate breeding habitat for this species. Gravel and sand deposits in the lowlands are prime development areas. Increased road building and road traffic in the river valleys are direct threats to individuals and general threats to breeding and foraging habitats and safe movement between them. In addition, this species has shown sensitivity to lowered pH, herbicides, pesticides, some metals, disease, parasites, and weather extremes such as those that could bring about mortality as a result of freezing (cold weather and lack of snow) or dehydration (drought). This species has undergone short-term population swings in Ontario but the duration of the swings is much shorter than the period of time since we last observed this species in Vermont. The short-term cyclical nature of these populations in itself renders this species more vulnerable particularly if it requires repopulation across an increasingly fragmented landscape.

Populations of species at the edge of their ranges often carry unique gene combinations selected for by the specific environmental conditions at their edge locations. These genetic differences often allow them to survive weather extremes, disease, or other stressors that other populations of the same species would not be able to survive. Some studies of vertebrates have shown declines in populations taking place from the center of a species range to the edges, with the marginal populations surviving after more central populations have disappeared. Hence conserving edge-of-range populations is an important step toward conserving populations as a whole and the genetic diversity within species.

We are concerned that this species does not have the appropriate conservation status in Vermont and hence that it does not get the conservation attention it deserves from state, regional, and local planners and managers; as well as local conservation commissions and land owners.

Benefits of listing this species:

- Increased awareness of natural resource planners and land managers (e.g., Regional Planning in Windham County did not have this species on its radar screen as a result of its not being listed. Local entities and landowners are not aware of the relative significance of this species and its habitat).

- Make it easier for land conservation organizations, conservation commissions, planning commissions, land owners, the Vermont Fish and Wildlife Department, and other land managers to justify allocating time and money for the monitoring and conservation of this species.

- Increase the availability of federal and private funding to governmental and non-governmental organizations, and individuals for conservation of this species.

- Provide accurate and current information on the status of Vermont’s wildlife species to the citizens of Vermont by assigning this species its appropriate status under Vermont law.

I. Species Documentation

A. STATE OF VERMONT

1. ENDANGERED SPECIES COMMITTEE

1.	Scientific Name:	*Anaxyrus fowleri* (Previously *Bufo fowleri*)
2.	Common Name:	Fowler's Toad
3.	Species Code (*Department use only*):	
4.	Current Vermont Status:	S1, SC, High Priority SGCN
5.	Recommended Vermont Status:	Endangered
6.	Federal Status:	US: None, Global status S5
7.	Surrounding State & Provincial Status:	Canada: Endangered (COSEWIC, April 2010) NH S3, NY & CN S4 MA S4 (but extirpated from Nantucket, Muskeget, & Cuttyhunk) Ontario: Endangered (SARO)

POPULATION STATUS

8. Global, North American, and Vermont Ranges:

This species distribution is centered in the eastern US from the Mississippi drainage to the Atlantic coast but not including the Florida peninsula, coastal North or South Carolina, or northern Michigan, northern New York, northern New Hampshire, or any of Maine. However, in the Midwest this species has recently disappeared from portions of its former range in Ohio and other states where it was once common (Quinn and Scott, 2005). It is not native anywhere else in the world (see map below).

In New Hampshire this species has not been monitored (Mike Marchand pers. comm., 2011). However, reports exist from Hinsdale (2002) and Westmoreland (2001) along the Connecticut River in Cheshire County, from Boscawen (1938 & 2011) and Concord (1997 & 2002) along the Merrimack River in Merrimack County, and from Enfield (2004) and Grafton (2004) in the Mascoma Valley of Grafton County (2004). The Enfield site is approximately 10 miles east of our Hartford records.

The stronghold for this species in New York State is Long Island. However, populations reach north along the Hudson River drainage to the Albany Pine Bush (where they have been difficult to locate in the last 10 years). They were rarely reported anywhere east of the Hudson River in upstate New York (Al Breisch pers. comm., 2011).

In Canada this species "only occurs on sandy beaches in three disjunct areas along the north shore of Lake Erie (Ontario). It has disappeared from numerous historic sites on the Lake Erie shore and continues to decline in abundance and number" (COSEWIC, 2010).

In Massachusetts, Fowler's Toads are primarily located on or near Cape Cod but they were also found along the Connecticut River as far north as Amherst during the 1992-1998-atlas effort (Jackson et al., 2010).

In Vermont, Fowler's Toad was found along the southern Connecticut River Valley reaching as far north as White River Junction (Hartford) in the early- to mid-1980s but it has been found only in Vernon during the last two decades with the exception of one 2002 report from along the Saxton's River in Rockingham. It was last reported from Vernon in 2007.

9. Vermont's Position within Global Ranges: ____ Central __X__ Peripheral _____ Disjunct

10. Historic Occurrences in Vermont More Than 25 Years Ago (*Type, Number, General Location, Regularity of Use, Confidence in Records, etc.*):

This species had been confused with others from the same genus (American toad, *Anaxyrus americanus* in this area) in the past. It was first reported in Vermont in 1983 by Michael Caduto and Margaret Barker in White River Junction (town of Hartford). They reported numerous sightings in the vicinity of Hillcrest Terrace in that year and documented one sighting with a photograph. Doug Kibbe remembers hearing what he was convinced were Fowler's Toads from Allen Brother's Marsh in Westminster in late May 1985 but this report was not accompanied by photographs. Additional visits to these sites have not turned up any more recent reports. These locations made sense as an extension of the Connecticut River lowlands populations of Massachusetts. However, they were quite distant from the nearest populations in Massachusetts and no other populations were known in Vermont at that time.

The 1983 report served as a wake-up call for those collecting data on Vermont's amphibians. From then on, toads were checked carefully to rule out the possibility of Fowler's Toads. However, no other toads of this species were located at any site until they were located in Vernon in 1994. This species has a very distinctive call, quite unlike that of American Toads. Consequently it is fairly easy to locate during its calling season if it is present.

11. Historic Abundance More Than 25 Years Ago (*number of Breeding Individuals or Size of Area Occupied, Confidence in Records, etc.*):

The Hartford records were documented, photographed, and published. Mark DesMeules (Vermont Nongame and Natural Heritage Program at that time), Jim Andrews (Vermont Reptile and Amphibian Atlas 2011), and others confirmed the identification from the photo. Caduto and Barker reported numerous sightings in the vicinity of Hillcrest Terrace in 1983. We have no other data on the historic abundance of this species in Vermont. Historical abundances throughout the range of this species are unknown but populations have been known to vary widely over time and space (Breden, 1988; Green 1992, 1997; Hranitz et al., 1993).

12. Current Occurrences in Vermont (*Type, Number, General Location, Regularity of Use, Confidences in Records, Extent to which the Species has been Inventoried, etc.*):

This species was last documented in Vermont in 2007. Since the initial discovery of this species in Vermont in Hartford in 1983, we have gathered 19 reliable reports of this species from the southern Connecticut River Valley. The next report came in 1985 from Allen Brother's Marsh in Westminster. This marsh is in the immediate flood plain of the Connecticut River and the report of calls heard comes from experienced naturalist Doug Kibbe. After that report, there are no new reports until Jim Andrews traveled to the region in 1994 along with some students with the specific goal of finding Fowler's Toads. During that brief but focused survey, Fowler's Toads were found only along Stebbins Road in Vernon. Stebbins Road is a sparsely developed rural road on a plateau above the current floodplain of the Connecticut River. On that trip a minimum of four Fowler's Toads were heard calling, captured and/or photographed. A return trip to the region in 1996 revealed at least one Fowler's Toad along the same road. A volunteer crew from Bonnyvale Environmental Education Center in Brattleboro was trained to survey for this species but again located it only from the Stebbins Road area. Patti Smith of Bonnyvale found or heard about eight Fowler's Toads (could include duplicates) from the Stebbins Road area in July of 2002. She taped a breeding chorus from along the edge of the Connecticut River near the north end of Stebbin's Road. That same year, a surprisingly disjunct report came from one of the same naturalists who first reported the White River Junction Fowler's toads back in 1983 (Michael Caduto). He reported hearing calls from one spot along the Saxton's River in Rockingham. In 2003, Jim Andrews again did survey work in the region and found two toads along Stebbins Road despite a wider search. In 2004, Wendy Hardy (a student of Jim Andrews) did an extensive survey along the Connecticut River for this species from Rockingham south and west to Guilford. Again, Fowler's Toads were found only from the Stebbins Road area. She found the species four times between July and October of that year and took photographs to document the species. She and her husband boated the Connecticut in search of this species and found them calling from an island (technically NH) in the river adjacent to the Stebbin's Road area. Jim Andrews again found them from the same area in 2005 and Patti Smith found and photographed the last one seen in 2007. Despite the targeted and extensive efforts of graduate student Angela Michael in 2008 and brief but repeated visits by Jim Andrews, Patti Smith and other members of the Reptile and Amphibian Scientific Advisory Group to the Stebbin's Road area, to Allen Brothers Marsh, and to other potential habitat up and down the Connecticut River Valley south of Hartford, this species has not been located since the 2007 sighting.

Seven additional unverified and poorly documented reports from the Connecticut River drainage come from Baltimore, Guilford, Jamaica, Townshend, Vernon, and Weathersfield spanning the years from 2000 through 2009. The 2009 report from Vernon appears to be a hybrid between a Fowler's Toad and an American Toad (*Anaxyrus americanus*) and was found upstream only a short distance (< 0.5 miles) from the Stebbin's Road population.

Single unverified reports also exist from Middlebury, Sudbury, and Hartford, NY in the southern Lake Champlain basin. These span the years from 1983 through a 2008 report from Hartford, NY along Route 149 east of Fort Ann. Since none of these reports were documented with either photographs or tapes and were widely disjunct, they have not been included on maps but they could possibly represent populations.

13. Current Abundance (*Number of Breeding Individuals or Size of Area Occupied, Confidence in Records, Problems in Estimating Abundance, etc.*):

This species was last documented in 2007. This species is known to hybridize with American Toad (*A. americanus*) and some possible hybrids have been seen and heard in the southern Connecticut River Valley in the last few years; however, the current population of Fowler's Toads, if it exists at all, is small enough so that none have been located in the last five years.

14. Population Trend:

_X_ Declining
____ Stable
____ Increasing
____ Unknown

Estimate Based On:

_X_ Surveys
____ Counts
_X_ Observations
____ Other (*explain*) (see below)

Documentation & Comments:

Surveys for this species have targeted the Connecticut River Valley primarily south of Rockingham. Fortunately this species has a very distinctive and easily recognizable call. The Vermont Reptile and Amphibian Database contains over 70,000 reports from all corners of Vermont gathered by professional wildlife biologists and some very knowledgeable laypeople; however, no other documented reports for this species exist. All well-documented reports come from along the southern Connecticut River valley and in recent years, only from the Stebbin's Road area of Vernon.

According to the 2010 COSEWIC status report for this species, Fowler's Toad populations "fluctuate widely in abundance". At Long Point in Ontario, "their numbers have gone from dozens to hundreds of individuals and back over the 10 years from 1988 through 1997". In Ontario, their preferred habitat is "early stages of ecological succession in sand dune and lake-shore habitats". These habitats are inherently unstable and changing. Irregularly occurring severe storms both cause direct mortality and create new breeding habitat. Population viability analyses in Canada give the species a 20% chance of becoming extirpated from Canada in the next 100 years.

In the Ontario recovery strategy for this species (Green et al., 2011), they state that Fowler's Toads can repopulate areas after local extirpations "provided there are no barriers" since a small percentage (~2%) travel up to 8 miles from their place of birth. "Fowler's Toads repopulated Big Creek National Wildlife Area at Long Point in 1991 after an absence of a few years (Smith and Green, 2006).

We may be experiencing the depth of one of those cycles currently in Vermont. However, in Ontario those cycles began to rebound after a period of three years. It has been five years since we have seen the Vernon population and almost thirty years since we have seen the Hartford population. Given our inability to locate these populations in recent years and the distance to the nearest known populations (Gill, Massachusetts is roughly 10 miles south), we feel it is worthy of and would benefit from listing. Tom Tyning (Pers. comm. 2012) states that the species was still found in the Gill area in 2011. The most recently published data available are from Amherst in the mid 1990s (Jackson et al., 2010). Assuming the Gill population is still healthy, 4-6 years (two to three toad-generations) of optimal conditions might allow a population in the Gill area to recolonize the Vernon area if appropriate habitat is present here and along the way. However, this is based on the untested assumption that there are no insurmountable barriers to dispersal between Gill and Vernon. If small numbers of this species exist here or nearby, recolonization could occur sooner.

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(1) HABITAT IN VERMONT

15. General Description:

Fowler's Toads are tolerant of and dependent upon warmer temperatures then American Toads (Frost and Martin, 1971).

Along the north shore of Lake Erie all Fowler's Toad reports are within ½ kilometer of the shore and the toads require habitat in the early stages of ecological succession. At those sites they require five habitat types in close proximity to sustain a population (COSEWIC, 2010):

- Hibernation habitat (sandy dunes)
- Breeding, egg-laying habitat (sparsely vegetated still-water ponds, sandy bottom pools, shallow rocky shoals, or rocky pools)
- Feeding and hydration habitat (sandy riverside and lakeshore habitats with bare to sparse vegetation cover)
- Daytime retreat and aestivation habitat (sandy beaches and shoreline debris), and
- Dispersal corridor habitat.

Overwintering habitat is mentioned as a potential limiting factor in Canada (COSEWIC, 2010). Burrows must be deep enough for the toads to avoid freezing, close enough to the water table to be damp, but not so deep as to be flooded. Toads are not tolerant of freezing or of long-term submergence while over wintering.

Stille (1952) reported small home ranges with most toads emerging from the ground within 60-210 meters of the water's edge. In Canada (COSEWIC, 2010) Fowler's Toads (nocturnal) spend days buried in soil up to 400 m from the waters edge but they must move to the water as soon as they emerge to replace moisture lost while in the soil.

Along Lake Erie, Fowler's Toads depend upon breeding sites that are continually created or maintained by disturbance.

Breeding habitat in Vermont appears to be the disturbed margins of the Connecticut River and its tributaries in Windham and Windsor Counties, and perhaps shorelines of other water bodies near sandy soils in those floodplains. Terrestrial habitat appears to be largely open areas of adjacent floodplains and lower-elevation uplands within a few hundred meters of those breeding sites, particularly those with sandy or gravelly soils. This includes yard edges and moderately developed residential or agricultural areas. According to Klemens (1993) the species prefers well-drained sand and gravel habitat in Connecticut. Wright and Wright (1949) state "wherever Fowler's Toads are sympatric with American Toads (as they are anywhere in Vermont), Fowler's Toads occur in rivers, streams, or lake beaches" and American Toads in the uplands. This appears to be the case in Vermont. Soil maps show large deposits of sand in the Vernon area.

16. Habitat Losses in Past (*Amount and Location*):

Early successional habitat in sandy soils within 400 meters of the Connecticut River has probably been reduced significantly with the development of an extensive series of flood control dams in the Connecticut River drainage. In addition, sandy and gravelly soils in the floodplain have been desirable sites for shoreline development and agriculture. Some types of low-density development and agriculture (pasture, some crops, new farm ponds) may have created open early-successional foraging habitat or breeding habitat for this species; however, high-density development with heavy road traffic (toads suffer high road mortality), row crops and intensive pesticide or herbicide use (atrazine) are probably not consistent with continued Fowler's Toad use. Bank stabilization activities would also limit the amount of potential habitat for this species.

This floodplain area has also seen significant road building. Routes 91 and 5 both parallel the river within the floodplain on the Vermont side as well as numerous smaller roads such as 142 in Vernon.

17. Probable Habitat Losses in Future (*Amount, Location, and Type*):

The frequency and severity of floods in the future will likely be controlled as much as is possible with the extensive series of flood control dams in the Connecticut River drainage. This will continue to limit the creation and maintenance of the early successional habitat required by this species.

Although it seems unlikely that there will be many new roads built within 400 m of the Connecticut River and its major tributaries, traffic on the many roads already existing within these zones will continue to increase.

The area between Stebbins Road and the Connecticut River is currently changing from small scale farming with scattered seasonal camps to permanent homes. The area west of Stebbins Road and Route 142 has some large tract developments already in place. Traffic on area roads continues to increase.

According to VTrans (Chris Slesar pers. comm., 2011) the frequency of what once were considered one-hundred-year floods has increased over the last decade. In the future, these may produce appropriate habitat in larger tributaries of the Connecticut River without flood control dams.

18. Current Protected Status of Habitat:

___ Unknown Whether Any Protected
_X_ Believed To Be None Protected
____ At Least One Protected Occurrence
___ Several Protected Occurrences
___ Many Protected Occurrences
_X_ Other (*explain*) There are state-owned lands west of Route 142 but we have no historic or current records of Fowler's in those areas despite herpetological surveys on those lands.

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(2) POPULATION BIOLOGY

19. Population Threats (*Contaminants, Predation, Competition, Disease, Human Disturbance from Recreation, Collection,*
Harvest, etc.)

Degree of Threat:

_X_ Very Threatened, Species Directly Exploited or Threatened by Natural or Man-caused Forces
___ Moderately Threatened, Habitat Lends Itself to Alternate Use but is not Currently in Jeopardy
___ Little Threat, Self-protecting by Unsuitability for Other Uses
___ Unknown

Documentation & Comments:

Since this species has not been documented in Vermont since 2007, there are clearly factors or combinations of factors that occur (or did occur) that render it vulnerable to extirpation. However, it is unclear exactly what factors or combination of factors brought about the current situation. As noted above, this species regularly undergoes large population changes. If the population has dropped to zero, the existence of nearby healthy populations to recolonize previously occupied areas is essential. In addition, the colonizers within those populations need to be able to safely traverse the landscape along the river for some distance as populations rebuild. Given distances between populations that may be larger than the dispersal range of juvenile toads, all five required habitat types will need to be located fairly regularly (~every 8 miles) along the shore of the Connecticut River in order for recolonization to take place from a distant source. Impediments to travel exist in increased road traffic, more intensive or chemical dependent agricultural methods, and intensive development such as in the towns along the river.

According to Freda and Dunson (1986) this species shows decreased larval growth rates with increased acidity (lowered pH) due to acid rain. It is also less tolerant than most amphibians to atrazine (Birge et al., 2000), and is particularly sensitive to the insecticide azinphos-methol (Guthion; Mayer and Ellersieck, 1986). The organochlorides endrin, toxaphene, dieldrin, toxaphene, DDT, and lindane are also highly toxic to larval Fowler's Toads (Sanders, 1970). Adults were also highly sensitive to organochlorides (Ferguson and Gilbert, 1968) as well as pyrethroid insecticides (Bennett et al., 1983) and the metals chromium, gallium, titanium, and aluminum (Birge et al., 2000). In southwestern Ontario, agricultural chemicals were listed as a possible contributing factor to Fowler's Toads declines. The herbicide Trifluralin and the insecticide Endrin were reported to be particularly toxic to toads (COSEWIC, 2010). The disappearance of Fowler's Toads from many of the Massachusetts islands was thought to be the result of DDT use according to Lazell (1976). DDT is also suspected of eliminating populations on Point Pelee in Canada (COSEWIC, 2010). We have not looked at the available data on the level of any of these substances in the Connecticut River or on surrounding lands, although we expect atrazine is widely used on corn crops along the Connecticut River.

Fowler's Toads are susceptible to mycobacterial (Shively et al., 1981) and parasitic infections (Jilek and Wolff, 1978; Ashton and Rabalais, 1978; McAllister et al., 1989; and Vences et al., 2003). Botulism is also considered a potential threat to Fowler's Toads (COSEWIC, 2010). Along the north shore of Lake Erie is was noticed that shoreline mats of algae created the anaerobic conditions that allow *Clostridium botulinum* to survive.

20. Tolerance To Human Activity:

___ Fragile
_X_ Fairly Resistant
___ Tough
____Unknown

Documentation & Comments:

Fowler's Toads were reported from a residential area of White River Junction and were regularly found along and near Stebbins Road in Vernon. Historic clearing near the Connecticut River may have added to the open areas that this species frequently uses. Historically, frequent flooding as a result of over harvesting of trees may also have created more of the soil deposits and open pools along rivers that this species requires. However, flood control, chemical use, tilling, increased traffic, migration barriers, and intensive development may have limited available habitat for Fowler's Toads, their access to it, and or their ability to survive in it.

Toads overwinter and avoid predation and desiccation during the day and during dry periods by digging into sandy or loose soil (Harding and Holman, 1992). By the end of the winter they have burrowed to depths of up to 15-30 cm (R. Latham quoted in Oliver, 1955). Tilling of the soil in late fall or early spring may disturb or kill overwintering Fowler's Toads. Tilling during other times of the year could have the same impact on toads underground for the daytime hours or when aestivating to escape dehydration.

21. Reproduction Parameters (*Age to Sexual Maturity, Annual Production of Offspring, Reproductive Life, or Other Factors that Warrant Consideration*):

Fowler's Toads have a reported maximum life expectancy of five years in the wild (Kellner and Green, 1995), with most adult toads living to three years of age. Clarke (1977) reports a 22.5% annual survival rate after metamorphosis. However, both males and females reach reproductive age at an average age of two years (Breden, 1987) and females can produce up to 8000 eggs in a single breeding event (Wright and Wright, 1995). Survivorship from egg to adult is roughly 1 in 1,430 eggs (Clarke, 1977).

22. Reproductive Status: *Documentation & Comments*:

___ Reproduces in Vermont
- ____Confirmed In Last 2 Years
- _X_ Confirmed In Last 10 Years
- ___ Confirmed In Last 25 Years
- ___ Confirmed Prior To 25 Years Ago
- ___ Unconfirmed

___ Does Not Breed or is Migratory

Documentation & Comments:

Singing male Fowler's Toads were heard in 2002 in Vernon and Rockingham and in 2004 in Vernon. However, we have no evidence of the success of those breeding attempts. Since Fowler's Toad have a limited life span in the wild (maximum of five years, Kellner and Green, 1995) and were seen in 2007 they must have reproduced in the last decade.

23. Additional Study or Documentation Needed:

Annual surveys along the Connecticut River in both Windham and Windsor Counties on warm wet nights from June through July (timing based on Andrews, 2011A; The Vermont Reptile and Amphibian Atlas Database).

24. Attachments:
- 24.1 List of literature cited or other references
- 24.2 Map of worldwide distribution (IUCN, 2012)
- 24.3 Map of statewide distribution (Andrews, 2011)
- 24.4 Map of Fowler's Toad observations in southeastern VT (Andrews and Briggs, 2012)
- 24.5 Amphibian abundance chart (Andrews, 2012)
- 24.6 Narrative summary

25. Scientific Subcommittee Chairman: Date:

James S. Andrews

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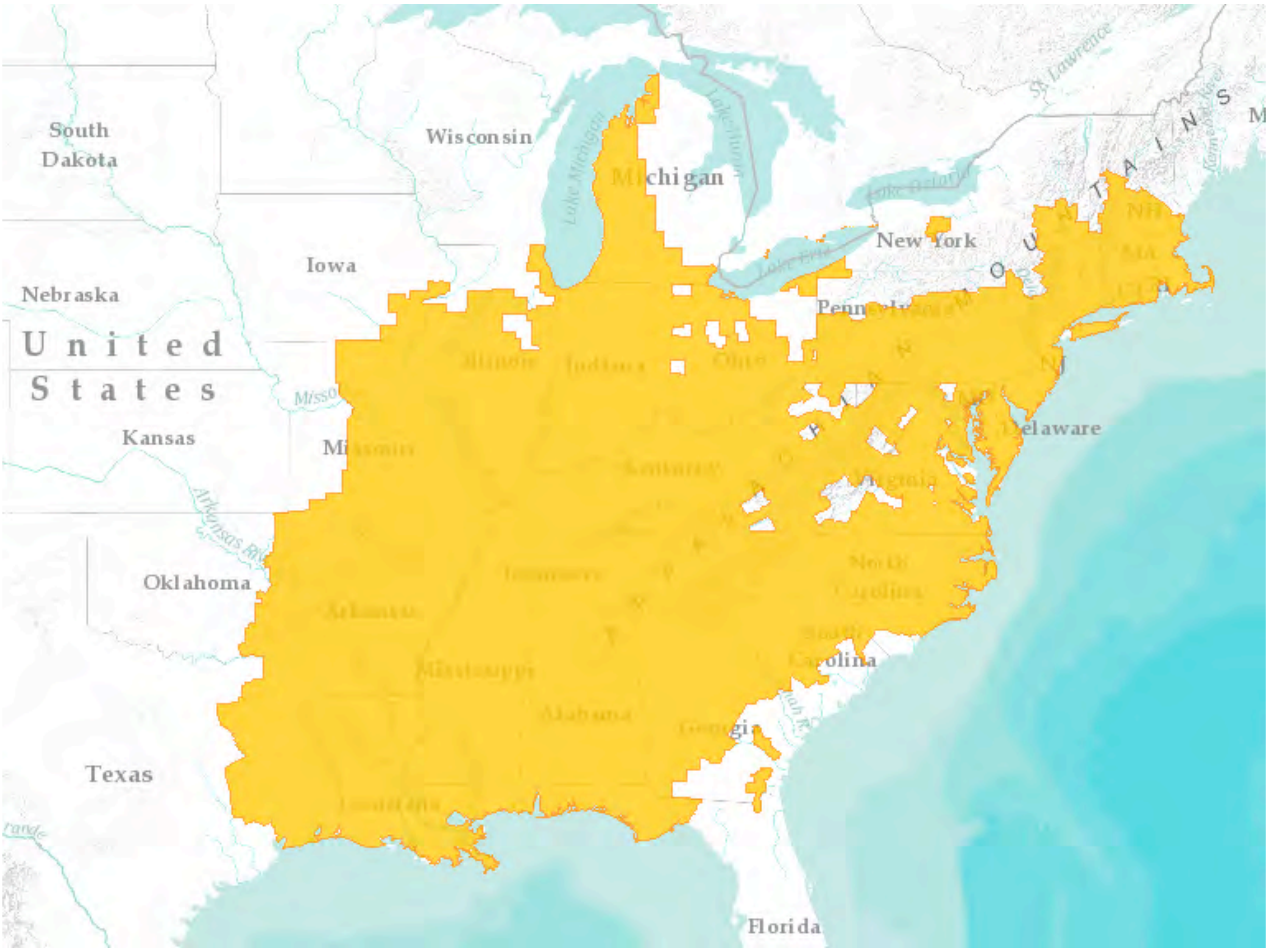
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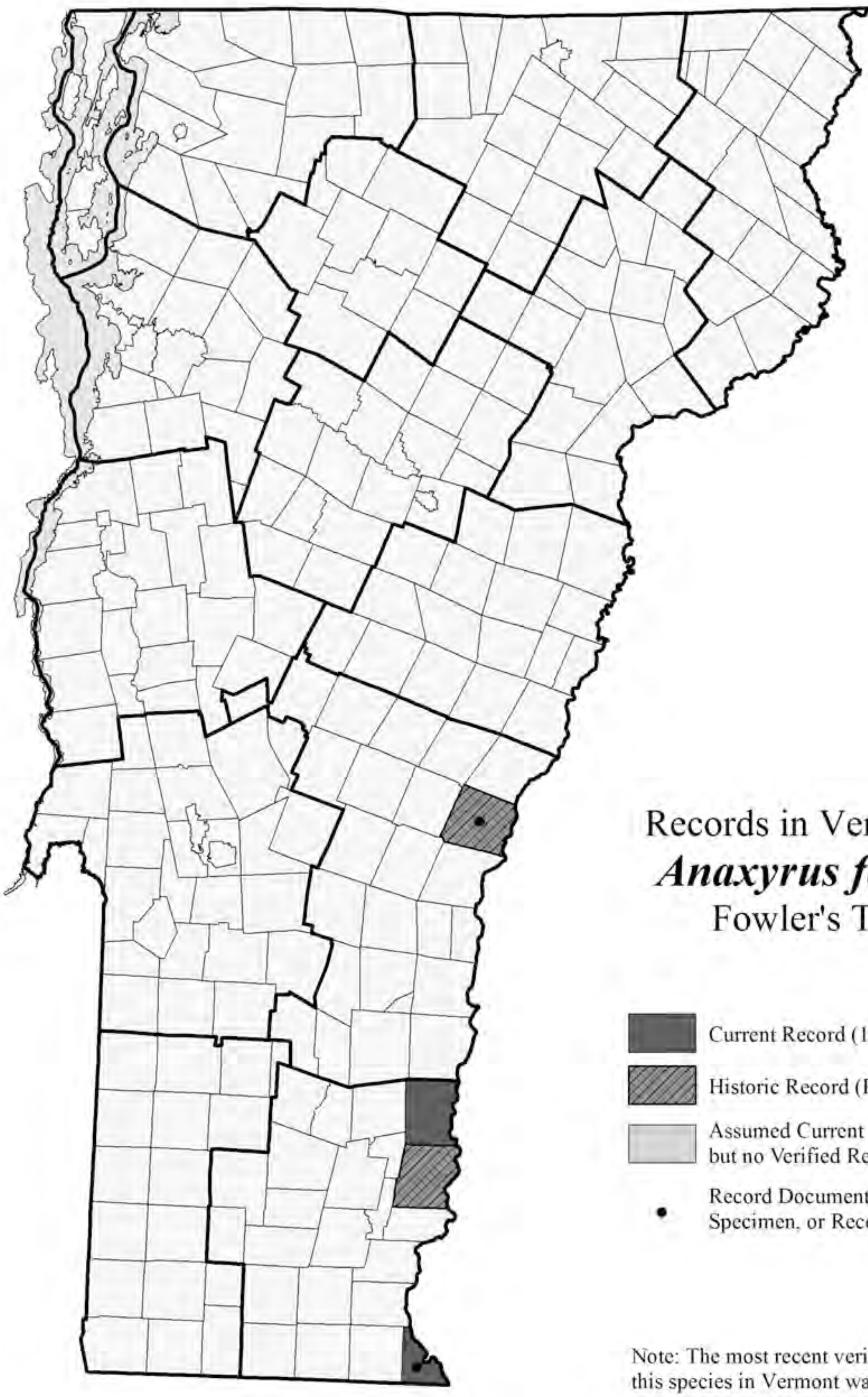


Records in Vermont of
Anaxyrus fowleri
Fowler's Toad

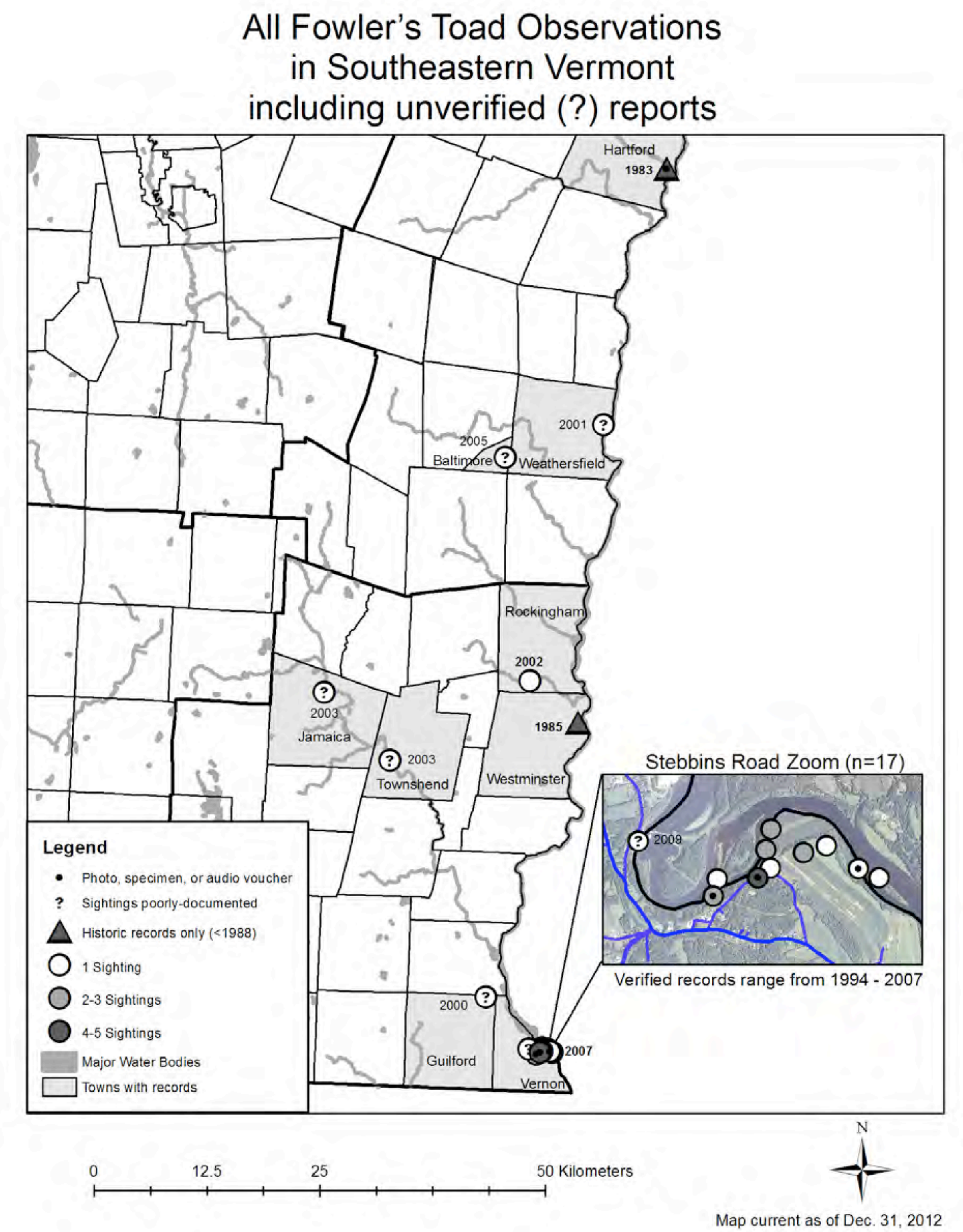
Current Record (1986 through 2010)

Historic Record (Prior to 1986)

Assumed Current Presence but no Verified Records

Record Documented with Photo, Specimen, or Recording

Note: The most recent verified report of this species in Vermont was in 2007.


All Fowler's Toad Observations
in Southeastern Vermont
including unverified (?) reports
Hartford
1983
2001
2005
Baltimore
Weathersfield
Rockingham
2002
1985
2003
Jamaica
2003
Townshend
Westminster
Stebbins Road Zoom (n=17)
2009
Verified records range from 1994 - 2007
Legend
Photo, specimen, or audio voucher
Sightings poorly-documented
Historic records only (<1988)
1 Sighting
2-3 Sightings
4-5 Sightings
Major Water Bodies
Towns with records
2000
Guilford
2007
Vernon
0
12.5
25
50 Kilometers
N
Map current as of Dec. 31, 2012

Vermont Amphibian Records
January 1, 1987 to December 31, 2011

Jim Andrews, Elizabeth Volpe, & Erin Talmage

These tables give a rough idea of the relative abundance and distribution of Vermont's herptiles. The comparisons are subject to bias by the audibility, visibility, notoriety, and ease of identification of species. For example, since salamanders don't call and are usually under cover, they are reported less often than frogs. Consequently, the species are sorted by taxonomic group so that some of these biases are alleviated. However, some other biases remain. For instance, Eastern Ribbonsnakes when observed may be assumed to be Common Gartersnakes and hence they may be under-reported. Aquatic species of turtle that bask only infrequently are probably reported less often than terrestrial or basking species. Still, these tables help the Scientific Advisory Group decide if the state rank and/or state status of a species needs to be reevaluated. Species are listed in descending order of the number of "sites" from which they have been reported. Errors in the number of known sites and towns for the more abundant species are almost certainly included and those numbers are changing monthly. There are a total of 255 "towns" (political units including towns, cities, gores, and unincorporated areas) in the state of Vermont.

Salamanders

Species	# of towns	# of sites	State Rank	State Status	Site Size	SGCN Priority
Eastern Newt	221	1151	S5		0.5km	
Spotted Salamander	218	861	S5		0.5km	Medium
Eastern Red-backed Salamander	239	777	S5		0.5km	
Northern Two-lined Salamander	216	557	S5		0.5km	
Northern Dusky Salamander	191	413	S5		0.5km	
Spring Salamander	102	181	S4		0.5km	
Blue-spotted Salamander Group	57	175	S3	SC	0.5km	Medium
Jefferson Salamander Group	54	94	S2	SC	0.5km	High
Mudpuppy	26	38	S2	SC	0.5km	High
Four-toed Salamander	21	26	S2	SC	0.5km	Medium

Frogs

Species	# of towns	# of sites	State Rank	State Status	Site Size	SGCN Status	Notes
Green Frog	253	1373	S5		0.5km		
Wood Frog	257	1170	S5		0.5km		
Spring Peeper	234	1042	S5		0.5km		
American Toad	250	1002	S5		0.5km		
Gray Treefrog	163	519	S5		0.5km		
Pickerel Frog	175	456	S5		0.5km		
American Bullfrog	170	423	S5		0.5km		
Northern Leopard Frog	74	357	S4		0.5km		
Mink Frog	43	75	S3		0.5km		
Fowler's Toad	2	2	S1	SC	0.5km	High	Missing since 2007
Boreal Chorus Frog	1	1	S1	E	0.5km	High	Missing since 1999

The State of New Hampshire
Department of Environmental Services

Thomas S. Burack
Commissioner

March 1, 2013

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, D.C. 20426

Subject: Comments on Pre-Application Documents and Study Requests for 5 Hydroelectric Projects on the Connecticut River:
Wilder Project (FERC No. 1892)
Bellows Falls Project (FERC No. 1855)
Vernon Project (FERC No. 1904)
Turners Falls Project (FERC No. 1889)
Northfield Mountain Pumped Storage Project (FERC No. 2485)

Dear Secretary Bose:

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)].

DES has reviewed the Preliminary Application Documents (PADs) and Scoping Document for the following five hydroelectric projects on the Connecticut River:

Wilder Project (FERC No. 1892)
Bellows Falls Project (FERC No. 1855)
Vernon Project (FERC No. 1904)
Turners Falls Project (FERC No. 1889)
Northfield Mountain Pumped Storage Project (FERC No. 2485)

Comments on the PADs and our formal study requests are provided below. In addition to the study requests provided herein, please note that DES also supports the study requests submitted by the New Hampshire Fish and Game Department in a letter dated February 27, 2013 for the Turners Falls and Northfield Mountain Projects (FERC Nos. 1889 and 2485).

We thank you for the opportunity to comment.

Sincerely,

Gregg Comstock

Gregg Comstock, P.E.
Supervisor, Water Quality Planning Section
New Hampshire Department of Environmental Services

I. Preliminary Application Document (PAD) Comments

A. COMMENTS FOR WILDER PROJECT PAD (FERC NO. 1892)

A1. Section 2.3 Project Location

a. Figure 2.1-2 on page 2-3 is blurry and difficult to read.

A2. Section 2.1 Project Facilities

a. Figure 2.3-2 (page 2-9), Figure 2.3-4 (page 2-12), Figure 2.3-5 (page 2-13), Figure 2.3-6 (page 2-15), Figure 2.3-8 (page 2-19) and Figure 2.3-9 (page 2-20) are blurry and difficult to read.

A3. Section 2.4. Project Reservoir

a. Figure 2.4-1 on page 2-24 shows how reservoir volume and surface area varies with elevation. It should be explained how these curves were developed (i.e., were they based on bathymetric mapping of the reservoir?).
b. If available, a similar figure should be developed showing the change in exposed shoreline (average and maximum values in feet) with elevation.
c. Figure 2.4-2 on page 2-25 shows the water surface profiles at various flows. It should be stated how these were determined (i.e., were they based on a model?).
d. On page 2-27 it is stated that reservoir drawdown rates are typically 0.1 to 0.2 feet per hour and do not exceed 0.3 feet per hour. It should be explained why these rates were selected.

A4. Section 2.5.2 Normal Operations

a. On page 2-26, it is stated that the "project operates primarily on a daily run-of- river basis, meaning generally that over the course of a day, its operation passes the average daily inflow", The minimum, average and maximum percent of time that the average daily flow is not passed in 24 hours for each month for the period of record should be stated.
b. A description of maintenance procedures (i.e., refill procedures, how often maintenance is performed, how often it is necessary to draw the dam down below the minimum allowed elevation) should be provided.

A5. Section 2.5.5 High Flow Operation

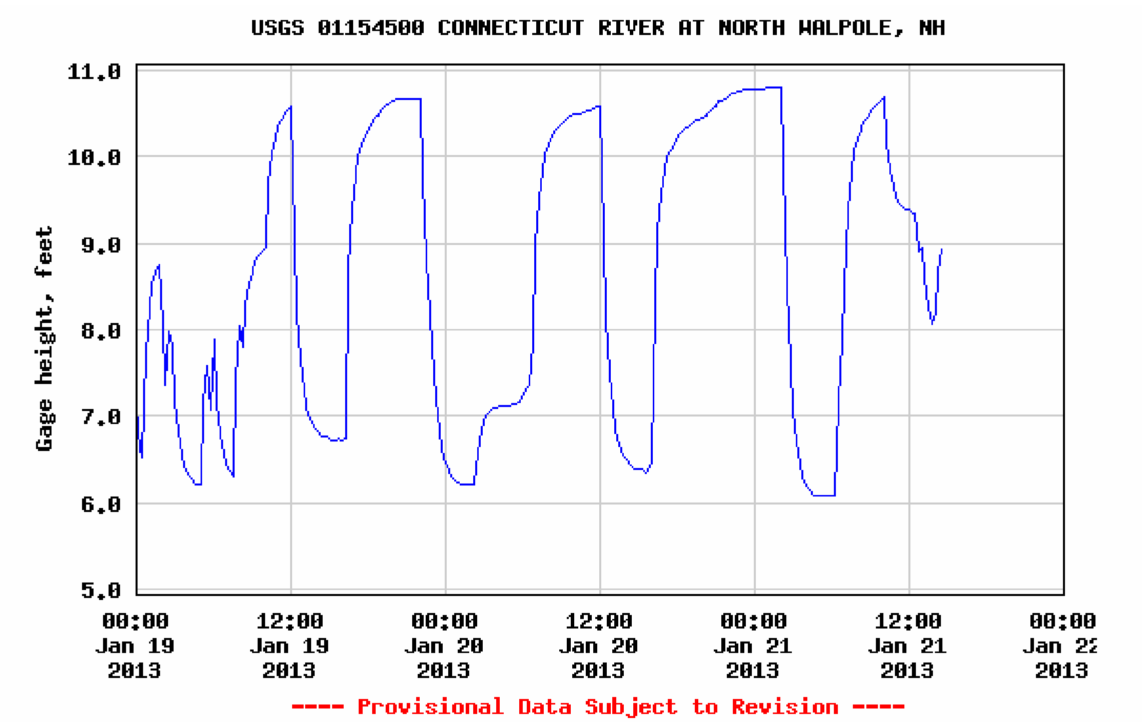
a. On page 2-30, it is stated that on occasion , inflows are anticipated to peak at a level just above station capacity and the reservoir is drawn down in advance to capture and avoid spilling, but these instances are the exception. The minimum, maximum and average percent of time this happens for each month for the period of record should be specified
b. Table 2.5-2 on page 2-31 shows the station discharge capacity at various water surface elevations. The discharge capacity for all the gates and stanchion bays increase with increasing elevation. However, the discharge capacity for the 3 generators decrease with increasing elevation. This should be explained.

A6. Section 2.6.4 Current License and License Amendment Requirements

a. Table 2.6-3 on page 2-36 provides a summary of license and amendment requirements in addition to "Standard" Articles 1 through 28 of the FERC license. It would be helpful to have include a complete summary of all FERC requirements (or perhaps provide a copy of the FERC license as an appendix).

A7. Section 3.4.5 Reservoir Shoreline and Streambanks

a. On page 3-13 it is stated that bank slumping was identified in the Kleinschmidt study (2011) as being the primary type of erosion present. This type of erosion is exacerbated by land/vegetation clearing close to the bank, commonly associated with farming practices. The Kleinschmidt survey concluded that 77 percent of the bank erosion in the Bellows Falls impoundment were associated with agricultural practices. The report does not mention the primary cause of the remaining 23 percent of the erosion sites. It is then concluded that impoundment level fluctuations caused by project operations are not likely to be significant contributors to erosion in the impoundment compared to naturally occurring high flows coupled with highly susceptible soils. It is not clear how such a statement can be made since bank vegetation (and stabilization) is reportedly sparse in the zone impacted by impoundment fluctuations (see section 3.8.3). It follows that this lack of stabilization would contribute to more erosion at all flows as compared to a bank with more vegetation. How much more is not discussed. That is, if the banks were better stabilized with vegetation, how would that reduce erosion under both low and high flows? This section also does not discuss the impact of daily impoundment fluctuations on downstream river fluctuations and erosion, but should. As shown in the graph below (based on the USGS gage located just below the Bellows Falls dam) water levels below the Bellows Falls dam can fluctuate approximately 4 feet twice per day. Similar fluctuations likely occur downstream of the Project dam. It appears more study is needed before statements can be made that suggest that daily impoundment fluctuations are insignificant contributors to erosion.



A8. Section 3.4.6 Project Effects (regarding Geology and Soils)

a. On pages 3-14 and 3-15, it is stated that impoundment fluctuations play a minor role in shoreline erosion, with flood flow from major storms playing a significant role. What does a "minor" role mean? This is a subjective statement that should be quantified. As discussed in the previous comment, it would seem that since Project operations have resulted in sparse growth along the banks and have therefore increased their erosion potential, the impact of the Project on erosion is significant. That is, the amount of erosion would likely be significantly less if there were more vegetation on the banks to stabilize them.

A9. Section 3.5.2 Hydrology

a. Figure 3.5-1 on page 3-20 shows a whisker graph of hourly water level in the impoundment for each month for the period January 1, 2001 to December 31, 2011. A similar plot should be prepared with the maximum daily change in impoundment elevation (in feet) on the y-axis. This would show the frequency and magnitude of the daily fluctuations. If water surface elevation is available downstream of the dam, a similar plot should be developed to show the frequency and magnitude of daily fluctuations downstream.

b. A whisker graph similar to Figure 3.5-1 on page 3-20 but with the y - axis equal to the predicted maximum daily change in impoundment elevation if the project were operated in an instantaneous run-of-river mode, should be developed and compared to the graph requested in comment 6.a. above. This would give an idea of the difference in magnitude and frequency of maximum daily impoundment fluctuations with current operations and with instantaneous run-of-river operations.

c. On page 3-23 it is stated that when inflows are less than station capacity of 10,700 cfs, the Project is operated as a daily peaking project to meet regional electrical demand. The average percent of time each year this occurs should be stated (i.e., 83 percent based on page 2-29 which states that station capacity is exceeded 17 percent of the time).

e. Figure 3.5-6 on page 3-23 shows a plot of the averaged hourly outflow and averaged monthly minimum, maximum and average outflow from January 1, 2001 to December 31, 2011. This graph is difficult to read. It is recommended the plot be expanded. A similar plot but with hourly impoundment elevation on the y-axis is requested to show the frequency, duration and magnitude of impoundment fluctuations. Another plot is requested showing the predicted hourly impoundment elevation if the Project was run in the instantaneous run-of-river mode.

A10. Section 3.5.5 Water Quality Standards - State Standards

a. A note should be added at the bottom of Table 3.5-3 on page 3-26 which states that for impoundments, the dissolved oxygen standards apply to the epilimnion or to the top 25 percent of depth if not stratified.

A11. Section 3.5.6.2 TransCanada Water Quality Studies

a. This section presents a summary of the data collected and concludes (see page 3-33) that the 2012 data are within a range that is typical of large, good quality riverine systems. This statement is subjective and is not supported by any data from other large rivers that are in compliance with state water quality standards. Though there were only pH violations of NH water quality standards (which were most likely due to acidic atmospheric deposition), there were significant increases in temperature within the impoundment and the instantaneous (5mg/L) and average daily percent saturation (75%) DO standards were close to being violated (5.66 mg/L and 77.6% saturation). Unsupported statements such as this should be deleted or modified

b On page 3-33, it is stated that temperature and specific conductivity increased slightly from upstream to downstream in the impoundment. Such subjective terms should be quantified (i.e., include the value of the change for each paramenter). It is further stated that "Generally minor changes in upstream to downstream values of study parameters may reflect the impacts of impoundment of riverine waters, thereby increasing time-of-travel and water column activity.". The word "may" should be deleted from this sentence unless another plausible explanation can be presented..

c. On page 3-34 it is stated that values depicted in table 3.5-11 reflect nutrient loading from upriver wastewater treatment plant discharges but are not considered high enough to cause significant impairment. This statement is not substantiated and should be deleted or revised. Wastewater treatment plant discharges are not the only source of nutrient loadings. Examples of other possible sources of nutrient loading are stormwater runoff, and nutrients in sediment or soils eroding into the river.
d. The report should discuss if the impoundment became stratified or not and provide profiles of DO and temperature with depth to support any conclusions. DES considers a surface water stratified when there is a defined thermocline showing greater than a 1 degree (Celcius) change per meter.
e. To determine if the data is representative of near worse case conditions (i.e., when parameters such as temperature, DO and algal activity are likely to be highest), this section should indicate what the flow was in the river and bypass channel prior to and during sampling. A comparison of the flow to the 7Q10 low flow should also be included in the discussion. Plots showing the flow and sampling results with time would be helpful.
f. To facilitate data analysis, DES requests that the data be uploaded in the DES Environmental database.

A12. Section 3.5.7 Project Effects on Seasonal Variation of Water Quality

a. On page 3.5.7 it is stated that the "Project has no significant impact on the primary water quality parameters of concern, DO, or other physical and chemical parameters." DES does not believe that the information provided in the PAD supports such a broad-sweeping conclusion and should be deleted or modified. As previously discussed (see comment A.11 above), the impoundment is close to violating NH DO standards. Further, since the data was not likely not taken during worse case conditions it is possible violations may be occurring. In addition the data indicates an approximate two degree increase in temperature in the impoundment. This statement also does not appear to consider the potential impact of Project operations on sediment (and associated nutrient) loadings associated with erosion.

A13. Section 3.6.2 Summary of Existing Conditions - Fish Assemblage and Habitat Assessment of the Upper Connecticut River

a. Figure 3.6-2 on pages 3-49 and 3-50, shows the Index of Biological Integrity (IBI) results for the Project area based on sampling conducted in 2008 (and reported by Yoder et. al. in 2009) . Results were analyzed using three indices: the Atlantic Slope IBI, the Interim Maine Rivers IBI and the Modified Index of Well-Being. Two of the indices (Interim Maine Rivers IBI and the Modified Index of Well-Being) showed lower values just upstream of the dam. Moving further upstream, however, the values increase and then decrease again near the upstream portions of the project. No explanation is provided for this behavior. For example, what is the impact of impoundment fluctuations on the results? Also, what is considered a good and poor IBI score? If available, this information should be included in the discussion.

A14. Section 3.6.2 Summary of Existing Conditions - Connecticut River Fish Tissue Contaminant Study

a. This section discusses the result of the Hellyer (2006) Connecticut River Fish Tissue Contaminant Study. Page 3-51 provides a general discussion on total mercury concentrations found in smallmouth bass, white sucker and yellow perch. Graphs and or tables showing actual results in each reach and river mile (with dam locations indicated) should be provided to allow the reader to quantify terms used in this section such as "generally similar" and "higher than".

b. This section (or perhaps a new section) should also discuss the potential impacts of impoundment fluctuations due to Project operations on methylmercury formation (the bioavailable form) and how this can result in increased mercury concentrations in fish and other organisms.

A15. Section 3.6.6 Aquatic Habitat

a. Figure 3.6-6 on page 3-77 shows Qualitative Habitat Evaluation Index (QHEI) scores for various reaches of the Connecticut River. The discussion on page 3-76 states that the QHEI has been shown to correspond predictably with key attributes of fish assemblage quality however, no indication is given of what is considered a good or bad QHEI score. This information should be provided.

A16. Section 3.6.7 Mussels and Macroinvertebrates

a. On page 3-71 it is stated that the dwarf wedgemussel is a federal and state endangered species in New Hampshire and Vermont. On page 3-69 it is stated that 39 dwarf wedgemussels were found from 27 to 41 miles upstream of the dam. This section should include a discussion of how Project operations may be impacting the dwarf wedgemussels and what could be done to increase the population of this endangered species.

b. On page 3-71 it is stated that National Rivers and Streams Assessment (NRSA) collected baseline benthic macroinvertebrate at two locations in the Project impoundment in 2008 and 2009; Station FW08NH009 in Lyme (17 miles upstream of the Wilder dam) and Station FB08NH020 in Haverhill (41 miles upstream of the dam). It is further reported that EPA will develop indices to rate the condition of each site as good, fair or poor and that the final report is due out by the end of 2012. Please note that based on preliminary results provided by EPA, it is our understanding that both the Lyme and Haverhill sites will be rated as poor.

A17. Section 3.6.8 Project Effects (regarding Fish and Aquatic Resources)

a. On page 3-75 it is stated that the normal reservoir operating range of approximately 2.5 feet daily in the Project impoundment minimizes fluctuations that could affect fish spawning habitat. It is not clear why a 2.5 foot fluctuation minimizes impacts on fish spawning habitat as compared to smaller fluctuations or instantaneous run-of-river operation. This should be explained or this sentence deleted.

b. On page 3-75 it is stated that threats to mussel species and macroinvertebrates include stranding from water level fluctuations, sedimentation, and erosion. DES concurs that these impacts are or are likely to be occurring. The next sentence states that because no changes are proposed to Project operations, no new effects on aquatic resources are anticipated. There should be a discussion on what can be done to improve aquatic conditions for species, including, but not limited to, the endangered dwarf wedgemussel.

A18. Section 3.7.3 Plant and Animal Species

a. Table 3.7-4 on page 3-96 (invasive plant species) should include invasive alga *Didymosphenia geminata* (freshwater planktonic alga) and invasive aquatic macrophyte *Najas minor* (submersed).

A19. Section 3.7.4 Project Status (regarding Wildlife and Botanical Resources)

a. On page 3-98 it is stated that potential effects of the Project to wildlife and botantical resources can occur as a result of hydroelectric operations. The daily water level fluctuations of approximately 2.5 vertical feet has resulted in a zone of sparse vegetation, along most of the shorelines of the impoundment. Wetland or water dependent wildlife and plant species will be adversely affected by the daily wetting and drying cycles along the river's edge. Disturbance resulting at least partially from project operations also creates opportunities for invasive plant species to colonize and dominate the shorelines of the project. DES concurs that these impacts are or are likely to be occurring. This section further states that because no changes are proposed to Project operations, no new effects on wildlife and botanical resources are anticipated. Since impacts of Project operations have been acknowledged in the PAD, there should be a discussion on what can be done to improve conditions rather than continuing with the status quo.

A20. Section 3.8.1 Summary of Existing Conditions (regarding Wetlands, Riparian, Littoral and Floodplain Habitat)

a. On page 3-99 it is stated that mapping by the National Wetlands Inventory (NWI) was the primary source for describing the wetland and littoral vegetated habitats for the Project. Actual wetland mapping would provide a more accurate baseline. Are there any plans to perform wetland mapping in the Project area?

A21. Section 3.8.3 Project Status (regarding Wetlands, Riparian, Littoral and Floodplain Habitat)

a. On page 3-104 it is stated that potential effects of the Project on wetland, floodplain, riparian, and littoral resources can occur as a result of hydroelectric operations. The average daily water level fluctuation of approximately 2.5 vertical feet has resulted in a zone of sparse vegetation along most shorelines of the impoundment. Wetland and littoral resources in this zone are limited by the frequent wetting and drying. DES concurs that these impacts are or are likely to be occurring. This section further states that because no changes are proposed to Project operations, no new effects on wetland, floodplain, riparian, and littoral resources are anticipated. Since impacts of Project operations have been acknowledged in the PAD, there should be a discussion on what can be done to improve conditions rather than continuing with the status quo.

A22. Section 3.9.5 Project Status (regarding Rare, Threatened and Endangered Species)

a. On pages 3-112 and 3-113 it is stated that potential effects of the Project on RTE species or communities can occur as a result of hydroelectric operations. Project impacts on dwarf wedgemussel can occur as a result of river fragmentation, impoundment and hydroelectric operations. The project impoundment results in a more lentic environment characterized by reduced current speed and complexity, and increased sedimentation, and therefore reduced substrate complexity/increased substrate embeddedness. Peaking project operations alter the flow regime downstream of the Project, which alters downstream habitat on a sub-daily time scale and could impact feeding, spawning, and recruitment. DES concurs that these impacts are or are likely to be occurring. This section further states that because no changes are proposed to Project operations, no new effects on rare state, or federal terrestrial plant species or communities are anticipated. Since impacts of Project operations have been acknowledged in the PAD, there should be a discussion on what can be done to improve conditions rather than continuing with the status quo.

B. COMMENTS FOR THE BELLOWS FALLS PROJECT PAD (FERC NO. 1855)

B1. Section 2.3 Project Location

a. Figure 2.1-2 on page 2-3 is blurry and difficult to read.

B2. Section 2.1 Project Facilities

a. Figure 2.3-2 (page 2-9), Figure 2.3-4 (page 2-11), Figure 2.3-6 (page 2-14), Figure 2.3-7 (page 2-15), Figure 2.3-9 (page 2-19) and Figure 2.3-11 (page 2-21) are blurry and difficult to read.

B3. Section 2.4. Project Reservoir

a. On page 2-24 the useable storage at a drawdown of 3 feet (288.63) is provided which we understand is the maximum allowed drawdown for this project, yet this section also provides the maximum useable storage for a 4 foot drawdown. It is not clear why this was provided when the maximum allowable drawdown is 3 feet.
b. Figure 2.4-1 shows how reservoir volume and surface area varies with elevation. It should be explained how these curves were developed (i.e., were they based on bathymetric mapping of the reservoir?).
c. If available, a similar figure should be developed showing the change in exposed shoreline (average and maximum values in feet) with elevation.
d. Figure 2.4-2 on page 2-26 shows the water surface profiles at various flows. It should be stated how these were determined (i.e., were they based on a model?).
e. On page 2-27 it is stated that reservoir drawdown rates are typically 0.1 to 0.2 feet per hour and do not exceed 0.3 feet per hour. It should be explained why these rates were selected.

B4. Section 2.5.2 Normal Operations

a. On page 2-27, it is stated that the "project operates primarily on a daily run-of- river basis, meaning generally that over the course of a day, its operation passes the average daily inflow", The minimum, average and maximum percent of time that the average daily flow is not passed in 24 hours for each month for the period of record should be stated.
b. A description of maintenance procedures (i.e., refill procedures, how often maintenance is performed, how often it is necessary to draw the dam down below the minimum allowed elevation) should be provided.

B5. Section 2.5.5 High Flow Operation

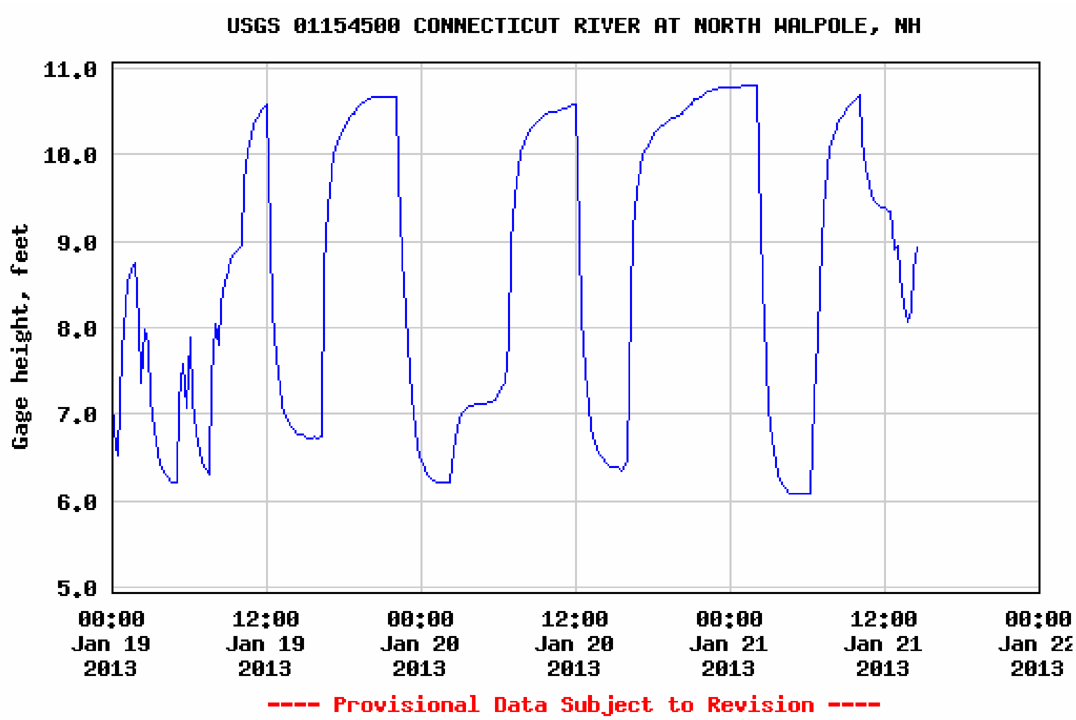
a. On page 2-30, it is stated that on occasion , inflows are anticipated to peak at a level just above station capacity and the reservoir is drawn down in advance to capture and avoid spilling, but these instances are the exception. The minimum, maximum and average percent of time this happens for each month for the period of record should be specified
b. Table 2.5-2 on page 2-31 shows the station discharge capacity at various water surface elevations. The discharge capacity for all the gates and stanchion bays increase with increase elevation. However, the discharge capacity for the 3 generators decrease with increasing elevation. This should be explained.

B6. Section 2.6.4 Current License and License Amendment Requirements

a. Table 2.6-3 on page 2-36 provides a summary of license and amendment requrements in addition to "Standard" Articles 1 through 28 of the FERC license. It would be helpful to have include a complete summary of all FERC requirements (or perhaps provide a copy of the FERC license as an appendix).

B7. Section 3.4.5 Reservoir Shoreline and Streambanks

a. On page 3-13 it is stated that bank slumping was identified in the Kleinschmidt study (2011) as being the primary type of erosion present. This type of erosion is excacerbated by land/vegetation clearing close to the bank, commonly associated with farming practices. The Kleinschmidt survey concluded that 54 percent of the bank erosion in the Bellows Falls impoundment were associated with agricultural practices. The report does not mention the primary cause of the remaining 46 percent of the erosion sites. It is then concluded that impoundment level fluctuations caused by project operations are not likely to be significant contributors to erosion in the impoundment compared to naturally occurring high flows coupled with highly susceptible soils. It is not clear how such a statement can be made since bank vegetation (and stabilization) is reportedly sparse in the zone impacted by impoundment fluctuations (see section 3.8.3). It follows that this lack of stabilization would contribute to more erosion at all flows as compared to a bank with more vegetation. How much more is not discussed. That is, if the banks were better stabilized with vegetation, how would that reduce erosion under both low and high flows? This section also does not discuss the impact of daily impoundment fluctuations on downstream river fluctuations and erosion, but should. As shown in the graph below (based on the USGS gage located just below the Bellows Falls dam) water levels below the dam can fluctuate approximately 4 feet twice per day. It appears more study is needed before statements can be made that suggest that daily impoundment fluctuations are insignificant contributors to erosion.



B8. Section 3.4.6 Project Effects (regarding Geology and Soils)

a. On pages 3-14 and 3-15, it is stated that impoundment fluctuations play a minor role in shoreline erosion, with flood flow from major storms playing a significant role. What does a "minor" role mean? This is a subjective statement that should be quantified. As discussed in the previous comment, it would seem that since Project operations have resulted in sparse growth along the banks and have therefore increased their erosion potential, the impact of the Project on erosion is significant. That is, the amount of erosion would likely be significantly less if there were more vegetation on the banks to stabilize them.

B9. Section 3.5.2 Hydrology

a. Figure 3.5-1 on page 3-19 shows a whisker graph of hourly water level in the impoundment for each month for the period January 1, 2001 to December 31, 2011. A similar plot should be prepared with the maximum daily change in impoundment elevation (in feet) on the y-axis. This would show the frequency and magnitude of the daily fluctuations. A similar graph should also be prepared using the USGS gage No. 01154500 - Connecticut River, North Walpole NH, located just downstream of the Bellows Falls dam. This would provide a better idea of the frequency and magnitude of daily fluctuations up and downstream of the dam.

b. A whisker graph similar to Figure 3.5-1 on page 3-19 but with the y - axis equal to the predicted maximum daily change in impoundment elevation if the project were operated in an instantaneous run-of-river mode , should be developed and compared to the graph requested in comment 6.a. above. A similar plot should then be developed assuming instantaneous run-of-river at both the Wilder and Bellows Falls projects. This would give an idea of the difference in magnitude and frequency of maximum daily impoundment fluctuations with current operations and with instantaneous run-of-river operations

c. On page 3-19 it is stated that for Tropical Storm Irene, the minimum reservoir level was 283.5 due to the need to pull two bays of stanchions and a portion of a third. It should be stated how long the impoundment was at this level (i.e., how long it took to fix the stanchions) and how long it took before the impoundment was at normal pool.

d. On page 3-22 it is stated that when inflows are less than station capacity of 11,400 cfs, the Project is operated as a daily peaking project to meet regional electrical demand. The average percent of time each year this occurs should be stated (i.e., 69 percent based on page 2-30 which states that station capacity is exceeded 31 percent of the time).

e. Figure 3.5-6 on page 3-23 shows a plot of the averaged hourly outflow and averaged monthly minimum, maximum and average outflow from January 1, 2001 to December 31, 2011. This graph is difficult to read. It is recommended the plot be expanded. A similar plot but with hourly impoundment elevation on the y-axis is requested to show the frequency, duration and magnitude of impoundment fluctuations. Another plot is requested showing the predicted hourly impoundment elevation if the Bellows Falls project was run in the instantaneous run-of-river mode and then another plot assuming both the Wilder and Bellows Falls projects were run in the instantaneous run-of-river mode.

B10. Section 3.5.5 Water Quality Standards - State Standards

a. A note should be added at the bottom of Table 3.5-3 on page 3-26 which states that for impoundments, the dissolved oxygen standards apply to the epilimnion or to the top 25 percent of depth if not stratified.

B11. Section 3.5.6.2 TransCanada Water Quality Studies

a. This section presents a summary of the data collected and concludes (see page 3-34) that although there were a few violations of state water quality standards, the 2012 data are within a range that is typical of large, good quality riverine systems. This statement is subjective and is not supported by any data from other large rivers that are in compliance with state water quality standards. Unsupported statements such as this should be deleted or modified.

b On page 3-33, it is stated that temperature and specific conductivity increased slightly from upstream to downstream in the impoundment. Such subjective terms should be quantified (i.e., include the value of the change for each paramenter). It is further stated that "Generally minor changes in upstream to downstream values of study parameters may reflect the impacts of impoundment of riverine waters, thereby increasing time-of-travel and water column activity.". The word "may" should be deleted from this sentence unless another plausible explanation can be presented..

c. On page 3-34, it is stated that BF-01 exceeded NH water quality standards for pH. Based on Table 3.5-8, station BF-BR also exceeded NH pH standards. This should be added to the report. The report states that the high pH readings were measured on 7/12/12 and are most likely due to algal activity since DO levels were well above saturation at the time (120%). The report should add that this is supported by the chlorophyll-a data presented in Table 3.5-11 which shows chlorophyll-a increasing from 3.8 to 6.6 mg/m3 from 7/11/12 to 7/18/2012.
d. On page 3-35 it is stated that values depicted in table 3.5-11 reflect nutrient loading from upriver wastewater treatment plant discharges but are not considered high enough to cause significant impairment. This statement is not substantiated and should be deleted or revised. Wastewater treatment plant discharges are not the only source of nutrient loadings. Examples of other possible sources of nutrient loading are stormwater runoff, and nutrients in sediment or soils eroding into the river.
e. As reported, in addition to pH, violations of NH water quality standards also occurred for DO in one of the weekly profiles for BF-01.
f. The report should discuss if the impoundment became stratified or not and provide profiles of DO and temperature with depth to support any conclusions. DES considers a surface water stratified when there is a defined thermocline showing greater than a 1 degree (Celcius) change per meter.
g. To determine if the data is representative of near worse case conditions (i.e., when parameters such as temperature, DO and algal activity are likely to be highest), this section should indicate what the flow was in the river and bypass channel prior to and during sampling. A comparison of the flow to the 7Q10 low flow should also be included in the discussion. Plots showing the flow and sampling results with time would be helpful.
h. To facilitate data analysis, DES requests that the data be uploaded in the DES Environmental database.

B12. Section 3.5.6.3 Section 303(d) Listing, Non-compliant Waters and TMDLs

a. The following revisions should be made to Table 3.5-12 on pages 3-37 and 3-38:
   - The AUID for the Bellows Falls Impoundment in the 2012 and 2010 cycles should be NHIMP801060703-05 (not NHIMP801060703-5).
   - The AUID for "From RR Bridge, Lebanon to confluence Mascoma River" for the 2010 cycle should be NHRIV801060302-01 (not RIV801060302-01). This impairment should also be added to the 2012 cycle.
b. The discussion regarding Commissary Brook on page 3-36 (last paragraph) states that "New Hampshire DES found that the sediment deposits.....". Since Commissary Brook is listed by Vermont as impaired, "New Hampshire DES" should be deleted and probably be replaced with "Vermont DEC" (confirm with Vermont DEC).

B13. Section 3.5.7 Project Effects on Seasonal Variation of Water Quality

a. On page 3.5.7 it is stated that the "Project has no significant impact on the primary water quality parameters of concern, DO, or other physical and chemical parameters." DES does not believe that the information provided in the PAD supports such a broad-sweeping conclusion and should be deleted or modified. As previously discussed (see comment B.11 above), the impoundment appears to be contributing to violations of pH and possibly DO. Further, since the data was most likely not taken during worse case conditions it is possible additional violations may be occurring. In addition the data indicated almost a two degree increase in temperature in the impoundment and DO supersaturation reflective of significant chlorophyll-a levels. This statement also does not appear to consider the potential impact of Project operations on sediment (and associated nutrient) loadings associated with erosion.

B14. Section 3.6.2 Summary of Existing Conditions - Fish Assemblage and Habitat Assessment of the Upper Connecticut River

a. Figure 3.6-2 on pages 3-51 and 3-52, show Index of Biological Integrity (IBI) results for the Project area based on sampling conducted in 2008 (and reported by Yoder et. al. in 2009) . Results were analyzed using three indices: the Atlantic Slope IBI, the Interim Maine Rivers IBI and the Modified Index of Well-Being. Two of the indices (Interim Maine Rivers IBI and the Modified Index of Well-Being) showed lower values just upstream of the dam. Moving further upstream, however, the values increase and then decrease again near the upstream portions of the project. No explanation is provided for this behavior. For example, what is the impact of impoundment fluctuations on the results? Also, what is considered a good and poor IBI score? If available, this information should be included in the discussion.

B15. Section 3.6.2 Summary of Existing Conditions - Connecticut River Fish Tissue Contaminant Study

a. This section discusses the result of the Hellyer (2006) Connecticut River Fish Tissue Contaminant Study. Pages 3-54 and 3-55 provide a general discussion on total mercury concentrations found in smallmouth bass, white sucker and yellow perch. Graphs and or tables showing actual results in each reach and river mile (with dam locations indicated) should be provided to allow the reader to quantify terms used in this section such as "generally similar" and "higher than".

b. This section (or perhaps a new section) should also discuss the potential impacts of impoundment fluctuations due to Project operations on methylmercury formation (the bioavailable form) and how this can result in increased mercury concentrations in fish and other organisms.

B16. Section 3.6.6 Aquatic Habitat

a. Figure 3.6-8 on page 3-77 shows Qualitative Habitat Evaluation Index (QHEI) scores for various reaches of the Connecticut River. The discussion on page 3-76 states that the QHEI has been shown to correspond predictably with key attributes of fish assemblage quality however, no indication is given of what is considered a good or bad QHEI score. This information should be provided.

B17. Section 3.6.7 Mussels and Macroinvertebrates

a. On page 3-81 it is stated that the dwarf wedgemussel is a federal and state endangered species in New Hampshire and Vermont. On page 3-80 it is stated that of the nine species of mussels found in the Project area, dwarf wedgemussels were the least abundant. This section should include a discussion of how Project operations may be impacting the dwarf wedgemussels and what could be done to increase the population of this endangered species.

b. On page 3-82 it is stated that National Rivers and Streams Assessment (NRSA) collected baseline benthic macroinvertebrate at two locations in the Project impoundment in 2008 and 2009; Station FW08NH011 in Claremont (17 miles upstream of the Bellows Falls dam) and Station FB08NH017 in Cornish (24 miles upstream of the dam). It is further reported that EPA will develop indices to rate the condition of each site as good, fair or poor and that the final report is due out by the end of 2012. Please note that based on preliminary results provided by EPA it is our understanding the Cornish site will be rated as good and the Clarement site (closer to the dam) will be rated as poor.

B18. Section 3.6.8 Project Effects (regarding Fish and Aquatic Resources)

a. On page 3-85 it is stated that the normal reservoir operating range of approximately 2.5 feet daily in the Project impoundment minimizes fluctuations that could affect fish spawning habitat. It is not clear why a 2.0 foot fluctuation minimizes impacts on fish spawning habitat as compared to smaller fluctuations or instantaneous run-of-river operation. This should be explained or this sentence deleted.

b. On page 3-85 it is stated that threats to mussel species and macroinvertebrates include stranding from water level fluctuations, sedimentation, and erosion. DES concurs that these impacts are or are likely to be occurring. The next sentence states that because no changes are proposed to Project operations, no new effects on aquatic resources are anticipated. There should be a discussion on what can be done to improve aquatic conditions for species, including, but not limited to, the endangered dwarf wedgemussel.

B19. Section 3.7.3 Plant and Animal Species

a. Table 3.7-5 on page 3-106 (invasive plant species) should include invasive alga *Didymosphenia geminata* (freshwater planktonic alga) and invasive aquatic macrophyte *Najas minor* (submersed).

B20. Section 3.7.4 Project Status (regarding Wildlife and Botanical Resources)

a. On page 3-108 it is stated that potential effects of the Project to wildlife and botantical resources can occur as a result of hydroelectric operations. The daily water level fluctuations of approximately 2 vertical feet has resulted in a zone of sparse vegetation, specific to the operating range, along most of the shorelines of the terrestrial project area. Wetland or water dependent wildlife and plant species will be adversely affected by the daily wetting and drying cycles along the river's edge. Areas of erosion along the riverbank can result in impacts to floodplains and riparian habitats. Disturbance resulting at least partially from project operations also creates opportunities for invasive plant species to colonize and dominate the shorelines of the project. DES concurs that these impacts are or are likely to be occurring. This section further states that because no changes are proposed to Project operations, no new effects on wildlife and botanical resources are anticipated. Since impacts of Project operations have been acknowledged in the PAD, there should be a discussion on what can be done to improve conditions rather than continuing with the status quo.

B21. Section 3.8.1 Summary of Existing Conditions (regarding Wetlands, Riparian, Littoral and Floodplain Habitat)

a. On page 3-109 it is stated that mapping by the National Wetlands Inventory (NWI) was the primary source for describing the wetland and littoral vegetated habitats for the Project. Actual wetland mapping would provide a more accurate baseline. Are there any plans to perform wetland mapping in the Project area?

B22. Section 3.8.3 Project Status (regarding Wetlands, Riparian, Littoral and Floodplain Habitat)

a. On page 3-115 it is stated that potential effects of the Project on wetland, floodplain, riparian, and littoral resources can occur as a result of hydroelectric operations. The normal daily water level fluctuation of approximately 2 vertical feet has resulted in a zone of sparse vegetation along most shorelines of the impoundment. Wetland and littoral resources in this zone are limited by the frequent wetting and drying. Areas of erosion along the riverbank can result impacts to floodplains and riparian habitats. DES concurs that these impacts are or are likely to be occurring. This section further states that because no changes are proposed to Project operations, no new effects on wetland, floodplain, riparian, and littoral resources are anticipated. Since impacts of Project operations have been acknowledged in the PAD, there should be a discussion on what can be done to improve conditions rather than continuing with the status quo.

B23. Section 3.9.5 Project Status (regarding Rare, Threatened and Endangered Species)

a. On page 3-124 it is stated that potential effects of the Project on RTE species or communities can occur as a result of hydroelectric operations. Project impacts on dwarf wedgemussel can occur as a result of river fragmentation, impoundment and hydroelectric operations. The project impoundment results in a more lentic environment characterized by reduced current speed and complexity, and increased sedimentation, and therefore reduced substrate complexity/increased substrate embeddedness. Peaking project operations alter the flow regime downstream of the Project, which alters downstream habitat on a sub-daily time scale and could impact feeding, spawning, and recruitment. DES concurs that these impacts are or are likely to be occurring. This section further states that because no changes are proposed to Project operations, no new effects on rare state, or federal terrestrial plant species or communities are anticipated. Since impacts of Project operations have been acknowledged in the PAD, there should be a discussion on what can be done to improve conditions rather than continuing with the status quo.

C. COMMENTS FOR THE VERNON PROJECT PAD (FERC NO. 1904)

C1. Section 2.3 Project Location

a. Figure 2.1-2 on page 2-3 is blurry and difficult to read.

C2. Section 2.1 Project Facilities

a. Figure 2.3-2 (page 2-9), Figure 2.3-4 (page 2-13), Figure 2.3-5 (page 2-16), Figure 2.3-7 (page 2-19), Figure 2.3-8 (page 2-20) and Figure 2.3-9 (page 2-22) are blurry and difficult to read.

C3. Section 2.4. Project Reservoir

a. Figure 2.4-1 on page 2-26 shows how reservoir volume and surface area varies with elevation. It should be explained how these curves were developed (i.e., were they based on bathymetric mapping of the reservoir?).
b. If available, a similar figure should be developed showing the change in exposed shoreline (average and maximum values in feet) with elevation.
c. Figure 2.4-2 on page 2-27 shows the water surface profiles at various flows. It should be stated how these were determined (i.e., were they based on a model?).
d. On page 2-27 it is stated that reservoir drawdown rates are typically 0.1 to 0.2 feet per hour and do not exceed 0.3 feet per hour. It should be explained why these rates were selected.

C4. Section 2.5.2 Normal Operations

a. On page 2-28, it is stated that the "project operates primarily on a daily run-of- river basis, meaning generally that over the course of a day, it's operation passes the average daily inflow", The minimum, average and maximum percent of time that the average daily flow is not passed in 24 hours for each month for the period of record should be stated.
b. A description of maintenance procedures (i.e., refill procedures, how often maintenance is performed, how often it is necessary to draw the dam down below the minimum allowed elevation) should be provided.

C5. Section 2.5.5 High Flow Operation

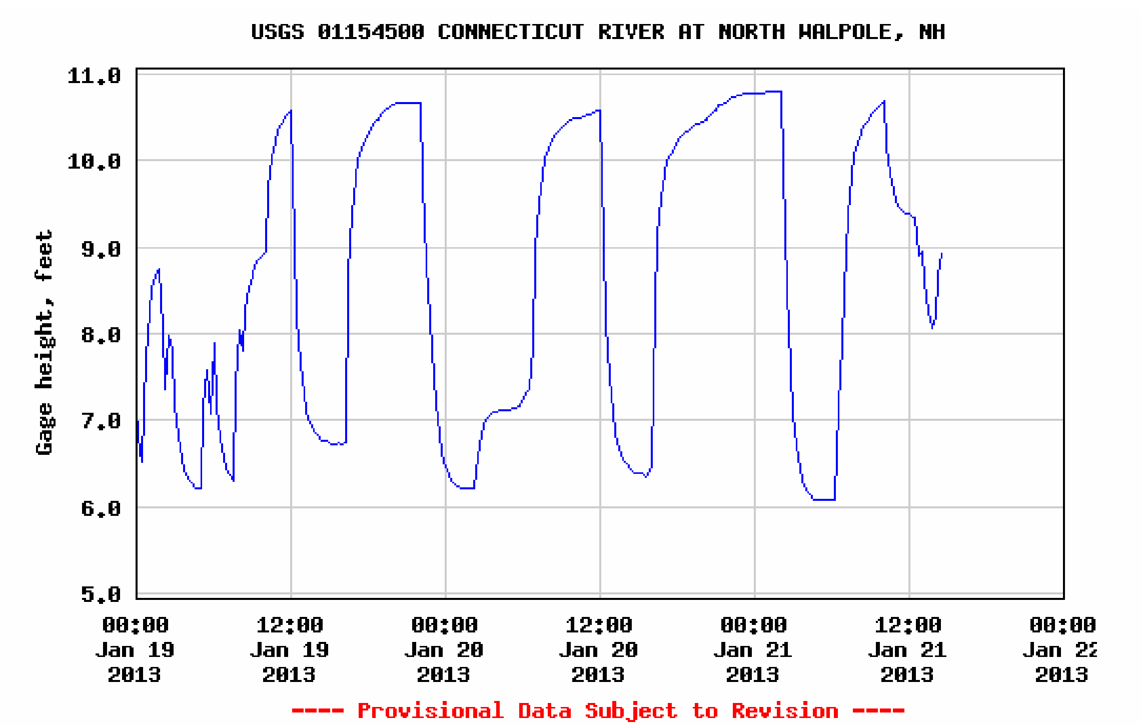
a. On page 2-31, it is stated that on occasion , inflows are anticipated to peak at a level just above station capacity and the reservoir is drawn down in advance to capture and avoid spilling, but these instances are the exception. The minimum, maximum and average percent of time this happens for each month for the period of record should be specified
b. Table 2.5-2 on page 2-32 shows the station discharge capacity at various water surface elevations. The discharge capacity for all the gates and stanchion bays (except the 8 hydraulic floodgates which are submerged at the maximum pond elevation of 228.1), increase as the impoundment water surface elevation increasees. However, the discharge capacity of the generators, drops from 21,000 cfs at pond elevation 220.1 to 0 cfs at pond elevation 228.1. This should be explained.

C6. Section 2.6.4 Current License and License Amendment Requirements

a. Table 2.6-3 on page 2-38 provides a summary of license and amendment requirements in addition to "Standard" Articles 1 through 28 of the FERC license. It would be helpful to include a complete summary of all FERC requirements (or perhaps provide a copy of the FERC license as an appendix).

C7. Section 3.4.5 Reservoir Shoreline and Streambanks

a. On page 3-13 it is stated that bank slumping was identified in the Kleinschmidt study (2011) as being the primary type of erosion present. This type of erosion is exacerbated by land/vegetation clearing close to the bank, commonly associated with farming practices. The Kleinschmidt survey concluded that 47 percent of the bank erosion in the Bellows Falls impoundment were associated with agricultural practices. The report does not mention the primary cause of the remaining 53 percent of the erosion sites. It is then concluded that impoundment level fluctuations caused by project operations are not likely to be significant contributors to erosion in the impoundment compared to naturally occurring high flows coupled with highly susceptible soils. It is not clear how such a statement can be made since bank vegetation (and stabilization) is reportedly sparse in the zone impacted by impoundment fluctuations (see section 3.8.3). It follows that this lack of stabilization would contribute to more erosion at all flows as compared to a bank with more vegetation. How much more is not discussed. That is, if the banks were better stabilized with vegetation, how would that reduce erosion under both low and high flows? This section also does not discuss the impact of daily impoundment fluctuations on downstream river fluctuations and erosion, but should. As shown in the graph below (based on the USGS gage located just below the Bellows Falls dam) water levels below the Bellows Falls dam can fluctuate approximately 4 feet twice per day. Similar fluctuations likely occur downstream of the Project dam. It appears more study is needed before statements can be made that suggest that daily impoundment fluctuations are insignificant contributors to erosion. It appears more study is needed before statements can be made that suggest that daily impoundment fluctuations are insignificant contributors to erosion.



C8. Section 3.4.6 Project Effects (regarding Geology and Soils)

a. On page 3-14, it is stated that impoundment fluctuations play a minor role in shoreline erosion, with flood flow from major storms playing a significant role. What does a "minor" role mean?

This is a subjective statement that should be quantified. As discussed in the previous comment, it would seem that since Project operations have resulted in sparse growth along the banks and have therefore increased their erosion potential, the impact of the Project on erosion is significant. That is, the amount of erosion would likely be significantly less if there were more vegetation on the banks to stabilize them.

C9. Section 3.5.2 Hydrology

a. On page 3-17, it is stated that upper reaches of the Turners Falls reservoir extend to the base of the Vernon dam. Please explain how this was determined. It is our understanding that at the scoping meeting FirstLight indicated that their project assessment may provide evidence that the upstream extent of the Turners Falls impoundment may not reach all the way to the Vernon dam. As discussed below (see comment C15 regarding section 3.6.6), there is data that suggests it may be more riverine.

b. Figure 3.5-1 on page 3-18 shows a whisker graph of hourly water level in the impoundment for each month for the period January 1, 2001 to December 31, 2011. A similar plot should be prepared with the maximum daily change in impoundment elevation (in feet) on the y-axis. This would show the frequency and magnitude of the daily fluctuations. If water surface elevation is available downstream of the dam, a similar plot should be developed to show the frequency and magnitude of daily fluctuations downstream.

c. A whisker graph similar to Figure 3.5-1 on page 3-18 but with the y - axis equal to the predicted maximum daily change in impoundment elevation if the project were operated in an instantaneous run-of-river mode , should be developed and compared to the graph requested in comment 6.a. above. A similar plot should then be developed assuming instantaneous run-of-river at the Wilder, Bellows Falls and Vernon projects. This would give an idea of the difference in magnitude and frequency of maximum daily impoundment fluctuations with current operations and with instantaneous run-of-river operations

d. On page 3-19 it is stated that for Tropical Storm Irene, the minimum reservoir level was 212.0 and that the river must reach the concrete crest, in order to reposition the stanchion beams and reconstruct the retention structure. It should be stated how long the impoundment was at this level (i.e., how long it took to fix the stanchions) and how long it took before the impoundment was at normal pool.

e. On page 3-22 it is stated that when inflows are less than station capacity of 11,400 cfs, the Project is operated as a daily peaking project to meet regional electrical demand. The average percent of time each year this occurs should be stated (i.e., 80 percent based on page 2-31 which states that station capacity is exceeded 20 percent of the time).

f. Figure 3.5-6 on page 3-23 shows a plot of the averaged hourly outflow and averaged monthly minimum, maximum and average outflow from January 1, 2001 to December 31, 2011. This graph is difficult to read. It is recommended the plot be expanded. A similar plot but with hourly impoundment elevation on the y-axis is requested to show the frequency, duration and magnitude of impoundment fluctuations. Another plot is requested showing the predicted hourly impoundment elevation if the Project was run in the instantaneous run-of-river mode and then another plot assuming the Project, as well as the Wilder and Bellows Falls projects were run in the instantaneous run-of-river mode.

C10. Section 3.5.5 Water Quality Standards - State Standards

a. A note should be added at the bottom of Table 3.5-3 on page 3-26 which states that for impoundments, the dissolved oxygen standards apply to the epilimnion or to the top 25 percent of depth if not stratified.

C11. Section 3.5.6.2 TransCanada Water Quality Studies

a. This section presents a summary of the data collected and concludes (see page 3-33) that there were no violations of state water quality standards and that the 2012 data are within a range that is typical of large, good quality riverine systems. This statement is subjective and is not supported by any data from other large rivers that are in compliance with state water quality standards. Unsupported statements such as this should be deleted or modified

b On page 3-32, it is stated that temperature and specific conductivity increased from upstream to downstream in the impoundment. It is further stated that "Generally minor changes in upstream to downstream values of study parameters may reflect the impacts of impoundment of riverine waters, thereby increasing time-of-travel and water column activity." Subjective terms such as "generally minor" should be quantified (i.e., include the value of the change for each paramenter). In addition, the word "may" should be deleted from this sentence unless another plausible explanation can be presented.

c. It should be mentioned that there were violations of the NH water quality standards for pH at station V-TR (pH = 8.04).

d. It would be helpful to show the location of the Vermont Yankee discharge on Figure 3.5-7 on page 3-30.

e. On page 3-32 it is stated that minor stratification may be occurring at station V-01. Profiles of DO and temperature with depth should be provided to support any conclusions. DES considers a surface water stratified when there is a defined thermocline showing greater than a 1 degree (Celcius) change per meter.

f. To determine if the data is representative of near worse case conditions (i.e., when parameters such as temperature, DO and algal activity are likely to be highest), this section should indicate what the flow was in the river and bypass channel prior to and during sampling. A comparison of the flow to the 7Q10 low flow should also be included in the discussion. Plots showing the flow and sampling results with time would be helpful.

g. To facilitate data analysis, DES requests that the data be uploaded in the DES Environmental database.

C12. Section 3.5.7 Project Effects on Seasonal Variation of Water Quality

a. On page 3.5.7 it is stated that the "... existing and newly collected water quality data indicate the Project has, and will continue to have, no significant impact on the primary water quality of concern, DO, or on other physical or chemical parameters. DES does not believe that the information provided in the PAD supports such a broad-sweeping conclusion and should be deleted or modified. As previously discussed (see comment C11 above), it is not known if the data was collected under worse case conditions. This statement also does not appear to consider the potential impact of Project operations on sediment (and associated nutrient) loadings associated with erosion. Temperature was also relatively high in the impoundment (maximum of 29.33 degrees C at station V-01 per Table 3-5.6, (although part of this could be due to thermal discharges from Vermont Yankee).

C13. Section 3.6.2 Summary of Existing Conditions - Fish Assemblage and Habitat Assessment of the Upper Connecticut River

a. Figure 3.6-1 on pages 3-69 and 3-70, shows Index of Biological Integrity (IBI) results for the Project area based on sampling conducted in 2008 (and reported by Yoder et. al. in 2009) . Results were analyzed using three indices: the Atlantic Slope IBI, the Interim Maine Rivers IBI and the Modified Index of Well-Being. Two of the indices (Interim Maine Rivers IBI and the

Modified Index of Well-Being) showed lower values just upstream of the dam. Moving further upstream, however, the values increase and then decrease again near the upstream portions of the project. No explanation is provided for this behavior. For example, what is the impact of impoundment fluctuations on the results? Also, what is considered a good and poor IBI score? If available, this information should be included in the discussion.

C14. Section 3.6.2 Summary of Existing Conditions - Connecticut River Fish Tissue Contaminant Study

a. This section discusses the result of the Hellyer (2006) Connecticut River Fish Tissue Contaminant Study. Page 3-73 provides a general discussion on total mercury concentrations found in smallmouth bass, white sucker and yellow perch. Graphs and or tables showing actual results in each reach and river mile (with dam locations indicated) should be provided to allow the reader to quantify terms used in this section such as "generally similar" and "higher than".
b. This section (or perhaps a new section) should also discuss the potential impacts of impoundment fluctuations due to Project operations on methylmercury formation (the bioavailable form) and how this can result in increased mercury concentrations in fish and other organisms.

C15. Section 3.6.6 Aquatic Habitat

a. Figure 3.6-6 on page 3-97 shows Qualitative Habitat Evaluation Index (QHEI) scores for various reaches of the Connecticut River. The discussion on page 3-96 states that the QHEI has been shown to correspond predictably with key attributes of fish assemblage quality however, no indication is given of what is considered a good or bad QHEI score. This information should be provided.
b. The discussion on page 3-97 states that an exceptionally high QHEI score was obtained at 5.2 miles downstream of the Vernon dam. This result is not what one would expect for an impounded section of river (on page 3-17 it is stated the upper reaches of the Turners Falls reservoir extend to the base of the Vernon Dam). How was it determined that the river below the Vernon dam is impounded?

C16. Section 3.6.7 Mussels and Macroinvertebrates

a. On page 3-98 it is stated that the dwarf wedgemussel is a federal and state endangered species and that none were found in the Project area. This section should include a discussion of how Project operations may be impacting the dwarf wedgemussels and what could be done to increase the population of this endangered species.
b. The discussion on macroinvertebrates begins on page 3-100. It is stated that two macroinvertebrate stations were sampled downstream of the Vernon dam, one less than one mile downstream of the dam and the other about 5 miles below the dam. However, because the downstream stations are outside of the Project affected area, this data was not included in this review. DES requests that this information be included as the Project likely impacts these locations and, as previously mentioned, the extent of the Turners Falls impoundment is questionable (see comment C15 above).
c. Table 3.6-11 on page 3-101 shows the abundance of macroinvertebrates found on Hester-Dendy Multiplate samplers in the lowest section of the Vernon impoundment in 2002. A discussion of what the results mean should be provided.
d. Similarly a discussion should be provided of what the results shown in Table 3.6-12 on page 3-105 (composition of macroinvertebrates collected less than one mile downstream of the Project dam) mean.

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e On page 3-107 it is stated that National Rivers and Streams Assessment (NRSA) collected baseline benthic macroinvertebrate at two locations in the Project impoundment in 2008 and 2009; Station FW08NH016 in Hinsdale (6 miles upstream of the Vernon dam) and Station FB08NH007 in Walpole (23 miles upstream of the dam). It is further reported that EPA will develop indices to rate the condition of each site as good, fair or poor and that the final report is due out by the end of 2012. Please note that based on preliminary results provided by EPA, it is our understanding that both sites will be rated as poor.

C17. Section 3.6.8 Project Effects (regarding Fish and Aquatic Resources)

a. On page 3-110 it is stated that threats to mussel species and macroinvertebrates include stranding from water level fluctuations, sedimentation, and erosion. DES concurs that these impacts are or are likely to be occurring. The next sentence states that because no changes are proposed to Project operations, no new effects on aquatic resources are anticipated. There should be a discussion on what can be done to improve aquatic conditions for species, including, but not limited to, the endangered dwarf wedgemussel.

C18. Section 3.7.3 Plant and Animal Species

a. Table 3.7-5 on page 3-134 (invasive plant species) should include invasive alga *Didymosphenia geminata* (freshwater planktonic alga) and invasive aquatic macrophyte *Najas minor* (submersed). In should also include *Trapa natans*, which were documented in low abundance above the Vernon Dam in August 2012. The plants were hand removed but caltrops may have been dropped before the plant was removed, so this is currently a "watch" species above the dam.

C19. Section 3.7.4 Project Status (regarding Wildlife and Botanical Resources)

a. On page 3-136 it is stated that potential effects of the Project to wildlife and botantical resources can occur as a result of hydroelectric operations. The daily water level fluctuations of approximately 2 vertical feet and associated daily wetting and drying cycles along the river's will likely adversely impact wetland or water dependent wildlife and plant species. Disturbance resulting at least partially from project operations also creates increased opportunities for invasive plant species to colonize and dominate the shorelines of the project. DES concurs that these impacts are or are likely to be occurring. This section further states that because no changes are proposed to Project operations, no new effects on wildlife and botanical resources are anticipated. Since impacts of Project operations have been acknowledged in the PAD, there should be a discussion on what can be done to improve conditions rather than continuing with the status quo.

C20. Section 3.8.1 Summary of Existing Conditions (regarding Wetlands, Riparian, Littoral and Floodplain Habitat)

a. On page 3-137 it is stated that mapping by the National Wetlands Inventory (NWI) was the primary source for describing the wetland and littoral vegetated habitats for the Project. Actual wetland mapping would provide a more accurate baseline. Are there any plans to perform wetland mapping in the Project area?

C21. Section 3.8.3 Project Status (regarding Wetlands, Riparian, Littoral and Floodplain Habitat)

a. On page 3-143 it is stated that potential effects of the Project on wetland, floodplain, riparian, and littoral resources can occur as a result of hydroelectric operations. The daily water level fluctuation of approximately 2 vertical feet has resulted in a zone of sparse vegetation along most shorelines of the impoundment. Wetland and littoral resources in this zone are limited by the frequent wetting and drying. DES concurs that these impacts are or are likely to be occurring. This section further states that because no changes are proposed to Project operations, no new effects on wetland, floodplain, riparian, and littoral resources are anticipated. Since impacts of Project operations have been acknowledged in the PAD, there should be a discussion on what can be done to improve conditions rather than continuing with the status quo.

C22. Section 3.9.5 Project Status (regarding Rare, Threatened and Endangered Species)

a. On page 3-124 it is stated that potential effects of the Project on RTE species or communities can occur as a result of hydroelectric operations. The normal daily water level fluctuation of approximately 2 feet has resulted in a zone of sparse vegetation along most shorelines of the impoundment. Rare species that use habitats along the impoundment edge may be adversely affected by the daily wetting and drying cycles while others rely on the continual or seasonal flooding and souring to maintain suitable habitat and suspend succession. Project impacts on dwarf wedgemussel can occur as a result of river fragmentation, impoundment and hydroelectric operations. The project impoundment results in a more lentic environment characterized by reduced current speed and complexity, and increased sedimentation, and therefore reduced substrate complexity/increased substrate embeddedness. DES concurs that these impacts are or are likely to be occurring. This section further states that because no changes are proposed to Project operations, no new effects on rare state, or federal listed terrestrial plant species or communities are anticipated. Since impacts of Project operations have been acknowledged in the PAD, there should be a discussion on what can be done to improve conditions rather than continuing with the status quo.

II. Study Requests

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is a Class B surface water. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)].

DES submits the following formal study requests to inform the Clean Water Act § 401 water quality certification process and to ensure that state water quality standards will be met. The Northfield Mountain Pumped Storage and Turners Falls projects impact the Turners Falls impoundment, a portion of which (5.7 miles) is in New Hampshire. These projects are therefore included in some of our study requests. In addition to the study requests provided herein, DES also supports the study requests submitted by the New Hampshire Fish and Game Department on February 27, 2013 for the Turners Falls and Northfield Mountain Projects (FERC Nos. 1889 and 2485).

Study Request 1a: Recreational Survey and Enhancement Study at Wilder Hydroelectric Project (FERC NO. 1892)

Goal and Objective

The goal of this study is to determine if potential impacts from project operations at the Wilder Hydroelectric facility support the goals of the NH Fish and Game Departments' Public Boating Access program and the Vermont and New Hampshire's Water Quality Standards Water Quality Standards for recreational uses, and to identify operational modifications that could be performed to enhance recreational opportunities.

The objectives are to:

Survey recreational users and potential users to identify to what extent existing recreational opportunities are being utilized by the public within the project boundaries and why potential recreational users are not using the resource.

Identify how project operations impact recreational users and how operations could be modified to improve recreational opportunities.

Identify how recreational opportunities in the vicinity of the project could be developed to enhance future recreational opportunities, including, but not limited to, boat access, primitive camping sites, improvement in portage trails, etc.

Resource Management Goals

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)]. This study request will inform the 401 water quality certification process and help ensure that State water quality standards will be met.

The Connecticut River is considered a Class B waters. Vermont Water Quality Standards requires that Class B waters be managed to provide full support for all recreational uses, including swimming and other primary contact forms of recreation and boating, fishing and other recreational uses.

A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources. Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998); which are relevant to this study request are:

1) New Hampshire has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.

2) New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.

3) New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.

4) Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

Our study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest Consideration

The requestor is a state natural resource agency.

Existing Information

The PAD provides information on the existing recreational resources, but does not provide information on how project operations adversely affect recreational opportunities or perception of recreational users utilizing opportunities in the vicinity of the project.

Project Nexus

The project impounds 45 miles of river that would otherwise be free flowing. The project currently operates in a peaking mode, with allowable impoundment fluctuations of up to 5 feet, with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (675 cfs), but can increase rapidly during times of power generation. Recreational resources and opportunities can be affected by the operations of the hydropower project. The PAD provides limited information on how project operations affect recreational users and opportunities within the project impoundment and tailrace. The NHFGD requests a study to assess how recreational opportunities are impacted by normal daily/seasonal operation of the project.

Proposed Methodology

The proposed study methodology should include an inventory of all the recreational facilities and

opportunities within the project boundary, and a determination of the number of recreational users utilizing the resources. The study should include a component to survey an equal proportion of recreational users utilizing different activities to determine how project operations affect their recreational use and experience, and identify any safety issues associated with project operations or current recreational facilities. Potential recreational users in the area should be identified to determine why potential recreational users do not use the resource. An analysis of the recreational facilities should be conducted to identify future projects that could improve the recreational resources and/or the need to improve existing recreational facilities or access to the resource.

Level of Cost and Effort

The cost and effort of this study will be moderate, but is important to document the potential impact operations on recreational opportunities. This study will also identify opportunities for future enhancement of recreational resources in the vicinity of the project.

Literature Cited:

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010), Concord, NH.

Study Request 1b: Recreational Survey and Enhancement Study at Bellows Falls Hydroelectric Project (FERC NO. 1855)

Goal and Objective

The goal of this study is to determine if potential impacts from project operations at the Wilder Hydroelectric facility support the goals of the NH Fish and Game Departments' Public Boating Access program and the Vermont and New Hampshire's Water Quality Standards Water Quality Standards for recreational uses, and to identify operational modifications that could be performed to enhance recreational opportunities.

The objectives are to:

Survey recreational users and potential users to identify to what extent existing recreational opportunities are being utilized by the public within the project boundaries and why potential recreational users are not using the resource.

Identify how project operations impact recreational users and how operations could be modified to improve recreational opportunities.

Identify how recreational opportunities in the vicinity of the project could be developed to enhance future recreational opportunities, including, but not limited to, boat access, primitive camping sites, improvement in portage trails, etc.

Resource Management Goals

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)]. This study request will inform the 401 water quality certification process and help ensure that State water quality standards will be met.

The Connecticut River is considered a Class B waters. Vermont Water Quality Standards requires that Class B waters be managed to provide full support for all recreational uses, including swimming and other primary contact forms of recreation and boating, fishing and other recreational uses.

A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources. Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998); which are relevant to this study request are:

1) New Hampshire has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.

2) New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.

3) New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.

4) Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

Our study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest Consideration

The requestor is a state natural resource agency.

Existing Information

The PAD provides information on the existing recreational resources, but does not provide information on how project operations adversely affect recreational opportunities or perception of recreational users utilizing opportunities in the vicinity of the project.

Project Nexus

The project impounds 26 miles of river that would otherwise be free flowing. The project currently operates in a peaking mode, with allowable impoundment fluctuations of up to 3 feet, with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (1083 cfs), but can increase rapidly during times of power generation. Recreational resources and opportunities can be affected by the operations of the hydropower project. The PAD provides limited information on how project operations affect recreational users and opportunities within the project impoundment and tailrace. The NHFGD requests a study to assess how recreational opportunities are impacted by normal daily/seasonal operation of the project.

Proposed Methodology

The proposed study methodology should include an inventory of all the recreational facilities and

opportunities within the project boundary, and a determination of the number of recreational users utilizing the resources. The study should include a component to survey an equal proportion of recreational users utilizing different activities to determine how project operations affect their recreational use and experience, and identify any safety issues associated with project operations or current recreational facilities. Potential recreational users in the area should be identified to determine why potential recreational users do not use the resource. An analysis of the recreational facilities should be conducted to identify future projects that could improve the recreational resources and/or the need to improve existing recreational facilities or access to the resource.

Level of Cost and Effort

The cost and effort of this study will be moderate, but is important to document the potential impact operations on recreational opportunities. This study will also identify opportunities for future enhancement of recreational resources in the vicinity of the project.

Literature Cited:

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Study Request 1c: Recreational Survey and Enhancement Study at Vernon Hydroelectric Project (FERC NO. 1904)

Goal and Objective

The goal of this study is to determine if potential impacts from project operations at the Wilder Hydroelectric facility support the goals of the NH Fish and Game Departments' Public Boating Access program and the Vermont and New Hampshire's Water Quality Standards Water Quality Standards for recreational uses, and to identify operational modifications that could be performed to enhance recreational opportunities.

The objectives are to:

Survey recreational users and potential users to identify to what extent existing recreational opportunities are being utilized by the public within the project boundaries and why potential recreational users are not using the resource.

Identify how project operations impact recreational users and how operations could be modified to improve recreational opportunities.

Identify how recreational opportunities in the vicinity of the project could be developed to enhance future recreational opportunities, including, but not limited to, boat access, primitive camping sites, improvement in portage trails, etc.

Resource Management Goals

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)]. This study request will inform the 401 water quality certification process and help ensure that State water quality standards will be met.

The Connecticut River is considered a Class B waters. Vermont Water Quality Standards requires that Class B waters be managed to provide full support for all recreational uses, including swimming and other primary contact forms of recreation and boating, fishing and other recreational uses.

A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources. Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998); which are relevant to this study request are:

1) New Hampshire has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.

2) New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.

3) New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.

4) Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

Our study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest Consideration

The requestor is a state natural resource agency.

Existing Information

The PAD provides information on the existing recreational resources, but does not provide information on how project operations adversely affect recreational opportunities or perception of recreational users utilizing opportunities in the vicinity of the project.

Project Nexus

The project impounds 26 miles of river that would otherwise be free flowing. The project currently operates in a peaking mode, with allowable impoundment fluctuations of up to 8 feet, with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (1250 cfs), but can increase rapidly during times of power generation. Recreational resources and opportunities can be affected by the operations of the hydropower project. The PAD provides limited information on how project operations affect recreational users and opportunities within the project impoundment and tailrace. The NHFGD requests a study to assess how recreational opportunities are impacted by normal daily/seasonal operation of the project.

Proposed Methodology

The proposed study methodology should include an inventory of all the recreational facilities and

opportunities within the project boundary, and a determination of the number of recreational users utilizing the resources. The study should include a component to survey an equal proportion of recreational users utilizing different activities to determine how project operations affect their recreational use and experience, and identify any safety issues associated with project operations or current recreational facilities. Potential recreational users in the area should be identified to determine why potential recreational users do not use the resource. An analysis of the recreational facilities should be conducted to identify future projects that could improve the recreational resources and/or the need to improve existing recreational facilities or access to the resource.

Level of Cost and Effort

The cost and effort of this study will be moderate, but is important to document the potential impact operations on recreational opportunities. This study will also identify opportunities for future enhancement of recreational resources in the vicinity of the project.

Literature Cited:

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Study Request 2: Telemetry Study of Upstream and Downstream Migrating Adult American Shad to Assess Passage Routes, Effectiveness, Delays, and Survival (FERC NOs. 1904, 1889 and 2485)

Goals and Objectives

Assess behavior, approach routes, passage success, survival, and delay by adult American shad as they encounter the projects during both upstream and downstream migrations, under permitted project operations conditions, proposed operational conditions, and study treatment operational conditions at First Light Power's Turners Falls and Northfield Mountain Pumped Storage projects and TransCanada's Vernon Project. There are multiple fishways and issues related to both upstream and downstream passage success at the projects. Some of these issues at the Turners Falls Project are similar to and/or pertain directly to the Northfield Mountain and Vernon projects. Therefore, it is reasonable to address passage issues at all projects in a similar manner.

Telemetry Study - This requested study requires use of radio telemetry using both radio and Passive Integrated Transponder (PIT) tag types to provide information to address multiple upstream and downstream fish passage issues. The following objectives shall be addressed in these studies:

- Assessment of any migration delays resulting from the presence of the dam and peaking flow operations of the Turners Falls Project;
- Determine route selection and behavior of upstream migrating shad at the Turners Falls Project under various spill flow levels (e.g., movement to the dam, attraction to Cabot Station, attraction to Station 1 discharge, movement between locations, delay, timing, etc.). A plan and schedule for dam spill flow releases will need to be developed that provides sufficient periods of spill flow conditions, and various generating levels from Turners #1 Station coupled with Cabot Station generation flows (e.g., treatments will require multiple days of consistent discharge). Evaluated spill flows should include flows between 2,500 – 6,300 cfs, which relate to bypass flows identified as providing spawning opportunities for shortnose sturgeon in the lower bypass reach at the Rock Dam. (Kieffer and Kynard 2012). Sturgeon spawning and upstream shad passage occur concurrently;
- Assess near field, attraction to and entrance efficiency of the Spillway Ladder by shad reaching the dam spillway, under a range of spill conditions;
- Evaluate the internal efficiency of the Turners Falls Spillway Ladder;
- Continue data collection of Cabot Station Ladder and Gatehouse Ladder efficiency, to include rates of approach to fishway entrances, entry into fishways, and passage through them, under different operational conditions that occur in these areas;
- Evaluate modifications to the Cabot and/or Spillway fishways recommended by the Service if they are implemented;
- Assess upstream migration from Turners Falls to the Vernon Dam in relation to Northfield Mountain's pumping and generating operations and Vernon Project peaking generation operations. Typical existing and proposed project operation alterations should be evaluated;
- Assess near field, attraction to and entrance efficiency of the Vernon Dam Ladder;
- Assess internal efficiency of the Vernon Dam Ladder;
- Assess upstream passage past Vermont Yankee's thermal discharge (also located on the

west bank of the river 0.45 mile upstream of fish ladder exit)
- Assess upstream migration from Vernon Dam in relation to the peaking generation operations of the Bellows Falls Project. Typical existing and proposed project operation alterations should be evaluated;
- Determine post-spawn downstream migration route selection, passage efficiency, delays and survival related to the Vernon Project, including evaluation of the impact of the Vermont Yankee heated water discharge plume on downstream passage route, migrant delay/timing, efficiency and survival;
- Assess impacts of Northfield Mountain operations on up- and downstream adult shad migration, including delays, entrainment, and behavioral changes and migration direction shifts under existing and proposed project operations;
- Determine downstream passage route selection, timing/delay, and survival under varied project operational flows into the power canal and spill flows at Turners Falls Dam;
- Determine downstream passage route selection, timing/delay in the canal, Cabot Station fish bypass facility effectiveness, and survival of Cabot-bypassed adult shad that enter the Turners Falls Canal system;
- Compare rates and or measures of delay, movement and survival etc., among project areas or routes utilized (e.g., spill at dam vs. power canal) under the range of permitted and proposed conditions; and
- Utilize available data sets and further analyze raw data (e.g., 2003- 2012 Conte Lab Studies) where possible to address these questions and inform power analyses and experimental design.

Information to address all of these questions would rely on the tagging of upstream migrating adult shad at Holyoke Dam and releasing them to migrate naturally from Holyoke through the Turners Falls and Vernon projects and back downstream after spawning. Additional tagged individuals would likely need to be released farther upstream (Turners Falls Canal, upstream of Turners Falls Dam, and upstream of Vernon Dam), to ensure that enough tagged individuals encounter project dams on both upstream and downstream migrations, that these individuals are exposed to a sufficient range of turbine and operational conditions to test for project effects, and to provide adequate samples sizes for statistically valid data analyses to address the many objectives listed. This study will require two years of field data collection to attempt to account for inter-annual variability in river discharge and water temperatures.

<u>Evaluation of Past Study Data</u>- In addition to collection and analysis of new telemetry data, substantial data has already been collected at Turners Falls from multiple years of passage assessments conducted for First Light by U.S. Geological Survey’s Conte Anadromous Fish Research Center (Conte Lab) researchers and there are also data from the 2011 and 2012 full river study conducted by the Conte Lab that address Turners Falls, Northfield Mountain and Vernon project migration and passage questions that have not yet been analyzed. These data include several million records each year from more than 30 radio telemetry receivers deployed between Middletown, CT and Vernon Dam. This data will provide substantial information free from the field data collection costs and therefore should be analyzed as part of this study. This data analysis should be completed in 2013 to help inform the design of subsequent field studies.
Evaluation of Methods to Get Shad Past Cabot Station for Spillway Passage at the Turners Falls Dam – The poor passage efficiency of the Cabot Ladder, the first and most used fishway encountered by shad arriving at the Turners Falls Project, and at the entrance to the Gatehouse Ladder, which all Cabot fishway-passed fish must use, has resulted in very poor overall shad

passage efficiency at the project. An alternative to passing fish at the Cabot Station is to install a fish lift at the dam that would put fish directly into the Turners Falls pool, thereby eliminating problems with the Cabot Fishways, and the Gatehouse Fishway entrance and the variable passage efficiency of the Gatehouse Fishways. For this to be effective, attraction of shad to the Cabot Station discharge and associated delays would need to be overcome. It is possible that spillway flow releases coupled with behavioral measures at Cabot Station that dissuade shad from that tailrace could achieve this end. In order to assess the possibilities, we recommend the following study:

1. A literature search and desk-top assessment of the possible behavioral measures that could be effective in getting shad to pass Cabot Station tailrace and continue upstream to the dam.

2. Based on results of the desk-top assessment, possible evaluation of behavioral measures that are likely to be effective.

3. Field evaluation of the effect of different levels of spill at the dam that would induce fish to move past the Cabot Station into the bypass reach and up to the dam (as noted in objectives).

Besides passage success and delays at passage facilities, these studies would assess the impacts of project operations on migration passage delay, route, timing, injury, mortality, and passage structure attraction, retention, and success. Of particular interest will be fish behavior during periods when flow releases from the project increase from the required minimum flows to peak generation flows and when flows subside from peak generation flows to minimum flows and the operation of NMPS in pumping and generation modes.

Resource Management Goals

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)]. This study request will inform the 401 water quality certification process and help ensure that State water quality standards will be met.

The Connecticut River Atlantic Salmon Commission (CRASC) developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually. (Table 1)

2. Achieve annual passage of 40 to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem.

3. Maximize outmigrant survival for juvenile and spent adult shad.

The Atlantic States Marine Fisheries Commission, Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010 includes the following objective:

1. Maximize the number of juvenile recruits emigrating from freshwater stock complexes and recommendations:

Upstream Passage –

1. American shad must be able to locate, enter, and pass the passage facility with little effort and without stress.

2. Where appropriate, improve upstream fish passage effectiveness through operational or structural modifications at impediments to migration.

3. Fish that have ascended the passage facility should be guided/routed to an appropriate area so that they can continue upstream migration, and avoid being swept back downstream below the obstruction.

Downstream Passage –

4. To enhance survival at dams during emigration, evaluate survival of post spawning and juvenile fish passed via each route (e.g., turbines,, spillage, bypass facilities, or a combination of the three) at any given facility, and implement measures to pass fish via the route with the least delay and best survival rate.

Based on the CRASC plan, the New Hampshire Fish and Game Department (NHFGD) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.

2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to American shad movement and migration, the NHFGD's goals are:

1. Minimize current and potential negative project operation effects such as migration delays, false attraction, turbine entrainment, survival of project passage routes, and trashrack impingement that could hinder management goals and objectives.

A mission of the NHFGD relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1) New Hampshire has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.
2) New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.
3) New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.
4) Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

This study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The requestor is a state natural resource agency.

Existing Information

Passage of adult shad at the Turners Falls fishway complex has been the subject of intense study by the Conte Lab since before 1999. These studies have clearly demonstrated that passage through the existing fishways at Cabot and Spillway is poor (<10% in many years). Passage through the Gatehouse fishway is better, but still rarely exceeds 80%, despite the short length of this ladder. In addition to poor passage for fish entering the ladders, shad that ascend the Cabot Fishway experience extensive delays before entry into the Gatehouse Fishway. Shad that ascend Spillway frequently fall back into the canal and are also subject to these upstream delays. A new entrance to the Gatehouse Fishway installed in 2007 led to dramatic improvements in passage out of the canal (from 5% to over 50% in 2011), but passage still falls well short of management goals. In addition, shad spend considerable time (up to several weeks) attempting to pass. These delays likely influence spawning success and survival. Adult shad, unable to pass Gatehouse, experience similar delays in downstream passage, even after they have stopped trying to pass Gatehouse. Without spill, all outmigrating shad that have passed Gatehouse must enter the canal at the Gatehouse and may be subject to delays exiting the canal.

During the course of these studies a very large dataset has been compiled that could yield useful information for further improving passage of shad out of the canal in both the upstream and downstream directions. A unique feature of these data is a 2-dimensional array covering the canal just downstream of Gatehouse, documenting fine scale movements and occupancy of this zone. These data should be combined with computational fluid dynamics (CFD) and real-time hydraulic data to determine how canal hydraulics influence the ability of shad to locate and enter the fishway, and to identify modifications that are likely to lead to improvements in approach and entry rates. A separate CFD modeling study is requested that includes modeling of the Gatehouse Fishway entrance are at the head of the power canal.

In addition, whole-river shad telemetry studies performed in 2011 and 2012 will likely provide useful information and should be analyzed. These data should allow quantification of delay below Turners Falls, and could help guide studies requested above. Preliminary analyses of data through 2011 have been made available to FirstLight and the resource agencies (Castro-Santos and Haro 2005; Castro-Santos and Haro 2010).

The whole-river studies have also shown that, at least in 2011, most shad that pass Turners Falls rapidly progress upstream to Vernon Dam where extensive delays also occur. Data from the 2012 study were not available at this time, but Dr. Castro-Santos stated similar patterns were noted in the data between the years on the topic of upstream delay (personal communication, Dr. Theodore Castro-Santos). Similarly, concerns relative to the downstream passage of spent shad also remain relative to delays, with existing unpublished USGS telemetry data sets suggesting this is an issue within the Turners Falls canal.

Since the first year of operation of the Turners Falls upstream fishways (1980), the percent passage of American shad annually passed upstream of Turners Falls Dam compared to the number passed at the Holyoke Fish Lift has averaged 3.6% (1980-2012 data). The highest values for this metric has not exceed 11% and are well below the noted CRASC Management Plan target range for this objective noted earlier as 40-60% on a five year running average.

Since the first year of operation of the Vernon Dam upstream fish ladder (1981), the percent passage of American shad annually passed at Vernon compared to the number passed upstream of Turners Falls Dam (Gatehouse counts) has averaged 39.4%, ranging from 0.42% to 116.4% (> 100% due to counting error at one or both facilities, unknown).

Nexus to Project Operations and Effects

Existing project operations (peaking power generation) and limited bypass flows have a direct impact on instream flow and zones of passage (migration corridors). Project flow releases affect passage route selection, entry into fishways, and create delays to upstream migration. Inefficient downstream bypasses can result in migration delays and increased turbine passage. Mortality of adult shad passing through these turbines is expected to be high (Bell and Kynard 1985), additional stresses associated with passage and delay may cause mortality as shad are unable to return to salt water in a timely manner. The project's upstream and downstream passage facilities need to be designed and operated to provide timely and effective upstream and downstream fish passage to meet restoration goals of passage to upstream habitat and maximize post-spawn survival. These factors are all critically important to the success of restoration efforts.

Methodology

Use of radio including passive-integrated transponder (PIT) telemetry is widely accepted as the best method to assess fish migratory behavior and passage success and has been used extensively to assess migration and passage issues at Turners Falls as well as other Connecticut River projects. These studies include one conducted in 2011 and 2012 by the Service and U.S. Geological Survey's Conte Anadromous Fish Research Center, which has provided substantial information related to some of the issues identified here. The requested study will build and expand on the information collected over the past two years.

The study design must specify sample sizes, tag configurations and receiver configurations, to ensure that rates of entry and exit to the tailraces, fishways, downstream bypasses, and the bypassed reach can be calculated with sufficient precision to determine effectiveness of flow and ensonification treatments (separate Study Request). For project assessments at Turners Falls (e.g., Cabot, Spillway and Gatehouse ladder attraction and entry, route selection, operational effects), double tagged (radio and PIT) shad will be required for release from Holyoke Dam. Additional shad must be released directly into the Turners Falls Canal to support assessment of the various operational and structural conditions in effect, to be modified in this period, and proposed conditions within the Turners Falls power canal relative to entrances to the Gatehouse fishway. A related request on CFD modeling in the Cabot Station tailrace, the upper power canal near Gatehouse, and in the area around the entrance of the Spillway Ladder will address related project operational effects that will also address identified objectives in this telemetry request. Shad captured at Holyoke and tagged and release upstream of Turners Falls Dam, or tagged out of Gatehouse Ladder, would help to ensure an adequate sample size for evaluations in the vicinity of NMPS and to the Vernon Dam and the ability to address identified study objectives in those project areas. Additional tagged shad are expected to be required for release upstream of the Vernon Dam, which should ensure adequate sample for a separate study request, where shad spawn upstream of Vernon Dam as well as ensuring there is an adequate number of outmigrating spent adults to address related study objectives for adult outmigrants. The required number of tagged fish to address study objectives may be adjusted accordingly from area to area depending on target numbers (i.e., best information on resultant viable tagged fish and power analyses to detect effects) to account for typical passage rates, survival rates, and handling effects as examples.

Existing information on captured, handled, tagged fish performance (e.g., percent that drop back, unsuitable for tracking) and factors such as timing of tagging and potentially transport, must all be carefully considered to ensure an adequate sample size of healthy (e.g., viable to characterize behavior, survival, etc.) tagged fish is available to address the many questions identified in this request (as supported by a statistical power analysis). Additionally, ensuring adequate downstream adult fish sample sizes (to address project effect questions above) requires close consideration as expected losses of healthy tagged fish during upstream passage, natural mortality rates, and tagging related effects, are expected to reduce sample sizes on downstream passage objectives/questions as the season progresses. The use of single PIT tagged fish can help improve sample sizes, but will be of limited use to answer some of the passage questions we have identified.

Due to environmental variability, two years of study work will be necessary. A large array of stationary monitoring stations (radio and PIT) will be needed to address the issues identified among the project areas. A sufficient level of radio receiver and PIT reader coverage will be required, to provide an appropriate level of resolution, for data analyses, to answer these questions on project operational effects. The study will provide information on a variety of structural and operational aspects of fish migration, relative to route selection, timing, survival, and up and downstream passage attraction, retention, delay, efficiency, survival as some examples at three projects (Turners Falls, NMPS, and Vernon). The use of video monitoring may also be utilized for specific study areas such as the Spillway Ladder, to provide additional information on shad entrance activity, with the understanding of some data limitations associated with this approach (fish identification, water visibility). This study will be coordinated with the proposed study request to evaluate ensonification as a shad behavioral deterrent at the Cabot

Station tailrace which will be an additional treatment of the telemetry study.
In addition to the tagging studies, use of video monitoring of the Spillway Fishway would provide additional overall data on Spillway Fishway efficiency as all shad attempting to pass could be monitored versus just those shad that have been tagged.

Level of Effort/Cost, and Why Alternative Studies will not suffice

The requested study is extensive and will require a substantial effort and cost to capture, PIT tag, and radio tag a sufficient number of shad at Holyoke to release at upstream locations. We are not aware of any other study technique that would provide project specific fish behavior and migration information to adequately assess existing project operations and provide insight in possible alternative operations and measures needed to address observed negative impacts to fish migration success. Video monitoring of the Spillway fishway would add a modest cost to this study.

Due to the fact tagged shad will move throughout the larger five project area, to varying degrees, there will be expected cost savings (e.g., radio tags) to both owner/operators, provided cooperation in study planning and implementation occurs.

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Study Request 3: Evaluation of Timing of Downstream Migratory Movements of American Eels on the Mainstem Connecticut River (FERC NOs. 1892, 1855, and 1904)

Goals and Objectives

The goal of this study is to better understand migration timing of adult, silver-phase American eels as it relates to environmental factors and operations of mainstem hydropower projects on the Connecticut River.

The objectives of this study are:

1. Quantify and characterize the general migratory timing and presence of adult, silverphase American eels in the Connecticut River relative to environmental factors and operations of mainstem river hydroelectric projects

Resource Management Goals

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)]. This study request will inform the 401 water quality certification process and help ensure that State water quality standards will be met.

The Atlantic States Marine Fisheries Commission has developed two documents related to the management of American eel:

1. Interstate Fishery Management Plan for American Eel. April 2000. Atlantic States Marine Fisheries Commission.
2. Addendum II to the Fishery Management Plan for American Eel. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

Objectives of the management plan include: (1) protect and enhance American eel abundance in all watershed where eel now occur; and (2) where practical, restore American eel to those waters where they had historical abundance but may now be absent by providing access to inland waters for glass eel, elvers, and yellow eel and adequate escapement to the ocean for pre-spawning adult eel.

Addendum II contains specific recommendations for improving upstream and downstream passage of American eel, including requesting that member states and jurisdictions seek special consideration for American eel in the FERC relicensing process.

In addition, the Connecticut River Atlantic Salmon Commission (CRASC) developed A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin in 2005. The goal of the plan is "to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem…" Management objectives in the plan include the following:

1. Protect and enhance eel populations where they currently exist;
2. Where practical, restore populations to waters where they had historical abundance;
3. Provide effective upstream and downstream fish passage around dams and other barriers within the species' range in the basin; and
4. Comply with all requirements of the Fishery Management Plan of the ASMFC.

Based on these plans, the New Hampshire Fish and Game Department (NHFGD) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to downstream passage of American eel, the NHFGD's goals are:

1. Minimize current and potential negative project operation effects that could hinder management goals and objectives.
2. Minimize project-related sources of downstream passage delay, injury, stress, and mortality in order to maximize the number of silver eels migrating to the spawning grounds.

The American eel is also one of New Hampshire and Vermont's Species of Greatest Conservation Need (SGCN). The status for conservation need in Vermont is listed as high priority (Kart et al. 2005), and the species is listed as "vulnerable" in New Hampshire. As identified in Vermont's Wildlife Action Plan (Kart et al. 2005), threats to the species include the construction of large dams on rivers which obstruct juvenile fish access to critical rearing habitats, as well as mortality associated with passing through hydroelectric facilities' turbines during their outmigration to sea.

A mission of the NHFGD relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1) New Hampshire has a wide range of naturally occurring habitats and healthy,

naturally functioning ecosystems.
2) New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.
3) New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.
4) Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

Our study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The requestor is a state natural resource agency.

Existing Information

Data on timing of downstream migratory movements and rates of American eels in the mainstem Connecticut River are sparse and relatively incomplete. Preliminary data on presence of "eelsized" acoustic targets have been collected (Haro et al. 1998) within the Turners Falls Project's Cabot Station forebay that were somewhat confirmed by video monitoring at the Cabot Station downstream fish bypass; however, these were short-term studies, with acoustic monitoring only performed from 17 September to 5 October and video monitoring only conducted between 18 September to 22 October.

Some daily monitoring of the downstream bypass at the Holyoke Dam (canal louver array) was performed in 2004 and 2005 (Kleinschmidt, Inc. 2005, 2006, Normandeau Associates 2007); these studies also were of relatively short duration (spanning from October 5 to November 10 in 2004 and September 9 to November 11 in 2005) and the sampler was only operated at night.

To date, no other directed studies of eel migratory movements have been conducted at any location on the Connecticut River mainstem. This information gap needs to be filled, as it relates directly to when downstream passage and protection measures need to be operated.

We also note that within the past seven years, the United States Fish and Wildlife Service (USFWS) has received two petitions to list the American eel under the Endangered Species Act. The first petition was received on November 18, 2004. On July 6, 2005 the USFWS issued a substantial 90-day finding on the petition and initiated a 12-month status review that concluded on February 2, 2007 with a finding that listing was not warranted. The second petition was filed on April 30, 2010 by the Council for Endangered Species Act Reliability. On September 29, 2011 the USFWS issued a substantial 90-day finding and initiated a 12-month status review. It is our understanding that the USFWS is still accepting new American eel information for the ongoing status review.
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Nexus to Project Operations and Effects

The timing of downstream migration of adult eels is poorly defined for the Connecticut River; therefore the general effects of hydroelectric project operations on eel survival to the ocean are unknown. Although separate study requests have been submitted to address project-specific downstream passage route selection, delays, and mortality of eels, general characteristics of river flow and environmental conditions may have significant relationships with project operation and eel migratory success and survival. For example, eels may tend to move immediately before or during periods of significant precipitation (or consequently river flow); times at which projects may be generating at maximum capacity or spilling, which may (or may not) present a higher passage risk to eels. Conversely, periods of low flow may be associated with a significant proportion of total river flow passing through turbine units, which present additional (or different) passage risk to eels. If discrete conditions which promote eel downstream migration are known, it may be possible to take actions with respect to project operations which reduce or minimize passage risk; i.e., operation of a bypass, reduction of intake approach velocities, directed spillage through a "safe" route, etc. These studies should provide baseline information on river-specific downstream migration to predict when silver-phase eels are expected to be migrating in the mainstem Connecticut River, from which project operations could be modified to minimize passage risks.

The studies are proposed for a single or multiple sites; the results will be relevant to all sites on the Connecticut River mainstem.

Methodology Consistent with Accepted Practice

Quantification of downstream movements of American eels in river systems requires systematic sampling of migrants throughout the migratory season. This can be accomplished with traditional active trapping methods; i.e., fyke or stow net sampling, weirs, or eel racks, but these methods are technically challenging on larger mainstem rivers, due to the scale of flows that need to be sampled, difficulties in operation throughout all flow conditions, and high debris loading during fall flows. Passive monitoring of migrant eels using hydroacoustic methods offers an alternative to active trapping. However, passive monitoring requires verification of potential acoustic targets with some level of active (collection) or visual (traditional optical or acoustic video) sampling. Two potential locations offer opportunities to conduct simultaneous passive and active sampling: the Cabot Station (Turners Falls project) canal/forebay and the Holyoke Dam forebay and canal louver/bypass system. Each location possesses a route of downstream passage which conducts a significant proportion of river flow (Cabot canal and Holyoke forebay or canal), and each has a proximal bypass equipped with a sampler so that fish can be concentrated/collected from the passage route and identified to species. Project operations do influence the relative proportion of flow (and thus numbers of downstream migrant eels) in each passage route, so numbers of eels sampled in each route represent only a proportion of the total number of eels migrating downstream within the entire river. Because the absolute proportion of eels using a specific route at any one time is unknown, numbers of eels quantified within a route must serve as a relative index of the degree of migratory movement.

This study shall quantify eel movements in either one, or preferably both, locations for two consecutive years (since environmental conditions strongly influence migratory timing of eels, which can vary significantly from year to year; Haro 2003). Eels will be quantified using methods similar to Haro et al. (1999), by continuously monitoring a fixed location at the projects with hydroacoustics. Because eels tend to concentrate in areas of dominant flow (Brown et al. 2009, EPRI 2001), the zone to be monitored should pass a dominant proportion of project flow throughout most periods of operation (i.e., forebay intake area). Hydroacoustic monitoring shall encompass the entire potential migratory season, beginning in mid-August and ending in mid-December, and shall operate 24 hours per day. Data will be recorded for later processing and archiving.

Systematic active quantification of eels at downstream bypass samplers shall be performed simultaneously with passive hydroacoustic monitoring, to verify presence of eels and relative abundance of eel-sized hydroacoustic targets from the hydroacoustic data. Although daily operation of the bypass sampler could be performed, a more comprehensive technique is to monitor eels entering the bypass with an acoustic camera (i.e. DIDSON, BlueView, etc.). The acoustic camera will afford positive visual identification of eels as they enter the bypass, which is a concentration point for migrating eels. Acoustic camera monitoring will also allow monitoring to be performed 24 hours a day, and will be relatively unaffected by water turbidity (which influences effectiveness of traditional optical video monitoring). The acoustic camera system will be operated during the same time period as acoustic monitoring, and images will be recorded for later processing and archiving.

Data analyses of hydroacoustic, acoustic camera, bypass sampling, and environmental/ operational data will follow standard methodology.

Project operation (flows, levels, gate openings, number of units operating and operation level) and environmental conditions (river flow, temperature, turbidity, air temperature, precipitation) will be monitored regularly (hourly measurements if possible) throughout the duration of the studies.

These methodologies are consistent with accepted practice.

Level of Effort/Cost, and Why Alternative Studies will not suffice

The level of cost and effort for the downstream migrant eel migratory timing study would be moderate, given the level of cost for instrumentation, deployment, and data review/analysis. The applicant did not propose any studies to meet this need in the PAD.

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Study Request 4: Impact of Project Operations on Shad Spawning, Spawning Habitat, and Egg Deposition in the Project Areas of the Turners Falls, Northfield Mountain Pumped Storage and Vernon Project Areas and downstream from Bellow Falls Dam. (FERC Nos. 1855, 1907, 1889, and 2485)

Conduct a field study of spawning by American shad in the Connecticut River mainstem downstream of Turners Falls Dam, in the Turners Falls Dam impoundment, in the Vernon Dam Project area, and downstream of Bellows Falls Dam to determine if project operations (including operations of the Northfield Mountain Pump Storage) negatively impact shad spawning behavior, spawning habitat use, areal extent and quality of those spawning areas, and spawning activity in terms of egg deposition in those areas.

Goals and Objectives

Determine if project operations (under the permitted and proposed operational ranges) affect American shad spawning site use and availability, spawning habitat quantity and quality, and spawning activity in the river reaches downstream from Cabot Station and in the project bypass reach of Turners Falls Dam, in the Turners Falls Dam impoundment and in relation to Northfield Mountain Pump Storage operations, downstream and upstream of the Vernon Dam, and in the project area downstream of Bellows Falls Dam. The following objectives will address this request:

- Determine areas utilized by American shad for spawning by conducting night-time visual observation of spawning activity, identify and define areas geospatially, and obtain data on physical habitat conditions effected by project operations (e.g., water depth, velocity, discharge, substrate, exposure and inundation of habitats);
- Determine project operation effects on observed spawning activity, under a range of permitted or proposed project operation conditions;
- Quantify effects (e.g., water velocity, depths, inundation, exposure of habitats) of project operation on identified spawning areas for a range of conditions, over the complete period of spawning activity;
- Quantify spawning activity as measured by night-time spawning/splash surveys and egg collection in areas of spawning activity, and downstream of these areas, to further determine project operation effects (location extent of exposure from changing water levels and flows and on associated habitats from project operations).

If it is determined that the Project operations are adversely affecting the spawning activity of American shad and impacting spawning area habitat, identify operational regimes that will reduce and minimize impacts spawning habitat and spawning success, within the project area. This study will require two years of field data to capture inter-annual variability to river discharge and water temperatures and to allow for evaluation of alternative flow regimes if year one studies determine that the present peaking regime negatively affects spawning.

Resource Management Goals

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)]. This study request will inform the 401 water quality certification process and help ensure that State water quality standards will be met.

The Connecticut River Atlantic Salmon Commission developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following:

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.

2. Achieve annual passage of 40% to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem.

The Atlantic States Marine Fisheries Commission, Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010 includes the following objective:

1. Maximize the number of juvenile recruits emigrating from freshwater stock complexesand recommendations:
2. To mitigate hydrological changes from dams, consider operational changes such as turbine venting, aerating reservoirs upstream of hydroelectric plants, aerating flows downstream, and adjusting in-stream flows.
3. Natural river discharge should be taken into account when instream flow alterations are being made to a river (flow regulation) because river flow plays an important role in the migration of diadromous fish.
4. Ensure that decisions on river flow allocation (e.g., irrigation, evaporative loss, out of basin water transport, hydroelectric operations) take into account instream flow needs for American shad migration, spawning, and nursery use, and minimize deviation from natural flow regimes.
5. When considering options for restoring alosine habitat, include study of impacts and possible alteration of dam-related operations to enhance river habitat.

The New Hampshire Fish and Game Department (NHFGD) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to American shad, the NHFGD's goals are:

1. Minimize current and potential negative project operation effects on American shad spawning and recruitment.

A mission of the NHFGD relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

> 1) New Hampshire has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.
> 2) New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.
> 3) New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.
> 4) Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

This study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The requestor is a state natural resource agency.

Existing Information

Since the construction of the first fish lift facility at Holyoke Dam in 1967, American shad have had access to spawning and rearing habitat upstream from Holyoke Dam. A number of improvements to the Holyoke fishway have occurred since that time, but while the numbers of shad lifted at Holyoke have reached as much as 721,764 and the overall shad population to the river exceeded 1.6 million shad in 1992 (CRASC 1992), total shad population, and numbers of shad passing Turners Falls and Vernon Dam, have not met CRASC management plan objectives. Population number and passage numbers past Holyoke have declined substantially from those totals in recent years, with average Holyoke passage numbers over the last 10 years of 211,850. Since historically, approximately half of the returning population of shad to the river passed upstream of Holyoke, recent returns are far below management goals. Effective upstream and downstream passage and successful in-river spawning and juvenile production are necessary to help achieve shad management goals for the Connecticut River.

American shad broadcast spawn in congregations over shallow flats and rocky or sandy substrates (Davis et al, 1970, Mansuetti and Kolb 1953), at depths less than 10 feet and often far shallower with spawning fish swimming vigorously near the surface in a closely packed circle (Marcy 1972, Mackenzie et al 1985). Fertilized eggs drift downstream until hatching (Mackenzie et al 1985).

American shad are known to spawn downstream from the Turners Falls Project. Layzer (1974) identified 6 spawning sites from an area below the mouth of the Deerfield River (river mile 191.9) to river mile 161.7 below the Mill River in Hatfield, MA. Kuzmeskus (1977) verified 16 different spawning sites ranging from downstream of the Cabot tailrace to just upstream of the Holyoke dam (river mile 87.1). The only parameter that all spawning sites had in common was current (Kuzmeskus 1977). The NHFGD is not aware of any more recent studies that document whether these 16 sites are still viable spawning locations for shad. We are not aware of any studies that have determined American shad spawning habitat or spawning sites upstream of Vernon Dam to Bellows Fall Dam (historic extent of upstream range).

First Light Power conducted studies in the late spring and summer of 2012, examining habitat conditions downstream of the Turners Falls Dam. The study documented that in low flow conditions, Cabot Station project operations produced fluctuations in water level elevations that can range over 4 feet in magnitude (daily operation) at the USGS Montague Gage Station, to lower values of 2 to 3 feet at the Route 116 Bridge, Sunderland, MA (PAD). Similar short-term, limited monitoring in the upper Turners Falls Dam impoundment identified water level changes due to project operations that cyclically varied several feet on a sub-daily frequency.

Nexus to Project Operations and Effects

American shad are known to spawn at five locations downstream from the Turners Falls Project from an area below the mouth of the Deerfield River (river mile 191.9) and ten other locations downstream to river mile 161.7 below the Mill River in Hatfield (Layzer 1974, Kuzmeskus 1977).

Shad spawning is likely influenced by river flow, which fluctuates greatly due to the project's peaking mode of operation. These fluctuations may impact shad spawning activity by altering current velocities and water depth at the spawning sites. Effects on spawning behavior could include suspension of spawning activity, poor fertilization, flushing of eggs into unsuitable habitat due to higher peaking discharges, eggs dropping out into unsuitable substrate and being covered by sediment deposition, and/or eggs becoming stranded on dewatered shoal areas as peak flows subside.

While a number of shad spawning and egg deposition studies were conducted in the 1970s, that research was aimed at assessing the potential impact of developing a nuclear power station in the Montague Plains section of the Connecticut River. We are not aware of any studies being conducted specifically designed to determine if a relationship exists between spawning behavior, habitat use, and egg deposition and project operations effects of the Turners Falls, Northfield Mountain Pump Storage and Vernon projects and downstream of Bellows Falls Dam.

We are concerned that peaking operations may be altering spawning behavior and contributing to the failure of the Connecticut River shad population to meet CRASC management targets.

Methodology

The first year of study should examine known spawning areas downstream of the Turners Falls Dam project, to determine operation effects on shad spawning behavior, activity, and success. In areas upstream of Turners Falls Dam to the Bellow Falls Dam tailrace, the first year study should identify areas utilized for spawning by American shad. In the second year, should results from year one determine project operations affected spawning activity, access to habitat, or success, downstream of Turners Falls Dam, then an identical more detailed assessment (identified objectives) should be conducted in spawning areas upstream of Turners Falls Dam to the Bellows Falls Dam tailwater. Measures to reduce or eliminate any documented project operation impacts should be explored and evaluated in year two, downstream of Turners Falls Dam. Potential impacts to spawning behavior would best be studied by night-time observations of actual in-river spawning behavior (Ross et al. 1993). Project discharge increases or decreases during actual observed spawning activity will provide empirical evidence of change in behaviors. The observational methodology should follow the protocol specified in Layzer (1974) and/or as described in Ross et al. (1993). The analysis should utilize the observational field data in conjunction with operational data from the projects (station generation and spill on a sub-hourly basis). To assess the impacts of changes in generation flows, the study should include scheduled changes in project operation to ensure that routine generation changes that occur during the nighttime spawning period affect downstream spawning habitats selected for study while shad are spawning. Stier and Crance (1985) provide optimal water velocities during spawning to range between 1 to 3 ft/sec.

In areas used for spawning, the characteristics of those areas (e.g., location, depth, flow, substrate) should be recorded. The effect of project operations (discharge, water velocity, inundation and exposure) should be assessed. Drift nets will be used to collect eggs to quantify egg production before and after flow changes at the spawning site. In the reaches above the Turners Falls dam, night time observations of splashing associated with shad spawning should be performed in each reach as sufficient numbers of shad are passed above each dam. Observations should be performed regularly until the end of the spawning season. The use of radio-tagged adult shad from a separate Study Request will aid in this effort. An estimate of the total area used for spawning and an index of spawning activity should be recorded for each site.

Level of Effort/Cost, and Why Alternative Studies will not suffice

Neither First Light or TransCanada propose any studies to meet this need. Estimated cost for the study is expected to be moderate for each owner, with the majority of costs associated with fieldwork labor.

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Study Request 5: Bellows Falls Bypass Flow (FERC NO. 1855)

Goals and Objectives

The goal of this study is to determine appropriate bypass flows that will meet State surface water quality standards and protect and enhance the aquatic resources of the Bellows Falls bypass reach.

The objective of the study will be to evaluate the relationship between flow and habitat suitability in the bypass reach.

Relevant Resource Management Goals

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)]. This study request will inform the 401 water quality certification process and help ensure that State water quality standards will be met.

Specific to aquatic resources within the Bellows Falls bypass reach, the goal is to provide appropriate flows in the bypass reach that meet State surface water quality standards

Pertinent standards for New Hampshire include, but are not limited, to the following:

> Regarding flow, Env-Wq 1703.01(d) states that "unless the flows are caused by naturally occurring conditions, surface water quantity shall be maintained at levels adequate to protect existing and designated uses." Designated uses include aquatic life.
>
> Regarding Biological and Aquatic Community Integrity, Env-Wq 1703.01 states the following:
> (a) The surface waters shall support and maintain a balanced, integrated, and adaptive community of organisms have a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region.
> (b) Differences from naturally occurring conditions shall be limited to non-detrimental differences in community structure and function.
>
> Regarding dissolved oxygen, Env-Wq 1703. states the following
> (b) Except as naturally occurs, or in waters identified in RSA 485-A:8, III, or subject to (c), below, class B waters shall have a dissolved oxygen content of at least 75% of saturation,

based on a daily average,and an instantaneous minimum dissolved oxygen concentration of at least 5 mg/l.

The New Hampshire Fish and Game Department (NHFGD) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to aquatic resources within the Bellows Falls bypass reach, the NHFGD's goals are:

1. Protect, enhance, or restore, diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
2. Provide appropriate flows in the bypass reach that meets the life history requirements of resident fish and wildlife, including freshwater mussels and other benthic invertebrates.
3. Minimize current and potential negative project operation effects on water quality and aquatic habitat.

A mission of the NHFGD relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1) New Hampshire has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.
2) New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.
3) New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.
4) Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

This study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The requestor is a state natural resource agency

Background and Existing Information

The Bellows Falls Project bypasses a 3,500 foot-long section of the Connecticut River. Presently this bypass reach only receives flow when inflow exceeds the hydraulic capacity of the Bellow Falls station. According to exceedance curves provided in the PAD, on a monthly basis the bypass reach receives flow the following amount of time:

Month	**% time flow > 11,000 cfs**	**Month**	**% Time Flow >11,000 cfs**
Jan.	15	July	10
Feb.	15	August	8
March	50	Sept.	4
April	90	Oct.	20
May	60	Nov.	35
June	20	Dec.	26

No information exists on the adequacy of the existing bypass flow regime to protect water quality and aquatic life. The bypass reach receives flow less than 30% of the time on an annual basis. While TransCanada did conduct a preliminary water quality study in the summer of 2012 that included water quality in the bypass reach only a summary of the data are provided in the PAD. It does not indicate where the sonde was located, nor the bypass reach conditions during the study period (e.g., What was the flow into the bypass reach during the study? Was the sonde located in the only wetted area of the bypass reach?). Further, the PAD provides no detailed description of the physical or biological characteristics of the bypass reach.

An empirical study is needed to provide information on the relationship between flow and habitat in the bypass reach for use in determining appropriate flows in the bypass reach.

Project Nexus

The Project includes a 3,500-foot-long bypass reach. Absent a mandated discharge at the dam, this habitat would remain dewatered during those times when inflow was within the hydraulic capacity of the units (~70% of the time on an annual basis). The existing license does not require any flow through the bypass reach. The current situation does not sufficiently protect the aquatic resources inhabiting or potentially inhabiting the bypass reach.

The Connecticut River in the project vicinity is dominated by sections that are impounded, backwatered from downstream impoundments or otherwise deep and slow-flowing. In contrast, the Bellows Falls bypass channel is very irregular and diverse, consisting of both coarse substrate of various sizes and in the more downstream segment, jagged, irregular ledge. Given an adequate flow regime, the bypass could provide habitat types that are now rare and therefore of great importance.

Results of the flow study will be used to determine an appropriate flow recommendation that will protect and/or enhance the aquatic resources in the bypass reach for the duration of any new license issued by the Commission.

Proposed methodology

It is requested that a bypass flow study be conducted at the Project. Bypass flow habitat assessments are commonly employed in developing flow release protocols that will reduce impacts or enhance habitat conditions in reaches of river bypassed by hydroelectric projects.

Given the size of the bypass reach (3,500 feet long) and the rareness of the habitat types it contains in this portion of the Connecticut River, we believe a study methodology that utilizes an IFIM approach is appropriate for this site. It is our understanding that this same protocol was used during the relicensing of the Housatonic River Project (FERC No. 2576),[1]and has been accepted by the Commission in other licensing proceedings[2]. Concurrent with the field work, dissolved oxygen/temperature dataloggers should be deployed to determine compliance of tested flows with State water quality standards.

Given the unique channel formation habitat modeling using standard PHABSIM 1 dimensional modeling may not be sufficient to assess the habitat suitability in the bypass reach but rather 2 dimensional, 2D modeling may be needed to better characterize flows and velocities in this reach. We recommend that the approach to habitat modeling be determined during the study plan development stage based on consultations between the applicant and the resource agencies.

Level of effort and cost

The expected level of effort and anticipated costs will be comparable to that experienced on similar FERC relicensing projects of this size.

Field work for flow studies can be reasonably extensive but will depend on consultation with the applicant on study methodology and on-site decisions on locations for data collection and the number of collection locations. Post-fieldwork data analysis would be a moderate cost and effort. Field work associated with this study could be done in conjunction with the Instream Flow Study Request. It is our understanding that the level of effort and costs will be comparable to that experienced on similar FERC relicensing projects (e.g., the Glendale Project, FERC No. 2801).

Literature Cited

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

[1] Housatonic River Project License Application, Volume 4, Appendix F. Connecticut Light and Power Company, August 1999.
[2] Glendale Project (FERC No. 2801) Final Bypass Reach Aquatic Habitat and Instream Flow Study in Glendale Hydroelectric Project Application for Subsequent License (FERC No. 2801), Volume 2, Appendix B, pages 7-8, October 2007.

Study Request 6: Shad Population Model for the Connecticut River (FERC NOs. 1892, 1855, 1904, 1889, and 2485)

Develop an American shad annual step, mathematical simulation population model for the Connecticut River to quantify how project operations and potential restoration/mitigation measures impact the population of shad in the Connecticut River.

Goals and Objectives

The goal of the model is to assess impacts of both upstream and downstream passage at each of the Connecticut River projects and potential management options for increasing returns to the river.

Specific objectives include:

- Annual projections of returns to the Connecticut River;
- A deterministic and stochastic option for model runs
- Life history inputs of Connecticut River shad
- Understanding the effect of upstream and downstream passage delay at projects
- Calibration of the model with existing data
- Analysis of the sensitivity of model inputs
- Analysis of sensitivity to different levels of up- and downstream passage efficiencies at all projects
- Multiple output formats including a spreadsheet with yearly outputs for each input and output parameter

Resource Management Goals

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)]. This study request will inform the 401 water quality certification process and help ensure that State water quality standards will be met.

The Connecticut River Atlantic Salmon Commission (CRASC) developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following:

1 Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.
2 Achieve annual passage of 40 to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem.
3 Maximize outmigrant survival for juvenile and spent adult shad.

The New Hampshire Fish and Game Department (NHFGD) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1 Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2 Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to American shad, the NHFGD's goals are:

1 Minimize current and potential negative project operation effects on American shad spawning and recruitment.

A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1) New Hampshire has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.
2) New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.
3) New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.
4) Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

This study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The requestor is a state natural resource agency.

Existing Information

Since the construction of the first fish lift facility at Holyoke Dam in 1967, American shad have had access to spawning and rearing habitat upstream from Holyoke Dam. A number of improvements to the Holyoke fishway have occurred since that time, but while the numbers of shad lifted at Holyoke have reached as much as 721,764 and the overall shad population to the river exceeded 1.6 million shad in 1992 (CRASC 1992), total shad populations, and numbers of shad passing Holyoke, Turners Falls and Vernon Dam have not met CRASC management goals. Population and passage numbers past Holyoke have declined substantially from those totals in recent years, with average Holyoke passage numbers since 2000 of 229,876. Whole river population estimates have shown that approximately half of the returning population of shad pass upstream of Holyoke. Recent returns to Holyoke are far below management goals. Average passage efficiency of shad at Turners Falls (Gatehouse counts) and Vernon since 2000 has been 3.1 and 20.4 % respectively. These too are well below the CRASC management goals. Safe, timely and effective up- and downstream passage along with successful spawning and juvenile production are necessary to help achieve shad management goals for the Connecticut River.

Nexus to Project Operations and Effects

Existing project operations and fish ladder efficiencies have a direct effect on shad populations in the Connecticut River. Poor upstream passage efficiencies and delays restrict river access to returning shad. Fish unable to reach upriver spawning grounds may not spawn or have reduced fitness or survival of young. Poor downstream passage survival and downstream passage delays affect outmigration and consequently repeat spawning, an important ecological aspect of the iteroparous Connecticut River shad population (Limberg et al. 2003).

There is concern that poor passage efficiencies and delays at projects may be limiting access to upstream reaches of the river, altering spawning behavior, decreasing outmigration survival and contributing to the failure of the Connecticut River shad population to meet management targets (Castro-Santos and Letcher 2010).

Development of a population model will allow an assessment of individual project impacts on the population as well as the cumulative impacts of multiple projects. The model will allow managers to direct their efforts in the most efficient manner toward remedying the conditions that most impact the shad population.

Methodology

Population models are commonly used to assess anthropomorphic and natural impacts and are consistent with accepted practice. A model similar to this request was constructed for the Susquehanna River by Exelon (FERC #405, RSP 3.4). The model is constructed in Microsoft Access

Specific parameters that would be included in the model:

- Upstream passage efficiency at Holyoke, Turners Falls (Cabot, Gatehouse and Spillway Ladders), Vernon fishways, and any impacts associated with Northfield Mountain.
- Distribution of shad approaching the Turners Falls project between the Cabot Ladder and the spillway at the dam
- Downstream passage efficiencies at Vernon, Northfield Mountain, Turners Falls, and Holyoke projects for juveniles and adults

- Entrainment at Mount Tom and Vermont Yankee
- Sex ratio of returning adults
- The proportion of virgin female adults returning at 4, 5, 6, and 7 years
- The proportion of repeat spawning females at 5, 6 and 7 years
- Spawning success of females in each reach
- Fecundity
- Percent egg deposition
- Fertilization success
- Larval and juvenile in-river survival
- Calibration factor to account for unknown parameters such as at sea survival
- Options for fry stocking and trucking as enhancement measures
- Start year and model run years
- Start population
- Rates of movement to and between barriers
- Temperature, river discharge, and other variable of influence to migration and other life history events

The model should be adaptable to allow the input of new data and other inputs.

Level of Effort/Cost, and Why Alternative Studies will not suffice

Neither First Light nor TransCanada have proposed any study to meet this need. Estimated cost for the study is expected to be low to moderate. As the model describes the impacts of multiple projects and two owners, both project owners would share the cost of model development.

Literature cited:

CRASC (Connecticut River Atlantic Salmon Commission). 1992. A management plan for American shad in the Connecticut River basin. Sunderland, MA

Castro-Santos, T and B. H. Letcher. 2010. Modeling migratory bioenergetics of Connecticut River American shad (*Alosa sapidissima*): implications for the conservation of an iteroparous anadromous fish. Can.J.Fish.Aquat.Sci. 67: 806-830

Limberg, K. E., K. A. Hattala, and A. Kahne. 2003. American shad in its native range. Pages 125-140 in K. E. Limberg and J. R. Waldman, editors. Biodiveristy, status and conservation of the world’s shads. American Fisheries Society, Symposium 35,Bethesda, Maryland

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Study Request 7: American Eel Survey Upstream of the Vernon, Bellows Falls, and Wilder Dams (FERC NOs. 1892, 1855, and1904)

Goals and Objectives

The goal of this study is to provide baseline data relative to the presence of American eel upstream of the Vernon, Bellows Falls, and Wilder Dams.

The objective of the study is to determine the relative abundance and distribution of American eel upstream of the Vernon, Bellows Falls and Wilder Dams in both riverine and lacustrine habitat.

Relevant Resource Management Goals

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)]. This study request will inform the 401 water quality certification process and help ensure that State water quality standards will be met.

The Atlantic States Marine Fisheries Commission has developed two documents related to the management of American eel:

1 <u>Interstate Fishery Management Plan for American Eel</u>. April 2000. Atlantic States Marine Fisheries Commission.
2 <u>Addendum II to the Fishery Management Plan for American Eel</u>. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

Objectives of the management plan include: (1) protect and enhance American eel abundance in all watersheds where eel now occur; and (2) where practical, restore American eel to those waters where they had historical abundance but may now be absent by providing access to inland waters for glass eel, elvers, and yellow eel and adequate escapement to the ocean for prespawning adult eel.

Addendum II contains specific recommendations for improving upstream and downstream passage of American eel, including requesting that member states and jurisdictions seek special consideration for American eel in the FERC relicensing process.

In addition, the Connecticut River Atlantic Salmon Commission (CRASC) developed A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin in 2005. The goal of the plan is "to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem…" Management objectives in the plan include the following:

1 Protect and enhance eel populations where they currently exist;
2 Where practical, restore populations to waters where they had historical abundance;
3 Provide effective upstream and downstream fish passage around dams and other barriers within the species' range in the basin; and
4 Comply with all requirements of the Fishery Management Plan of the ASMFC.

Based on these plans, the New Hampshire Fish and Game Department (NHFGD) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to American eels, the NHFGD's goals are:

1. Protect, enhance, or restore, diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
2. Understand the baseline condition with respect to the presence of American eel within and upstream of the project area.
3. Minimize current and potential negative project operation effects on American eel inhabiting the project area and/or moving through the area during upstream and downstream migrations

The American eel (*Anguilla rostrata*), is also listed as one of both New Hampshire's and Vermont's Species of Greatest Conservation Need (SGCN). The status for conservation need in Vermont is listed as high priority (Kart et al. 2005), and the species is listed as "vulnerable" in New Hampshire. As identified in Vermont's Wildlife Action Plan (Kart et al. 2005), threats to the species include the construction of large dams on rivers which obstruct juvenile fish access to critical rearing habitats, as well as mortality associated with passing through hydroelectric facilities' turbines during their outmigration to sea.

As outlined in Vermont's Wildlife Action Plan (Kart et al. 2005), research and monitoring needs for this SGCN include determining their distribution and abundance, as the contribution of eels in northern regions to overall stock is unknown. One of the conservation strategies for this species is to support efforts to enhance access of American eels to Vermont waters by minimizing impacts of dams and other obstructions along the Richelieu, St. Lawrence, and Connecticut Rivers.

A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1) New Hampshire has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.
2) New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.
3) New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.
4) Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

This study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq*.).

Public Interest

The requestor is a state natural resource agency.

Background and Existing Information

According to the PADs, very few American eels were collected in the Fish Assemblage and Habitat Assessment of the Upper Connecticut River (Yoder et al., 2009). In the Vernon Project area upstream of the dam, only one eel was collected; no eels were collected from the Bellows Falls pool, and none were found upstream of the Wilder Dam. However, in 2012 over 200 eels were documented using the upstream fish ladder at the Vernon Project and the New Hampshire Fish and Game Department has observed eels upstream of the Bellows Falls and Wilder dams. More recently, eels have been observed in Lake Morey, Vermont, which is located upstream of Wilder Dam (Lael Will, VDFW, personal communication). Therefore, while it is clear that some eels are passing all three dams (Vernon, Bellows Falls, and Wilder), it remains unknown how many eels may be rearing in the mainstem habitat upstream of the dams or in tributaries and lakes and ponds that feed into the mainstem river.

No targeted eel surveys have been conducted to determine the abundance and distribution of American eels in riverine and lacustrine habitat upstream of the three projects. This information gap needs to be filled so resource agencies can evaluate properly the need for, and timing of, downstream passage and protection measures for outmigrating silver phase eels.

We also note that within the past seven years, the United States Fish and Wildlife Service (USFWS) has received two petitions to list the American eel under the Endangered Species Act. The first petition was received on November 18, 2004. On July 6, 2005 the USFWS issued a substantial 90-day finding on the petition and initiated a 12-month status review that concluded on February 2, 2007 with a finding that listing was not warranted. The second petition was filed on April 30, 2010 by the Council for Endangered Species Act Reliability. On September 29, 2011 the USFWS issued a substantial 90-day finding and initiated a 12-month status review. It is our understanding that the USFWS is still accepting new American eel information for the ongoing status review.

Project Nexus

The project configurations present problems with respect to providing safe, timely and effective passage for outmigrating eels. The intakes are deep and, while no specification for the trashracks were provided in the PADs, it is unlikely that they would prevent impingement and/or entrainment of eels. Existing anadromous downstream passage facilities at the projects also would not be expected to be effective for eels; the target anadromous species are surfaceoriented, while eels tend to move much deeper in the water column. If eels are utilizing habitat upstream of the dams, then appropriate protection and downstream passage measures will be needed.

In order to understand the need for, and timing of, downstream eel passage at the projects, we are requesting that TransCanada undertake eel surveys in the Connecticut River upstream of the three dams and in tributaries feeding into the mainstem river within the project areas. Surveying tributary habitat is necessary because surveying the mainstem alone may lead to an underestimation of eel abundance, particularly if there are relatively short tributary streams that lead to a lake or pond (where eels may accumulate, leading to true high densities).

Proposed methodology

We request an eel survey be conducted in the mainstem river and tributaries upstream from the three projects. The methodology should be similar to that used in the relicensing of the Saluda Hydroelectric Project, FERC No. 516 (Appendix A), the eel assessment for the Merrimack River completed by the Service's Central New England Fishery Resources Office (Appendix B), and the proposed study plan for the relicensing of the Eastman Falls Project (FERC No. 2457, FERC Accession No. 20121214-512).

In general, a combination of electroshocking (backpack in wadeable rivers and boat-mounted in larger rivers and lakes) and eel pots should be used to collect eels and determine catch rates. Sampled habitat should include: the mainstem Connecticut River from upstream of Vernon Dam to below the Ryegate Dam; tributaries to the Connecticut within that stretch where eels have been collected previously; and lakes and ponds (such as, but not limited to, Spofford Lake and Lake Morey), where eels have been collected previously. Sampling should occur during the summer (July through September).

Level of effort and cost

The expected level of effort and anticipated costs will be comparable to that experienced on similar FERC projects of this size. A study plan recently submitted for the Eastman Falls Project (FERC No. 2457) on the Pemigewasset River in New Hampshire, which is utilizing a similar methodology, estimated that sampling a nine-mile-long impoundment with shocking and eel pots would cost $25,000. They estimated the effort to be two nights for the electrofishing survey. Given the much larger area that will need to be sampled under this request, we estimate moderate cost and effort will be required (20 days of shocking mainstem habitat plus another 5-10 days for tributaries and associated lake/pond habitat).

Literature Cited

Kart, J., R. Regan, S.R. Darling, C. Alexander, K. Cox, M. Ferguson, S. Parren, K. Royar, B. Popp, editors. 2005. Vermont's Wildlife Action Plan. Vermont Fish & Wildlife Department. Waterbury, Vermont. http://www.vtfishandwildlife.com/swg_cwcs_report.cfm. (Accessed September 10, 2012).

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Study Request 8: Channel Morphology and Benthic Habitat Impacts at the Vernon, Bellows Falls and Wilder Projects (FERC NOs. 1904, 1855 and 1892)

It is well known that dams interrupt the downstream continuum of sediment supply and transport, which in turn can affect channel morphology and limit the amount of coarse (i.e. gravel/cobble) substrate available for aquatic biota. The Vernon, Bellows Falls and Wilder projects' effects on fluvial processes, channel formation and associated anadromous and riverine fish habitat, as well as aquatic invertebrate habitat, is unclear. This study request aims to provide information on coarse sediment supply and transport as it relates to aquatic benthic habitat (e.g. gravel bars). Results will be used to identify techniques to minimize and/or mitigate impacts to this valuable habitat.

Goals and Objectives

The goal of this study is to understand how the projects affect bedload distribution, particle size and composition as it relates to habitat availability (amount and size of coarse substrate material) for different life-history stages of anadromous (e.g. sea lamprey) and riverine fishes (e.g. walleye), as well as invertebrates (e.g., tiger beetles, mussels- such as the federally-endangered dwarf wedgemussel).

The study objectives include:

1. Assess the distribution and extent of the existing substrate types, including gravel and cobble bars within the project affected areas.

2. Identify the current conditions of the channel and determine the stability of the present substrate/benthic habitat and identify if flow or sediment measures are necessary to improve the aquatic benthic habitat.

Resource Management Goals

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)]. This study request will inform the 401 water quality certification process and help ensure that State water quality standards will be met.

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Furthermore, the Vermont Fish and Wildlife Department's (VTFWD) mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Kart et al. 2005). Two of the VTFWD's planning goals are:

> 1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.
>
> 2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

> 1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.
> 2 New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.
> 3 New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.
> 4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

Gravel/cobble habitat is utilized by various riverine fish species during different life history stages and seasons, as it provides sites for spawning, feeding, and refuge (Gore and Shields 1995). Many fish species and aquatic invertebrates (e.g., fresh water mussels, snails, worms, and aquatic insects) live on or near gravel habitat, because it provides a source of food and cover (Miller 1988). Gravel bars also play an important role in water quality, hydrology, and morphology of rivers (Lewis 2005).

As identified in Vermont's Wildlife Action plan (Kart et al. 2005), several state listed mussel species are known to utilize gravel-type substrate. Furthermore, sea lamprey (*Petromyzon marinus*) spawning occurs over substrate composed of a mixture of sand, gravel and rubble. The sea lamprey, within the Connecticut River drainage, is one of New Hampshire and Vermont's Species of Greatest Conservation Need (SGCN). The conservation status of sea lamprey in New Hampshire is listed as "vulnerable." One of the threats identified in Vermont's Wildlife Action Plan (Kart et al. 2005) is degraded spawning habitat, which is second to habitat fragmentation. In support of the VTFWD and the NHFGD's missions, and the Vermont Water Quality Standards, it is important to gain a better understanding of the benthic habitat present in project affected areas and how projects operations may be affecting this habitat.

This study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The requestor is a state natural resource agency.

Existing Information

The PAD generally focuses on erosional impacts due to the projects' operations, but lacks specific information on fluvial geomorphic processes and substrate composition as it relates to impacts to aquatic benthic habitat. Recent studies assessing fluvial geomorphic process and substrate composition in Connecticut River tributaries have documented the impacts of regulated flows from dams on substrate composition, and the possible impacts on the mainstem of the river.

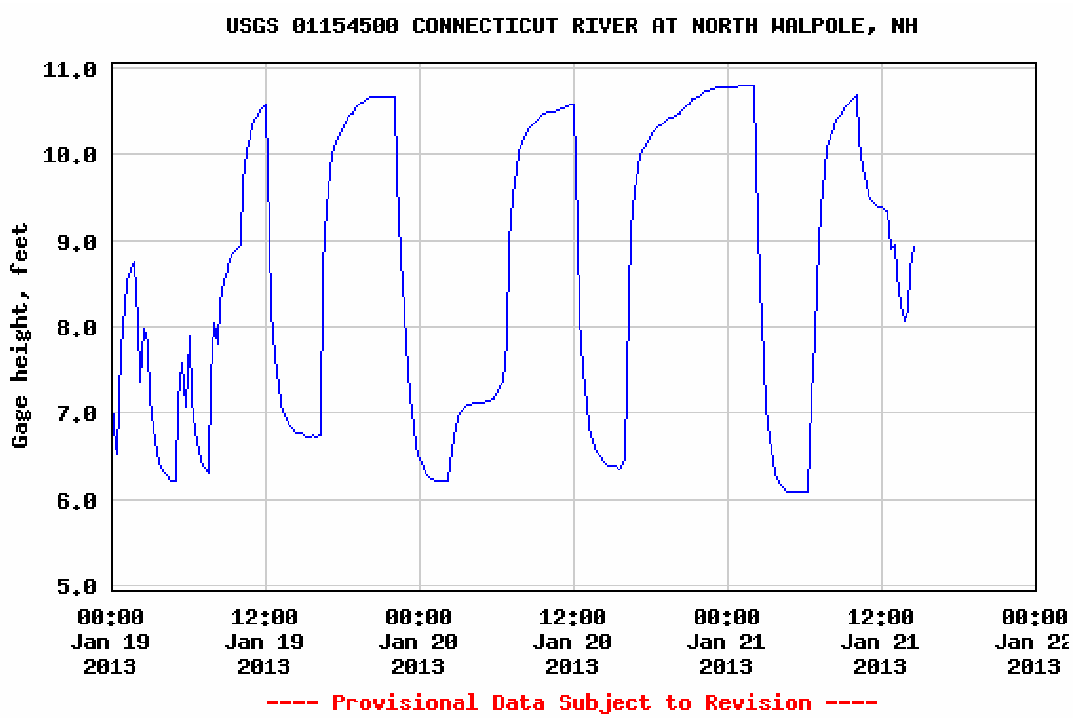
Curtis et al. (2010) utilized a combination of historical aerial photographs, mainstem- and tributary-channel pebble counts, and HEC-RAS flow modeling in the West and White River watersheds (tributaries to the Connecticut River). They documented the time series of postregulation channel narrowing and associated bar growth due to the influx of tributary sediment.
In the West River, Svendsen et al. (2009) quantified changes in channel bed morphology as a result of flow regulation. Utilizing bi-monthly cross-section data from the gauging stations they determined the mean water depth and bed elevation for each cross-section measurement during the pre-dam and post-dam periods. In addition, annual peak stream flow data for each station were used to calculate the flood recurrence, and surface grain distributions at sampling sites upstream and downstream of each tributary confluence using Wolman pebble counts. They found that the sediment load from tributaries are impacting the flow-regulated mainstem West River rather than ameliorating conditions, and that these impacts are reflected in the benthic community structure. These results indicate that environmental flows that mimic the natural hydrograph are needed in regulated reaches of river.

Nexus to Project Operations and Effects

Dams have major impacts on geomorphic processes, ecological function and in turn biotic communities. Changes to substrate composition can significantly affect aquatic life including stability of channel habitats, size distribution and embeddedness of substrate, and decreased habitat diversity and heterogeneity. The projects impound a large portion of the Connecticut River that otherwise would be free flowing and would transport fine sediment downstream leaving larger substrate material (gravel/cobble) exposed to be utilized by aquatic biota. By interrupting the downstream continuum of sediment supply and transport, dams can result in increased bed scour and bank erosion downstream (Kondolf and Matthews 1993). Given the large number of mainstem dams on the Connecticut River, any gravel coming in from tributaries becomes very important to the system. However, many of the tributaries in the project reach have also been dammed. Therefore, there is reason to be concerned about the effects the project dams are having on river processes and physical habitat.

Currently, the projects operate as hydro-peaking facilities as is evident from the USGS stream flow gauge at North Walpole, NH; with large water releases below the dam that increase shear stress on the river bed, substrate is mobilized that otherwise would only be moved during seasonal high flow events. Operations of the existing TransCanada hydroelectric projects likely affect channel morphology and fluvial processes including substrate mobility and particle size distribution. Project-induced changes to natural fluvial processes and channel morphology and substrate composition can have negative impacts on aquatic resources. For example, changes in sediment composition could relocate or decrease important walleye or sea lamprey spawning habitat. In a similar fashion, project-induced changes could make some habitats unsuitable for aquatic invertebrates, including the federally-endangered dwarf wedgemussel. A study is requested to investigate the impacts of project operations on fluvial processes, substrate composition and stability as it relates to aquatic benthic habitat. Results of this study will be used to develop potential license requirements to protect aquatic habitat in the project-affected areas, and may be used to inform other studies that evaluate project effects on related resources. Possible mitigation measures could include gravel augmentation, changes in flow regulation, and instream channel restoration.

An example of the water level fluctuations that occur in Connecticut River due to hydropower generation downstream of the Bellow Falls Project is shown below.



Methodology Consistent with Accepted Practice

Geomorphology studies are generally conducted during hydroelectric relicensing projects to determine channel condition, and substrate composition, and determine whether changes in project operations or sediment measures are necessary and/or whether channel restoration is necessary to improve aquatic benthic habitat.

We recommend a methodology similar to previously approved FERC studies (FERC No. 2246 and 2206). Specific study methods include, but are not limited to, utilizing a combination of historical aerial photographs, pebble counts, and HEC-RAS flow modeling to document and compare temporal changes in morphology and sediment transport dynamics in the project affected areas.

Additional study methods can be found in the FERC Project No. 2246, Yuba County Water Agencies Study Plan Determination: Study 1.1. Lemonds (2006) also conducted an empiricalbased study for the Yadkin-Pee Dee River Hydroelectric Project No. 2206.

Level of Effort/Cost

At a minimum, the study would require a combination of historical aerial photographs, pebble counts, and HEC-RAS flow modeling. Cross-section data from the gauging stations could be used to determine the mean water depth and bed elevation for each cross-section measurement. TransCanada has not proposed any studies to meet this need. Costs would be low to moderate.

Literature Cited:

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Lewis. L. 2005. Arkansas River navigation project mitigation proposal and the Arkansas River conservation initiative. United States Fish and Wildlife Service Concept Paper.

Miller, A. C. 1988. Experimental gravel bar habitat creation in the Tombigbee River Mississippi. U.S. Army Engineer Research and Development Center. Technical Note 07-4.

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Svendsen, K.M., C. E. Renshaw, F. J. Magilligan, K. H. Nislow and J. M. Kaste. 2009. Flow and sediment regimes at tributary junctions on a regulated river: impact on sediment residence time and benthic macroinvertebrate communities. Hydrological Processes. 23: 284–296.

Study Request 9: Downstream American Eel Passage Assessment at Vernon, Bellows Falls, and Wilder (FERC NOs. 1904, 1855, and 1892)

Goals and Objectives

The goal of this study is to determine the impact of three hydroelectric projects on the outmigration of silver eels in the Connecticut River. Entrainment at the conventional turbines at the Vernon, Bellows Falls, and Wilder projects can result in mortality or injury. It is important to understand the passage routes at each project and the potential for delay, injury, and mortality to assess alternative management options to increase survival.

The objectives of this study are:

1. Quantify the movement rates (including delays) and relative proportion of eels passing via various routes at the projects (i.e. through the turbines, through the downstream bypasses; spilled at the dams, etc.).
2. Evaluate instantaneous and latent mortality and injury of eels passed via each potential route.

Resource Management Goals

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)]. This study request will inform the 401 water quality certification process and help ensure that State water quality standards will be met.

The Atlantic States Marine Fisheries Commission has developed two documents related to the management of American eel:

> 1 Interstate Fishery Management Plan for American Eel. April 2000. Atlantic States Marine Fisheries Commission.
> 2 Addendum II to the Fishery Management Plan for American Eel. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

Objectives of the management plan include: (1) protect and enhance American eel abundance in all watershed where eel now occur; and (2) where practical, restore American eel to those waters where they had historical abundance but may now be absent by providing access to inland waters for glass eel, elvers, and yellow eel and adequate escapement to the ocean for pre-spawning adult eel.

Addendum II contains specific recommendations for improving upstream and downstream passage of American eel, including requesting that member states and jurisdictions seek special consideration for American eel in the FERC relicensing process.

In addition, the Connecticut River Atlantic Salmon Commission (CRASC) developed A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin in 2005. The goal of the plan is "to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem…" Management objectives in the plan include the following:

1 Protect and enhance eel populations where they currently exist;
2 Where practical, restore populations to waters where they had historical abundance;
3 Provide effective upstream and downstream fish passage around dams and other barriers within the species' range in the basin; and
4 Comply with all requirements of the Fishery Management Plan of the ASMFC.

Based on these plans, the New Hampshire Fish and Game Department (NHFGD) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1 Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2 Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to downstream passage of American eel, the NHFGD's goals are:

1 Minimize current and potential negative project operation effects that could hinder management goals and objectives.
2 Minimize project-related sources of downstream passage delay, injury, stress, and mortality in order to maximize the number of silver eels migrating to the spawning grounds.

The American eel (*Anguilla rostrata*), is also one of New Hampshire and Vermont's Species of Greatest Conservation Need (SGCN). The status for conservation need in Vermont is listed as high priority (Kart et al. 2005), and the species is listed as "vulnerable" in New Hampshire. As identified in Vermont's Wildlife Action Plan (Kart et al. 2005), threats to the species include the construction of large dams on rivers which obstruct juvenile fish access to critical rearing habitats, as well as mortality associated with passing through hydroelectric facilities' turbines during their outmigration to sea.

As outlined in Vermont's Wildlife Action Plan (Kart et al. 2005), research and monitoring needs for this SGCN include determining their distribution and abundance, as the contribution of eels in northern regions to overall stock is unknown. One of the conservation strategies for this species is to support efforts to enhance access of American eels to Vermont waters by eliminating or minimizing impacts of dams and other obstructions along the Richelieu, St. Lawrence, and Connecticut Rivers.

A mission of the NHFGD relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.
2 New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.
3 New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

This study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The requestor is a state natural resource agency.

Existing Information

The PAD contains information on the biology and life history of the American eel. It also summarizes eel collection data within the Vernon and Bellows Falls project areas. Eels have been collected both upstream and downstream of the Vernon Project and also have been counted passing the upstream anadromous fish ladder. Eels also have been documented upstream of the Bellows Falls and Wilder projects.

To date, no directed studies of eel entrainment or mortality have been conducted at any of the projects. These information gaps need to be filled so resource agencies can assess the relative and cumulative impact of project operations on outmigrating eels and develop adequate passage and protection measures to meet management goals and objectives.

We also note that within the past seven years, the United States Fish and Wildlife Service (USFWS) has received two petitions to list the American eel under the Endangered Species Act. The first petition was received on November 18, 2004. On July 6, 2005 the USFWS issued a substantial 90-day finding on the petition and initiated a 12-month status review that concluded on February 2, 2007 with a finding that listing was not warranted. The second petition was filed on April 30, 2010 by the Council for Endangered Species Act Reliability. On September 29, 2011 the USFWS issued a substantial 90-day finding and initiated a 12-month status review. It is our understanding that the USFWS is still accepting new American eel information for the ongoing status review.

Nexus to Project Operations and Effects

The Vernon, Bellows Falls, and Wilder projects operate as peaking facilities, except during periods when inflow exceeds the hydraulic capacities of the stations. Silver eels outmigrate during the mid- summer through late fall, a time of year when flows are generally within the operating capacities of the stations. Therefore, the projects would be expected to spill infrequently during the silver eel outmigration.

The project configurations present problems with respect to providing safe, timely and effective passage for outmigrating eels. The intakes likely are deep and, while no specification for the trashracks were provided in the PADs, it is unlikely that they would prevent impingement and/or entrainment of eels. Existing anadromous downstream passage facilities at the projects also would not be expected to be effective for eels; the target anadromous species are surface oriented, while eels tend to move much deeper in the water column. Eels are known to occur upstream of the dams; therefore, it is necessary to understand how eels move through the projects and the level of injury or mortality caused by entrainment through the projects' turbines.

Methodology Consistent with Accepted Practice

In order to understand the movements of outmigrating silver eels as they relate to operations at the Vernon, Bellows Falls, and Wilder projects, radio telemetry technology should be utilized. Radio telemetry is an accepted technology that has been used for a number of studies associated with hydropower projects, including at the Muddy Run Project (FERC No. 2355).

Studies should be designed to investigate route selection (i.e., entrainment vs. spill) independently from estimation of mortality/injury, because these metrics require different telemetric methodologies. Studies also will likely benefit from data collected over both study years (especially route selection studies, which may be more significantly affected by environmental conditions during a given season that mortality/injury studies). It is also envisioned that results from route selection studies can guide design of turbine mortality studies. Therefore, it is proposed, at a minimum, that route selection studies be conducted in multiple years, but mortality/injury studies may be conducted after the first year of route selection studies has been completed.

1. Objective 1: Route Selection

This study will involve systematic releases of radio-tagged silver phase eels at strategic points above areas of interest, to assess general routes of passage (i.e., via spill, bypass, or turbines). Active downstream migrants should be collected within-basin if possible (i. e., Cabot or Holyoke bypass samplers), but fish sourced from out of basin may be acceptable to meet sample size demands. Experimental fish must meet morphometric (e.g. eye diameter relative to body size) criteria to ensure they are migrant silver phase. Collections should be made within the migratory season (late Aug to mid Oct), and eels should be tagged and released within 21 days after capture, but preferably within seven days (particularly if the test eels are from out-of-basin).

All telemetered eels will be radio and passive integrated transponder (PIT) tagged. PIT antennas will be installed at bypasses at Vernon and Bellows Falls and monitored continuously to verify passage of eels via bypass channels.

Vernon Project Route Selection Study:
A minimum number of 50 telemetered eels (e.g., 5 separate groups of approximately 10 eels each) will be required to maximize the data return. Tagged eels should be released at least 5 km upstream of the Vernon project. Groups of eels should be released during spill and non-spill periods if possible. Telemetry receivers and antennas should be located to assess passage via the following potential routes: Vernon spillway; Fishway attraction water intake (if operational); Vernon downstream bypasses; and Vernon Station turbines.

Eels from the Bellows Falls route studies migrating to the Vernon Dam may be used to supplement (but not serve in lieu of) these release groups.

Bellows Falls Dam Route Selection Study:
A minimum number of 50 telemetered eels (e.g., 5 separate groups of approximately 10 eels each) will be required to maximize the data return. Groups of eels should be released during spill (if any) and non-spill and during periods of low, moderate, and high generation conditions, if possible. Tagged eels should be released at least 5 km upstream of the Bellows Falls Dam. If significant spillage occurs during releases, up to 50 additional eels should be released in the upper canal and allowed to volitionally descend through the canal to assure that sufficient number of eels are exposed to canal and powerhouse intake conditions. Telemetry receivers and antennas should be located upstream and downstream of the spillway, at the canal entrance, within the canal, in the fish downstream fish bypass entrance and turbine intakes and in mainstem below Bellows Falls Station to assess passage via the following potential routes: entrainment into the canal; passage over the spillway; into the upstream fishway attraction water intake (this should operated during the study to assess its use by eels as it may be operational in the future for riverine or eel passage as addressed in the Resident Fish Passage study request); the downstream fish bypass; and station turbines.
Eels from the Wilder route study migrating to the Bellow Falls Project may be used to supplement (but not serve in lieu of) these release groups.

Wilder Project Route Selection Study:
A minimum number of 50 telemetered eels (e.g., 5 separate groups of approximately 10 eels each) should be required to maximize the data return. Tagged eels should be released at least 5 km upstream of the Wilder Project. Groups of eels should be released during spill and non-spill periods if possible. Telemetry receivers and antennas should be located to assess passage via the following potential routes: Wilder spillway; Fishway attraction water intake (if operational); Wilder downstream bypasses; and Wilder Station turbines.

Mobile tracking (i.e., via boat) in river reaches between release sites and several km downstream of Vernon Station will be performed at regular intervals during and after releases to confirm routes and fates of passed fish, or fish lost to follow-up. Movement rates (time between release and detection at radio antenna locations, and between radio antenna locations) of eels passing the projects by various routes will also be quantified.

The route selection portion of this study should occur in both study years.

2. Objective 2: Spill, Bypass, and Turbine Mortality/Injury Studies

Spill, bypass, and turbine mortality will be assessed using a radio-telemetric balloon tag method. A minimum number of 50 tagged eels (e.g., 5 separate groups of approximately 10 eels each) will be required at each location (dam spillways, downstream bypasses, and station turbines) to maximize the data return.

For spill mortality sites (dam spillways and downstream bypasses), tagged eels will be injected or released into spill flow at points where water velocity exceeds 10 ft/sec, to minimize the possibility of eels swimming upstream into the headpond or canal. Passed balloon-tagged eels will be recovered below areas of spill and held for 48 hours in isolated tanks for observation of injury and latent mortality; unrecovered balloon-tagged eels will be censored from the data.

For turbine mortality sites (Vernon, Bellows Falls, and Wilder stations), tagged eels will be injected into intakes of units operating at or near full generation at points where intake water velocity exceeds 10 ft/sec, to minimize the possibility of eels swimming back upstream through the intakes. Passed balloon-tagged eels will be recovered in the tailrace and held for 48 hours in isolated tanks for observation of injury and latent mortality; unrecovered balloon-tagged eels will be censored from the data.

If the balloon tag mortality component of the study occurs in Study Year 1 then all possible route selection sites would need to be evaluated. If the balloon tag mortality component of the study occurs in Study Year 2, then results from the route selection study (Year 1) could be used to inform which sites need to be evaluated for mortality.. Eels recovered from balloon tag studies should not be used for route selection studies.

Data analyses of route selection and turbine mortality (instantaneous and latent) will follow standard methodology.

Project operation (flows, levels, gate openings, number of units operating and operation level) and environmental conditions (river flow, temperature, turbidity, air temperature, precipitation) will be monitored regularly (hourly measurements if possible) throughout the duration of the studies.

These methodologies are consistent with accepted practice.

Level of Effort/Cost

The level of cost and effort for the downstream eel passage study would be moderate to high;

silver eels would need to be collected, tagged, and released in several locations over the course of the migration season. Antennas and receivers would need to be installed at the intakes of all stations as well as at the dam spillways and Station bypasses, and monitored regularly. Data would need to be retrieved periodically, then analyzed. A multi-site route selection study conducted by the USGS Conte Lab on the Shetucket River in Connecticut cost approximately $75,000 for the first year of study.

The applicant did not propose any studies to meet this need in the PAD.

Literature Cited:

Brown, L.S. 2005. Characterizing the downstream passage behavior of silver phase American eels at a small hydroelectric facility. M.Sc. Thesis, Department of Natural Resource Conservation, University of Massachusetts, Amherst, Massachusetts. 110 pp.

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NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Study Request 10: In-stream Flow Habitat Assessment Downstream of Wilder, Bellows Falls, and Vernon Dams (FERC NOs. 1892, 1855, 1904)

Goals and Objectives

The goal of this study is to determine an appropriate flow regime that will protect and enhance the aquatic resources below the Wilder, Bellows Falls, and Vernon projects. Specifically, the objective of this study is to conduct an instream flow habitat study to assess the impacts of the range of proposed project discharges on the wetted area and optimal habitat for key species. The study should include non-steady flow approaches to assess effects of within-day flow fluctuations due to peaking power operations on target fish species and benthic invertebrate communities. Target species will include but are not limited to: American shad, fallfish, white sucker, yellow perch, smallmouth bass, walleye, and dwarf wedge mussel.

Resource Management Goals

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)]. This study request will inform the 401 water quality certification process and help ensure that State water quality standards will be met.

The New Hampshire Fish and Game Department (NHFGD) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

- Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
- Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to aquatic resources, the NHFGD's goals are:

- Protect, enhance, or restore diverse high quality aquatic and riparian habitats for plants,animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
- Provide an instream flow regime that meets the life history requirements of resident and migratory fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.

A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.
2 New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.
3 New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

This study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The requestor is a state natural resource agency.

Existing Information

The distance from the upstream end of the Wilder impoundment downstream to the Vernon dam is 120 miles. A total of 97 miles (81%) of this segment is impounded. The remaining riverine habitat is within the 17 miles downstream of Wilder dam and the 6 miles downstream of Bellows Falls. At the scoping meetings, FirstLight also indicated that their project assessment may provide evidence that the upstream extent of the Turners Falls impoundment may not reach all the way to Vernon Dam. This would suggest that there may be additional riverine habitat for a presently unknown distance below the Vernon project.

The Wilder, Bellows Falls, and Vernon projects are each operated as daily peaking facilities. Total hydraulic capacity of each facility is 12,700, 11,010, and 12,634 cfs, respectively. Each of the PADs for these projects indicate that "Generation can vary during the course of any day between the required minimum flow and full capacity if higher flows are available" (p. 2-28, p. 2-29, and p. 2-30 in the Wilder, Bellows Falls and Vernon PADs, respectively). Regular daily fluctuations on the order of 9,000 cfs or greater are commonly recorded at USGS gages 01144500 (Connecticut River at West Lebanon, below Wilder Dam) and 01154500 (Connecticut River at North Walpole, NH, below Bellows Falls Dam). Required minimum flows are 675, 1,083, and 1,250 cfs (or inflows if less) for each facility, respectively, though in practice minimum flows are operated as 700, 1300, and 1600 cfs, respectively. The PADs for these projects do not indicate how these minimum flow requirements were established or what specific ecological resources they are intended to benefit. We are not aware of any previously conducted studies that have evaluated the adequacy of this minimum flow in protecting aquatic resources in the 23+ miles of riverine habitat below these projects, nor project effects of daily hydropeaking on riverine habitat. Therefore, in order to fill this important information gap, an empirical study is needed to provide information on the relationship between flow and habitat in the Connecticut River downstream of the Wilder, Bellows Falls, and Vernon projects. Results will be used to determine an appropriate flow recommendation.

Nexus to Project Operations and Effects

The Wilder, Bellows Falls, and Vernon projects are currently operated with a minimum flow release that was not based on biological criteria or field study. Further, the projects generate power in a peaking mode resulting in substantial within-day flow fluctuations between the minimum and project capacity. The large and rapid changes in flow releases from peaking hydropower dams are known to cause adverse effects on downstream habitat and biota (Cushman 1985, Blinn et al. 1995, Freeman et al. 2001). There are at least 23 miles of lotic (flowing) habitat below the project's discharge that are impacted by peaking operations from these projects. This section of the Connecticut River contains habitat that supports native riverine species, including the federally endangered dwarf wedge mussel, and could include spawning and rearing habitat for migratory fish such as American shad. While the existing licenses of the Wilder, Bellows Falls, and Vernon projects do require a continuous minimum flow of 675, 1,083, and 1,250 cfs, respectively, we do not believe this flow sufficiently protects the aquatic resources, including endangered species, of these river reaches, especially in the context of the magnitude, frequency, and duration of changes in habitat that likely occur due to hydropeaking operations.

Results of the flow study will be used to determine an appropriate flow recommendation that will protect and/or enhance the aquatic resources below the Project.

Methodology Consistent with Accepted Practice

In-stream flow habitat assessments are commonly employed in developing operational flow regimes that will reduce the impacts or enhance habitat conditions downstream of hydroelectric projects.

We request that a flow study be conducted in the following areas: in the approximately 17 miles between the Wilder Dam and the headwaters of the Bellows Falls pool, in the approximately 6 miles between the Bellows Falls Dam and the headwaters of the Vernon pool, and in the approximately 1.5 miles between Vernon Dam and the downstream end of Stebbins Island (or the upstream extent of the Turners Pool as determined by FirstLight, whichever river length is greater).

Given the length of river reach (23+ miles) impacted by project operations, we believe a study methodology that utilizes an IFIM approach is appropriate for this context. Similar protocols have been used and accepted by FERC in numerous other licensing proceedings.
The study design should involve collecting wetted perimeter, depth, velocity, and substrate data along transects in the deep, straight-channel areas of the specified river reaches mentioned above. Two-dimensional hydraulic modeling should be conducted in the sections of river with more complex features such as islands, braiding, falls, and shallow-water shoals. The

measurements should be taken over a range of flows sufficient to model the full extent of the operational flow regime. This information should then be synthesized to quantify habitat suitability (using mutually agreed-upon habitat suitability index (HSI) curves) over a range of flows for target species identified by the fisheries agencies. Data should be collected in such a way that allows a dual-flow analysis and habitat time series or similar approaches that will permit assessment of how quality and location of habitat for target species changes over the range of flows that occur as part of the operational flow regime. Dataloggers should be deployed in each reach during the study to continuously measure dissolved oxygen and temperature for comparison to State water quality standards.

Level of Effort/Cost

Field work for instream flow studies can be reasonably extensive but will depend on consultation with the applicant on study methodology and on-site decisions on locations for data collection and the number of collection locations. Use of laser measurements, GPS, and/or an Acoustic Doppler Current Profiler (ADCP, if available) can improve efficiency and accuracy of field measurements. Post-fieldwork data analysis would be a moderate cost and effort. We anticipate that the level of effort and costs will be comparable to that of other FERC relicensing projects of similar size to these projects.

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Study Request 11: Impacts of Water Fluctuations Downstream of the Vernon, Bellows Falls and Wilder Projects on Resident Fish Spawning (FERC NOs. 1904, 1855, 1892)

Goals and Objectives

The goal of this study is to determine if the full range of project induced flow and water level fluctuations in the project-affected areas below the Vernon, Bellows Falls and Wilder Dams negatively impact resident fish spawning (smallmouth bass, common white sucker, walleye and fallfish), and if impacts are found to occur, to develop appropriate mitigation measures.

Specific objectives include:

1) Conduct field studies in the project-affected areas downstream from the Vernon, Bellows Falls and Wilder Dams to assess timing and location of fish spawning. Nesting locations should be mapped.

2) Conduct field studies in the Project affected areas below the Vernon, Bellows Falls and Wilder Dams to evaluate potential impacts of the full range of project induced water level fluctuations on nest abandonment, spawning fish displacement and egg dewatering. The study should also evaluate if changes in fluctuation range would mitigate for identified impacts and/or if other mitigative measures would lessen these impacts.

Resource Management Goals

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)]. This study request will inform the 401 water quality certification process and help ensure that State water quality standards will be met.

A mission of both the New Hampshire Fish and Game Department (NHFGD) and the Vermont Fish and Wildlife Department is to protect and conserve fish and their habitats. Resident fish species are an important component of the river's ecology and in some cases are the basis for a sport fishery. This requested study will help protect and conserve resident fish species by ensuring Project operations do not negatively impact their spawning success.

A mission of the NHFGD relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.
2 New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.
3 New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

This study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The requestor is a state natural resource agency.

Existing Information

To our knowledge, no information exists related to this requested study.

Nexus to Project Operations and Effects

Project operations have the potential to impact fish species by influencing spawning success and spawning habitat quality and quantity. For example, flow and water level changes due to Project operations could create conditions where fish eggs are exposed to air, where quality spawning habitat is dewatered, and/or where fish abandon nests containing eggs. A study of a regulated river found temporal fluctuations of streamflow appeared to be the most important abiotic factor determining smallmouth bass nesting success or failure (Lukas and Orth 1995). Similarly, other research suggests stream discharge during and immediately after spawning could be important to smallmouth bass recruitment success (Smith et al. 2005). Current can also impact early survival of walleye by moving eggs and larvae from spawning sites (Humphrey et al. 2012).

Methodology Consistent with Accepted Practice

Common tools to evaluate fish spawning would be used including electrofishing, visual observations, and telemetry. Specific areas of interest are locations in project-affected areas below the Vernon, Bellows Falls and Wilder Dams where it is determined that the before mentioned fish species spawn. A second year of study may be required if first year data collection is limited due to environmental or other conditions, or if river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period.

Level of Effort/Cost

TransCanada does not propose any studies to meet this need. Estimated cost for the study is moderate.

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Study Request 12: Effects of the Wilder and Bellows Falls Projects on the Dwarf Wedgemussel (*Alasmidonta heterodon*) (FERC NOs. 1892 and 1855)

Goals and Objectives

It has been well documented that the damming of rivers can have detrimental impacts on the mussel communities that inhabit areas both upstream and downstream of dams (Watters 1999, Layzer et. al. 1993, Moog 1993). The goal of this study is to evaluate the effects that the Wilder and Bellows Falls hydroelectric projects have on populations of the federally-endangered dwarf wedgemussel (*Alasmidonta heterodon*). In addition, the results of the study can be used to develop measures to minimize adverse impacts to the dwarf wedgemussel in the future. The specific objectives of the study are as follows:

Objective 1: Conduct an initial survey of the free flowing stretch of the Connecticut River from the Wilder Dam to the upstream end of the Bellows Falls impoundment to determine the distribution of the dwarf wedgemussel in this reach.

Objective 2: Determine the best sites for intensive quantitative sampling of mussel communities, with emphasis on the dwarf wedgemussel. Data will be collected to estimate density (mussels per unit area) and age class structure for all species.

Objective 3: Lay the groundwork for a long-term monitoring program.

Objective 4: Document instream behavior of mussels during varying flow conditions.

Objective 5: Determine how availability and persistence of dwarf wedgemussel habitat changes with water level and flow fluctuations.

Relevant Resource Management Goals

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)]. This study request will inform the 401 water quality certification process and help ensure that State water quality standards will be met.

It is the goal of the U. S. Fish and Wildlife Service (USFWS) to recover the dwarf wedgemussel so that it can be removed from the Endangered Species list in the future. According to the Recovery Plan (USFWS 1993), the Connecticut River dwarf wedgemussel population is one that must be demonstrated to be viable in order before the species can be downlisted to threatened. The Upper Connecticut metapopulation is likely the largest remaining population in the world (USFWS 2007), and so its protection is essential to the recovery of the species as a whole.

A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.
2 New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.
3 New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

This study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The requestor is a state natural resource agency.

Existing Information

In 2011, Biodrawversity, LLC conducted a freshwater mussel survey throughout the Vernon, Bellows Falls, and Wilder project areas (Biodrawversity and LBG 2012). This survey was semi-quantitative (i.e. timed searches were used) and the main goal was to assess the distribution, abundance, demographics, and habitat of the dwarf wedgemussel in the project areas. Dwarf wedgemussel were found in the Wilder impoundment (all within a 14-mile stretch of the river beginning 27 miles upstream of the Wilder Dam) and Bellows Falls impoundment (located sporadically in the upper 17 miles of the impoundment); none were found in the Vernon project-affected area. These results corroborate the results of other studies performed in the past in these areas (Nedeau 2006a, Nedeau 2006b).

Need for additional information

The 2011 survey did not include the 17-mile free flowing stretch of the Connecticut River downstream of Wilder Dam. The dwarf wedgemussel has, in the past, been found within this river reach, although overall there has been limited survey work in the area. A better understanding of the distribution and abundance of the dwarf wedgemussel in this stretch of the river is required before an evaluation of how the dam affects this species can be made. **This need is represented in Objective 1**.

Since the 2011 survey was semi-quantitative, it cannot be used as a basis for determining population estimates or trends (Wicklow 2005). In fact, few if any of the past surveys performed in the project-affected areas have employed quantitative methodology. In addition, there is little quantitative information regarding the age class structure, and therefore recruitment, of the mussel communities in the area. In order to demonstrate that a dwarf wedgemussel population is viable according to the Dwarf Wedgemussel Recovery Plan (USFWS 1993), it must have a large and dense enough population to maintain genetic variability and annual recruitment must be adequate to maintain a stable population. Thus, knowledge of population size and density as well as a better understanding of age class structure is a necessary step in determining the baseline status of dwarf wedgemussel populations. The 2011 survey and other surveys can be used to determine the best sites for implementing a monitoring program. **This need is represented in Objective 2**.

Once this baseline is established, it will be important to monitor the sites so that biologists can estimate and track changes to dwarf wedgemussel populations and/or evaluate any project-related population impacts. Therefore, there is a need to develop long-term monitoring plots that will be surveyed at regular intervals using methodology that is repeatable and yields quantitative, statistically valid results. **This need is represented in Objective 3**.

Flow conditions that result from dam operations may alter the behavior of individual dwarf wedgemussels or individuals of other species. Dam operations affect streamflow, temperature, and dissolved oxygen, and changes to these variables can often be rapid. It is not known how these rapid changes affect various aspects of a mussel's biology, including lure display, shell position (open/closed), siphoning rate, and vertical migration. **This need is represented in Objective 4**.

Dam operations can also affect the availability of habitat for mussels, and this availability can change quickly as water levels fluctuate under peaking operations. The persistence of habitat is a key element to the long-term success of sedentary lotic organisms such as the dwarf wedgemussel (Maloney et. al. 2012), which is unable to quickly move in response to rapid changes in its environment and can thus become stranded in areas of unsuitable habitat; however, there is currently no information concerning the relation of project operations to habitat persistence within the Wilder and Bellows project-affected areas. **This need is represented in Objective 5**.

Project Nexus

The dwarf wedgemussel is known to occur within the Wilder and Bellows Falls project areas and operations of these two dams may affect the viability of this species in the Connecticut River. This study plan will allow for a better understanding of how sub-daily flow and water level fluctuations influence dwarf wedgemussel abundance, available habitat, and behavior. This information can be used to inform the development of license requirements that can ensure the continued existence of this species within the project-affected areas.

Additionally, a long-term monitoring program of important dwarf wedgemussel sites within the project areas is necessary to evaluate any project-related population and/or behavioral impacts that may occur. This information can be used to inform decision makers in the future.

Proposed Methodology

A survey of the 17-mile reach between the Bellows Falls impoundment and the Wilder Dam is the logical first step of the study plan, and this can be done in well less than one field season. This may be treated as an extension of the Biodrawversity and LBG (2012) survey and the same semi-quantitative methodology may be used. Once completed, this survey will help fill in the knowledge gap that exists in the distribution of the dwarf wedgemussel within this reach of the Connecticut River. **This proposed methodology corresponds to Objective 1**.

Next, quantitative study plots should be established at sites throughout the two project affected areas that are known to support the dwarf wedgemussel. Plots should be set up and surveyed using methodology that will allow for the estimation of population density and size. Smith et. al. (2001) have developed such a methodology, which is also outlined in Strayer and Smith (2003). It is based on a double-sampling design (visual inspection of the substrate surface plus excavation of a random subset of quadrats) using 0.25 m2 quadrats that are placed systematically with multiple random starts. This protocol has been used to monitor dwarf wedgemussel populations at two sites on the Ashuelot River in Keene, NH (Nedeau 2004). A number of other recent studies have also made use of this protocol for different species of mussels (Fulton et. al. 2010, Crabtree & Smith 2009, Bradburn 2009).

Data to determine age class structure should also be collected at these selected sites. This would involve measuring the length and estimating the age (through external annuli counts) of each mussel sampled within a quadrat. Based on this information, an analysis of recruitment can be made. This field work and analysis was performed on the mussel community inhabiting the lower Osage River in Missouri as part of the relicensing process of the Osage Hydroelectric Project (FERC no. 459) (ESI 2003). The work done on the Osage can be used as a template for this study. Depending on how many plots are chosen, this phase of the study could take one or two field seasons. **This proposed methodology corresponds to Objective 2**.

The sites surveyed to meet Objective 2 should be resurveyed using the same methodology at regular intervals in the future so that any changes over time and/or over varied flow regimes can be evaluated. In addition, a mark-recapture pilot study should be initiated to evaluate the potential for using this methodology for long-term monitoring of dwarf wedgemussel abundance and survival. Mark-recapture methods provide statistically robust estimates of population parameters that are superior to simple count estimates in cases where it is not practicable to count all individuals in a population. Methods should be similar to those in Peterson et al. (2011), Meador et al. (2011), and Villella et al. (2004), but should focus on differences among sampled sites. Sites should be selected based on those sampled to meet Objective 2, but should also include sites outside of the project area to fully evaluate project effect and to account for any natural variability that may be independent of project effect.

A long-term mussel monitoring program was devised as part of the study plan for the relicensing of the Lake Blackshear Hydroelectric Project (FERC no. 659) on the Flint River in Georgia. According to the monitoring plan (Lake Blackshear Project 2009), three surveys will be conducted five years apart, beginning five years after issuance of the FERC license. Surveys will be quantitative (there is a qualitative aspect to the Lake Blackshear mussel monitoring plan that can be ignored) and will focus on evaluating changes in recruitment and population size of the purple bankclimber (*Elliptoideus sloatianus*), a federally-listed species. A similar protocol should be used to monitor dwarf wedgemussel populations in the project-affected areas of the Connecticut River post-license, although the number of surveys and the time between surveys may require some research and discussion. **This proposed methodology corresponds to Objective 3**.

In order to investigate the effects that the hydropower projects have on mussel behavior, individual mussels should be observed as flow fluctuates as a result of dam operations. Researchers should measure changes in shell position (open/closed), siphoning rate, lure display, horizontal migration (movement across the substrate), and vertical migration (burrowing). Past studies have quantified changes in vertical migration due to flow fluctuations (Saha & Layzer 2008, DiMaio & Corkum 1997). This phase of the study will likely take two field seasons in order to maximize the number of behavioral observations so that any trends can be identified and evaluated. **This proposed methodology corresponds to Objective 4**.

At these same sites, an evaluation of flow fluctuations on dwarf wedgemussel habitat persistence should be conducted following methods similar to those of Maloney et. al. (2012). This will include the development of a two-dimensional hydrodynamic model based on modeled depth, velocity, Froude number, shear velocity, and shear stress. This model will be used to quantify suitable dwarf wedgemussel habitat and its persistence over a range of flows, including flows typically experienced under peaking operations. These methods are being employed to evaluate persistence of dwarf wedgemussel habitat on the Delaware (Maloney et. al. 2012) and Susquehanna (T. Moburg, The Nature Conservancy, personal communication) rivers. Depending on how many plots are chosen, this phase of the study could take one or two field seasons. **This proposed methodology corresponds to Objective 5**.

Level of Effort and Cost

The cost for collecting the data for this study is entirely dependent on the number of study sites selected, as well as how frequently surveys will be conducted as part of the long-term monitoring plan. The expected level of effort and anticipated costs will be comparable to that of similar FERC relicensing projects of this size.

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Study Request 13: Determine the Fish Assemblage in Vernon, Bellows Falls and Wilder Project-Affected Areas (FERC NOs 1904, 1855, 1892)

Goals and Objectives

The goal of this study request is to determine the occurrence, distribution, and relative abundance of fish species present in the project-affected areas of the Vernon, Bellows Falls and Wilder Projects, which potentially includes Species of Greatest Conservation Need (SGCN) for both New Hampshire and Vermont.

Specific objectives include:

> 1) Document fish species occurrence, distribution and abundance within the project-affected areas along spatial and temporal gradients.
>
> 2) Compare historical records of fish species occurrence in the project-affected areas to results of this study.

Resource Management Goals

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)]. This study request will inform the 401 water quality certification process and help ensure that State water quality standards will be met.

A mission of both the New Hampshire Fish and Game Department (NHFGD) and the Vermont ish and Wildlife Department is to protect and conserve fish and their habitats. Riverine fish species are an important component of the river's ecology and are the basis for the sport fishery. Furthermore, several of the states' SGCN have been documented in the project-affected area.

Determining species occurrence, distribution and abundance will help address research and monitoring needs for species whose populations are poorly known. For example, as outlined in Vermont's Wildlife Action Plan (Kart et al.2005), research and monitoring needs for SGCN include monitoring and assessing populations and habitats for current conditions and future changes, and identifying and monitoring problems for species and their habitats.

A study that aims to provide a comprehensive investigation that documents which fish species are utilizing the project-affected areas in relation to spatial, temporal and environmental gradients (i.e. temperature, dissolved oxygen, pH, turbidity) will allow for a fuller understanding and examination of potential impacts that the Vernon, Bellows Falls and Wilder Project's operations have on the species that reside there. As noted below, there is little information concerning riverine fish in the project-affected areas as related to this study request.

A mission of the NHFGD relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.
2 New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.
3 New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

This study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The requestor is a state natural resource agency.

Existing Information

A thorough and comprehensive assessment of the fish assemblage present in the project-affected areas of the Bellows Falls and Wilder Projects is lacking. The PAD for the Bellows Falls Project acknowledges that, "Little comprehensive information is available regarding characterization of the fish community in relation to the Project." The PAD for the Wilder Project states, "No targeted studies have been conducted to characterize the fish community in relation to the Project."

The most relevant fish study related to the Bellows Falls and Wilder project-affected areas is a Connecticut River electrofishing survey conducted in 2008 (Yoder et al., 2009). While some sampling was conducted in both project-affected areas during the 2008 survey, this survey did not have the same goals and objectives as those outlined above. Additionally, both the Bellows Falls and Wilder PADs acknowledged that fish species assemblage data are limited and that the synthesized data may not be a full representation of species occurrence in the project-affected areas. Although, fish data has been collected by Vermont Yankee for many years in the Vernon Dam project-affected area, objectives and methodology for those fish surveys differ from those stated here, and gear types were generally limited to boat electrofishing which may not be suitable for properly assessing all species present in the project-affected areas. It is unknown if other species may inhabit or utilize aquatic habitats in the projects area that to this date have not been documented by previous surveys. It follows that without more information on the fish community in the project-affected areas, project impacts on fish species are also unknown.

Nexus to Project Operations and Effects

Project operations have the potential to directly impact fish species life history requirements, biological interactions, and habitat quantity and quality. For example, headpond and tailwater water level fluctuations could dewater important spawning areas or change available habitat, thus limiting productivity of important game fish species by direct impacts to their spawning success or indirectly by limiting the spawning success of forage fish species. Furthermore, several of New Hampshire and Vermont's SGCN have been documented in the project-affected area. Accordingly, a thorough understanding of the current fish assemblage structure and associated metrics are needed in order to examine any potential project-related impacts.

It should be noted that the NHFGD does periodically conduct fish surveys on the Connecticut River in the vicinity of these projects. However, past surveys were not spatially wide spread enough nor conducted in a short enough time frame to meet the goals and objectives of this study request.

Methodology Consistent with Accepted Practice

An accepted and robust field sampling design (e.g., as described in Pollock et al. 2002 or MacKenzie et al. 2006) and accepted methods for collecting fish species likely to be present in the project-affected areas (Bonar et al. 2009) should be used to conduct field surveys. Randomly sampling multiple habitat types using a multi-gear approach will be required to ensure that all fish species present are sampled. The spatial scope of the study will be from the most upstream area influenced by the Wilder Dam to the most downstream area influenced by the Vernon Project. Sampling should occur at each selected site across multiple seasons (spring, summer, and fall). Digital photographs should be taken to avoid misidentifying certain species such as Cyprinids.

The sampling design should include replicate samples for estimation of species detection probability. Sample replicates may be gathered temporally, using different methods, by independent observers, or by randomly sampled spatial replicates (MacKenzie et al. 2006). For each replicate sample, data that may be important for describing variation in species occurrence and presence/absence should be collected and recorded, such as gear type, mesohabitat type, depth, velocity, flow, water temperature, substrate, time of day, day of year, presence of cover, proportion of vegetation cover, size of individuals collected (juveniles may select different habitat), and other factors as determined by a qualified biologist. Species detection, occurrence, and/or abundance as related to these parameters should be estimated using methods as described by Kery et al. (2005) , MacKenzie et al. (2006), Wenger and Freeman (2008), or Zipkin et al. (2010).

Based on first year study results, specific studies examining impacts of project operations on specific fish species may be requested. A second year of study may be required if first year data collection is limited due to environmental or other conditions, or if river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period.

Level of Effort/Cost

The cost of the study will be moderate to high as seasonal sampling with several types of gear will be required. However, cost will also be partially dependent on the number of sites sampled, the number of sample replicates, and the extent of the covariate data that are measured. Provided the collected data are of high quality, analysis and synthesis should take approximately 10-20 days. TransCanada did not propose any studies specifically addressing this issue

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Study Request 14a: Model River Flows and Water Levels Upstream and Downstream from the Wilder, Bellows Falls, Vernon, Turners Falls and Northfield Mountain Pump Storage Stations and Integration of Project Modeling with Downstream Project Operations (FERC NOs. 1904, 1855, 1892, 1889, and 2485).

Goals and Objectives

The goal of this study is to develop river flow models that permit the evaluation of the hydrologic changes to the river caused by the physical presence and operation of the Wilder, Bellows Falls, Vernon, Northfield Mountain and Turners Falls Hydroelectric Projects and the interrelationships between the operation of all five hydroelectric projects up for relicensing and river inflows. Specific objectives of this study include:

1. Conduct quantitative hydrologic modeling of the hydrologic influences and interactions that exist between the water surface elevations of the Wilder, Bellows Falls, and Vernon project impoundments and discharges from the Wilder, Bellows Falls, and Vernon projects and the downstream hydroelectric projects including:
    a. Inflows into the Wilder, Bellows Falls, and Vernon impoundments from the Fifteen Mile Falls Project, FERC No. 2007, and other sources;
    b. Existing and potential discharges from the Wilder, Bellows Falls, and Vernon project generating facilities and spill flows, including existing and potential minimum flow and other operational requirements;
    c. Existing and potential water level fluctuation restrictions (maximum and minimum pond levels) of the Wilder, Bellows Falls, and Vernon impoundments, and consequent changes in downstream project discharges; and
    d. Incorporation of the potential effects of climate-altered flows on project operations over the course of the license.
    e. Comparison of hourly discharge and water surface elevations at various locations at current and proposed operating conditions to model results assuming instantaneous run-of-river at the Projects.
2. Assess how existing and potential operations of the Wilder, Bellows Falls, Vernon, Northfield Mountain and Turners Falls Projects impact one another including:
    a. How Wilder, Bellows Falls, and Vernon flow fluctuations affect pool levels of the Turners Falls impoundment; and
    b. How operations of the Wilder, Bellows Falls, and Vernon projects affect Turners Falls discharges.
    c. How operations at the Turners Falls and Northfield Mountain projects impact flow and water elevations in the Turners Falls impoundment.
    d. Comparison of hourly discharge and water surface elevations at various locations in the Turners Falls impoundment (approximately 5.7 miles of this impoundment is in New Hampshire) at current and proposed operating conditions to model results assuming instantaneous run-of-river at the Projects.

Resource Management Goals

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)].

Regarding flow, Env-Wq 1703.01(d) states that “unless the flows are caused by naturally occurring conditions, surface water quantity shall be maintained at levels adequate to protect existing and designated uses.”

Regarding Biological and Aquatic Community Integrity, Env-Wq 1703.01 states the following:

(c) The surface waters shall support and maintain a balanced, integrated, and adaptive community of organisms have a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region.

(d) Differences from naturally occurring conditions shall be limited to non-detrimental differences in community structure and function.

This study request will inform the 401 water quality certification process and help ensure that State water quality standards will be met. The Turners Falls and Northfield Mountain Pump Storage Projects are included in this request since their operation impacts the Turners Falls impoundment which extends approximately 5.7 miles into New Hampshire.

This study request is also intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures consistent with the Department’s 2010-2015 Strategic Plan that was released in the fall of 2010. The Plan includes two goals and several sub-goals that relate to climate change and shifting environmental conditions in the future. Those goals and sub-goals are as follows:

N.H. Department of Environmental Services Strategic Plan (2010 - 2015)

Goal 1: DES and its partners address climate change through effective mitigation and adaptation strategies and efforts to foster the transition to a clean energy economy.

1.1 DES will work in partnership with other state agencies to institutionalize climate change mitigation and adaptation throughout state operations

1.1.1 DES will consider and integrate climate change mitigation and adaptation across all existing DES program areas. (Target: Commence in 2010, and Ongoing)

1.2 DES will work in partnership with state, regional, and national organizations to integrate and coordinate mitigation and adaptation efforts.

1.2.2 DES will continue to take part in regional and national initiatives to advance the transition to a clean energy economy. (Target: Commence by 2010, and Ongoing)

1.2.3 DES will continue to participate in regional and national initiatives to better prepare for the impacts of climate change. (Target: Commence by 2010, and Ongoing)

1.3 DES will monitor, inventory and report climate change emissions and impacts.

1.3.2 DES will work with state research universities and other institutions and organizations to track the indicators and the impacts of climate change, and to support periodic reporting to policymakers and the public. (Target: Commence in 2010, and Ongoing)

1.4 DES will conduct comprehensive mitigation and adaptation education and outreach.

1.4.3 DES will collaborate with partners to support the provision of resources for technical assistance to communities and organizations that are seeking to incorporate adaptation measures into their projects and plans. (Target: Commence in 2010, and Ongoing)

Goal 2: DES and its partners effectively protect New Hampshire's natural resources and high quality of life as the state grows.

2.1 DES and its partners will strive for efficient land use and development patterns that reduce energy use, support sustainable use and conservation of natural resources, and maintain a viable working landscape.

2.1.4 DES will evaluate the effect of all DES Programs on land use and land development patterns (beginning with the DES Brownfields, Drinking Water, and Wastewater Programs), and modify policies and procedures to encourage efficient use of land and other best development practices. (Target: Commence by 2011, and Ongoing)

2.1.5 DES, in partnership with other organizations, will improve the integration of transportation, environmental, and land-use planning. (Target: Commence in 2011, and Ongoing)

2.2 DES and its partners will work to maintain natural resource functions and promote sustainable use of natural resources.

2.2.1 DES, with its partners, will explore appropriate mechanisms, including market-based approaches, to encourage natural resource conservation, ensure sustainable use of natural resources, promote the use of less impacting alternatives, and reduce the incremental conversion of farm and forest land to developed uses. (Target: Commence in 2011, and Ongoing)

The New Hampshire Fish and Game Department (NHFGD) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the projects. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to aquatic resources, the NHFGD’s goals are:

1. Protect, enhance, or restore, diverse high quality aquatic and riparian habitats for plants,

animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
2. Provide an instream flow regime that meets the life history requirements of diadromous fish and resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
3. Minimize current and potential negative project operation effects on water quality and aquatic habitat.

A mission of the NHFGD relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.
2 New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.
3 New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

This study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The requestor is a state natural resource agency.

Existing Information

Available information in the PAD does not indicate how project operations have altered the hydrology downstream from each of these facilities, which may affect resident and migratory fish, macroinvertebrates, rare, threatened and endangered species, aquatic plants and other biota and natural processes in the Connecticut River. It is also unclear how operations at one facility affect the operations at another and how operations compare to instantaneous run-of-river conditions.

Nexus to Project Operations and Effects

The Wilder, Bellows Falls, and Vernon projects are each currently operated with required minimum flows of 675, 1,083, and 1,250 cfs (or inflows if less) for each facility, respectively, though in practice minimum flows are operated as 700, 1300, and 1600 cfs, respectively. There is presently no required minimum flow for the bypassed reach of the Bellows Falls Project. Each of the projects operates as a daily peaking facility, such that "Generation can vary during the course of any day between the required minimum flow and full capacity if higher flows are available" (p. 2-28, p. 2-29, and p. 2-30 in the Wilder, Bellows Falls and Vernon PADs, respectively). Total hydraulic capacity of each facility is 12,700, 11,010, and 12,634 cfs, respectively. Regular daily fluctuations on the order of 9,000 cfs or greater are commonly recorded at USGS gages 01144500 (Connecticut River at West Lebanon, below Wilder Dam) and 01154500 (Connecticut River at North Walpole, NH, below Bellows Falls Dam). Daily fluctuations in headpond elevation are approximately 2.5' (382' to 384.5' MSL), 1.2' (289.9' to 291.1' MSL), and 1.2' (218.6' to 219.8' MSL) at the Wilder, Bellows Falls, and Vernon impoundments, respectively.

These described changes affect biotic habitat and biota upstream and downstream of each project. Project operations and potential changes to operations to mitigate impacts at each facility are influenced by inflows and operations of upstream projects. Results of river flow analyses will provide necessary information regarding changes that can be made to the Wilder, Bellows Falls, and Vernon Project flow releases and/or water level restrictions, how such changes may be constrained by inflows and upstream project operations, and how these changes potentially affect downstream resources. This information will then be used to develop flow-related license requirements and/or other mitigation measures.

The Turners Falls Project is currently operated with a seasonally-varying minimum bypass flow (400 cfs from 5/1 through 7/15, then 120 cfs through the winter until river temperature rises to ≥ 7°C) and year-round minimum flow below the projects of 1,433 cfs. The project operates as a daily peaking project, often with large, rapid, daily flow fluctuations between the minimum and project capacity (15,928 cfs) and fluctuations in headpond elevation (175' to 186' MSL). These changes affect biotic habitat and biota upstream and downstream of the project. Project operations and potential changes to operations to mitigate impacts are influenced by inflows and operations of upstream peaking projects and the Northfield Mountain Pumped Storage Project operations and potential changes in operations of each project could affect the ability to achieve desired operational changes at other projects.

Results of river flow analyses will then be used to develop flow-related license requirements and/or other mitigation measures that are consistent with State water quality standards.

Methodology Consistent with Accepted Practice

River hydrology statistics and hourly flow modeling are commonly employed at hydroelectric projects to assess implications of project operations on the river environment.

Level of Effort/Cost

Level of effort and cost of model development are expected to be moderate as much of the baseline modeling has already been completed, but running of various scenarios through the model(s) will be needed throughout the relicensing process to assess the implications of changes to the operations of each project on other projects and other resources. The modeling exercise will also require coordination and cooperation between TransCanada and First Light to assure that the model inputs and outputs can be accurately related.

We would anticipate that the expected level of effort and anticipated costs will be comparable to that experienced on similar FERC relicensing projects of this size (e.g., Conowingo, FERC No. 405).

Literature Cited:

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Study Request 15a: Impacts of Water Level Fluctuations on Riparian and Aquatic Vegetation, Including Invasive Species, in the Vernon, Bellows Falls and Wilder Project Impoundments and Riverine Reaches (FERC NOs. 1904, 1855, and 1892)

Goals and Objectives

The goal of this study is to determine if the full range of water level fluctuations from the Vernon, Bellows Falls and Wilder Hydroelectric Projects negatively impact emergent aquatic vegetation (EAV) and submerged aquatic vegetation (SAV) and their habitats in the impoundments and riverine reaches below the dams.

The objective is to conduct field studies in mainstem littoral zones, tributaries and backwaters to determine if EAV and SAV species distribution and abundance, and their habitats, are impacted by current water level fluctuations permitted under the TransCanada Projects' licenses and whether aquatic vegetation and its habitats can be enhanced by modifications to project operations or other mitigation measures and whether there is any unique or important shoreline or aquatic habitats that should be protected. Results of this study may also be used to help determine the adequacy of existing downstream minimum flow requirements.

The specific objectives of the field study, at a minimum, include:

The specific objectives of the field study, at a minimum, include:

- Quantitatively describe and map wetland types within 200 feet of the shoreline, and describe associated wildlife;
- Delineate, quantitatively describe, and map all wetland types including invasive species and wildlife observed (e.g., bald eagle nesting, water fowl nesting) within 200 feet of the shoreline, and the extent of this habitat if it extends beyond 200 feet; and
- Quantitatively describe (e.g., substrate composition, vegetation type and abundance) and map shallow water aquatic habitat types subject to project operation inundation and exposure, noting and describing additional areas where water depths at lowest operational range are wetted to a depth less than one foot (flats, near shore areas, gravel bars, with very slight bathymetric change);

A second year of study may be required should river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period.

The field study should produce a habitat inventory report that includes:

- The results of the field study in the form of maps and descriptions;
- An assessment of project effects on wetland, riparian, littoral zone vegetation and shallow water habitats, invasive plant species, and wildlife habitat at the project; and
- Recommendations for any necessary plant, habitat type, or wildlife, protection and/or invasive species control measures.

Resource Management Goals

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)].

Regarding Biological and Aquatic Community Integrity, Env-Wq 1703.01 states the following:

(e) The surface waters shall support and maintain a balanced, integrated, and adaptive community of organisms have a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region.

(f) Differences from naturally occurring conditions shall be limited to non-detrimental differences in community structure and function.

Aquatic vegetation, such as EAV and SAV, is an important component of the ecology of the Connecticut River. Aquatic vegetation in the areas affected by the project should be studied to demonstrate compliance with Env-Wq 1703.19. This study request will inform the 401 water quality certification process and help ensure that State water quality standards will be met.

A mission of both the New Hampshire Fish and Game Department (NHFGD) and the Vermont Fish and Wildlife Department is to protect and conserve fish and their habitats. Riverine fish species are an important component of the river's ecology and in some cases are the basis for a sport fishery. Aquatic vegetation is crucial fish habitat as the majority of fish in the project impoundments utilize EAV and SAV at some point during their life history. This requested study will help enhance EAV and SAV in the project impoundments.

A mission of the NHFGD relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1. New Hampshire has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.
2. New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.
3. New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.
4. Human activities and land uses are compatible with desired population and recreational

goals for fish, wildlife, and marine species and the ecosystems that sustain them.

This study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

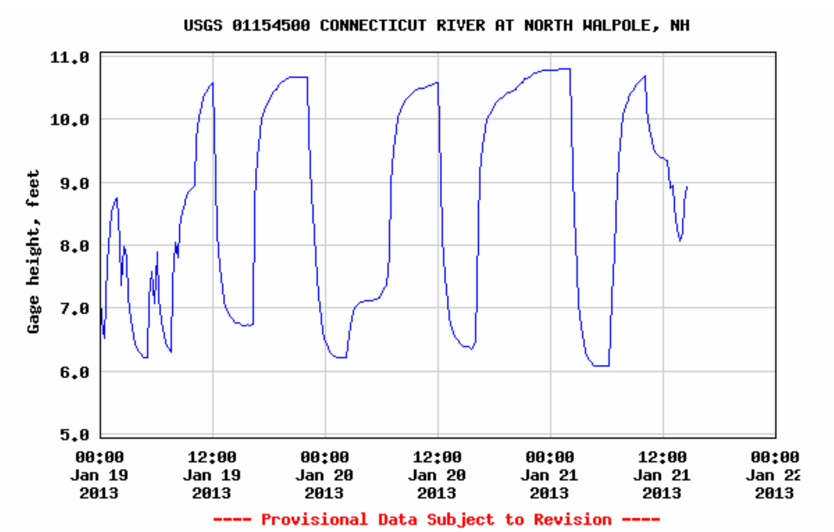
The requestor is a state natural resource agency.

Existing Information

Existing information in the PADs does not quantify EAV and SAV. However, the applicant acknowledges that water level fluctuations caused by the project have the potential to affect fringing wetland and littoral areas:

> "*The average daily water level fluctuation of 2.5 vertical feet has resulted in a zone of sparse vegetation along most of the shorelines of the impoundment. Wetland and littoral resources in this zone are limited by the frequent wetting and drying*." (Wilder PAD, p.3-104, see also similar language in the Bellows Falls PAD p. 3-115 and the Vernon PAD p. 3-143)

An example of the water level fluctuations due to hydropower generation that occur in the Lower Connecticut River downstream of the Bellows Falls Project is shown below.



Nexus to Project Operations and Effects

Water level fluctuations due to project operations have the potential to influence fish species life history requirements, biological interactions, and habitat quantity and quality by impacting EAV and SAV. For example, water level changes due to project operations could create conditions where EAV and SAV abundance is diminished, thus negatively impacting a habitat used by riverine fish for spawning, rearing, feeding, and cover. Additionally, water level fluctuations due to project operations could influence EAV and SAV habitat in the project impoundments and promote invasive plants over native species. This study needs to take into account existing and potential future limits on impoundment level fluctuations intended to limit recreation impacts, and the interactions of any changes in pond level fluctuation range or frequency and discharge changes.

Methodology Consistent with Accepted Practice

Vegetation mapping and mapping of littoral zones in relation to water level fluctuations are common tools for identifying EAV and SAV that may be impacted by changes in water levels. The study should include field surveys designed to describe the characteristics of each mapped wetland, riparian, littoral and shallow water habitat including plant species composition, relative abundance/density, habitat quality, and land use. These surveys should be conducted to describe these habitats at the lowest water level operational range permitted on a daily operation schedule, under low flow conditions. Information collected should include:

- Plant species composition, and their relative abundance/density and condition/structure (e.g., seedlings)
- Surveying for the federally Endangered Northeastern bulrush (*Scirpus ancistrochaetus*);
- Structured data, including estimates of average heights and aerial cover of each vegetation layer (specifically denoting invasive species);
- Aquatic habitat substrate composition, quantity (i.e., percent types and area), wood structure (relative abundance measure applied by area), water depths (inundated, exposed, and water less than one foot);
- Predominate land use(s) associated with each cover type;
- Wildlife sightings should be noted;
- Field verified wetland, riparian, and littoral and shallow water habitats and invasive species occurrences, should be geo-referenced as polygons and overlain on orthophoto at a suitable scale.
- Identification (mapped location, total area) of any EAV, SAV or other fish habitat (i.e. wood, rocks, etc) that is dewatered at the lowest water level operational range permitted on a daily operation schedule, under low flow conditions.

Bathymetric mapping of the littoral zone will be needed to model the extent of this zone that will be affected by different water fluctuation scenarios.

The study area is from the most upstream area influenced by the Wilder Dam to the most downstream area influenced by the Vernon Dam. Water level fluctuations caused by the projects may affect not only the impoundments, but also the downstream river reaches below the dams. Studies would occur in the main river littoral zone and in backwater areas during spring, summer and fall. A second year of study may be required if first year data collection is limited due to environmental or other conditions, or if river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period.

Level of Effort/Cost

Although the PAD's acknowledge that project operations have the potential to impact littoral resources, TransCanada did not propose any studies concerning aquatic vegetation. Analysis as described above is needed to understand potential impacts of the projects on these resources. Estimated cost for the study is moderate due to the need for field assessment.

Literature Cited:

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Study Request 15b: Impacts of Water Level Fluctuations due Operations at the Turners Falls and Northfield Mountain Pump Storage Project on Aquatic and Riparian Vegetation, Including Invasive Species, in the Turners Falls Impoundment in New Hampshire (FERC NOs. 1889 and 2485)

Goals and Objectives

The goal of this study is to obtain baseline information on riparian, wetland, emergent and submerged aquatic vegetation, and associated shallow water aquatic habitats (subject to operational inundation and exposure to near exposure) known to occur in the project area. Information would be used to determine whether riparian, wetland, EAV and SAV, littoral, and shallow water (e.g., mid river bars and shoals) habitats are impacted by current water level fluctuations permitted under the Turners Falls and Northfield projects' licenses and whether these vegetation types and shallow water habitats can be protected and restored by modifications to project operations or other mitigation measures. This analysis needs to take into account existing and potential future limits on pond level fluctuations intended to limit recreation impacts, and the interactions of any changes in pond level fluctuation range or frequency and discharge changes under a new licenses of the Turners Falls and upstream projects. This information is needed to determine whether the projects operation affects plants, habitat, and wildlife in the project area, whether aquatic vegetation and its habitats can be enhanced by modifications to project operations or other mitigative measures, and whether there is any unique or important shoreline or aquatic habitats that should be protected.

The specific objectives of the field study, at a minimum, include:

- Quantitatively describe and map wetland types within 200 feet of the shoreline, and describe associated wildlife;
- Delineate, quantitatively describe, and map all wetland types including invasive species and wildlife observed (e.g., bald eagle nesting, water fowl nesting) within 200 feet of the shoreline, and the extent of this habitat if it extends beyond 200 feet; and
- Quantitatively describe (e.g., substrate composition, vegetation type and abundance) and map shallow water aquatic habitat types subject to project operation inundation and exposure, noting and describing additional areas where water depths at lowest operational range are wetted to a depth less than one foot (flats, near shore areas, gravel bars, with very slight bathymetric change);

A second year of study may be required should river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period.

The field study should produce a habitat inventory report that includes:

- The results of the field study in the form of maps and descriptions;
- An assessment of project effects on wetland, riparian, littoral zone vegetation and shallow water habitats, invasive plant species, and wildlife habitat at the project; and
- Recommendations for any necessary plant, habitat type, or wildlife, protection and/or invasive species control measures.

The New Hampshire Department of Environmental Services (DES) is primarily interested in the portion of the Turners Falls impoundment that is in New Hampshire (estimated to be approximately 5.7 miles in length). It is our understanding that other agencies, such as the United States. Fish and Wildlife Service, are interested in studying the impacts of the Projects in Massachusetts as well.

Resource Management Goals

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)].

Regarding Biological and Aquatic Community Integrity, Env-Wq 1703.01 states the following:

(g) The surface waters shall support and maintain a balanced, integrated, and adaptive community of organisms have a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region.

(h) Differences from naturally occurring conditions shall be limited to non-detrimental differences in community structure and function.

Aquatic vegetation, such as EAV and SAV, is an important component of the ecology of the Connecticut River. Riverine fish species are an important component of the river's ecology and in some cases are the basis for a sport fishery. Aquatic vegetation is crucial fish habitat as the majority of fish in the project impoundment utilize EAV and SAV at some point during their life history. Aquatic vegetation in the areas affected by the project should be studied to demonstrate compliance with Env-Wq 1703.19. This requested study will help enhance EAV and SAV in the project impoundments and downstream.

3. Public Interest

The requestor is a natural resource agency.

Existing Information

Existing information in the PAD does not quantify EAV and SAV in this area, or other shallow aquatic habitat types and physical features (e.g., depths, substrates, wood structure) that are the environment for aquatic biota in the project area. The PAD does provide some limited monitoring data for 2012 (2 locations) on water surface elevations that show daily fluctuations, in the upper third of this impoundment, that varied over 4 feet on a daily cycling frequency, with fluctuations generally in the 2 foot range in low flow months for the data provided in the PAD. The current license does permit a greater pool elevation operational fluctuation, up to a 9 foot change in elevation, based on the Turners

Falls Dam water elevation. In the PAD it is noted these operational fluctuations under most circumstances at the Turners Falls Dam are within 3.5 feet.

In the PAD it is noted that FLP would like to expand its NMPS upper reservoir capacity (by up to 24%), how this may affect project operations and the habitats noted in this request is unknown. It is also noted that water is typically pumped to the upper reservoir in evening and generation back to the river occurs once to twice daily, in daytime hours, based upon power needs and power value. Under current license conditions, provided set thresholds for minimum flow and Turners Dam current license elevations are met, the NMPS may operate with no restriction in timing, frequency, or magnitude for pumping or generation. No data were provided on the operation of the NMPS plant over time relative to data on pumping and generation on an hourly basis, averaged values were provided over monthly periods. It is unclear what the actual timing, frequency and magnitude of these NMPS operations are over the course of a year and how that relates to; aquatic plant species establishment, growth, survival, littoral zone or other shallow water habitat fish spawning periods and their effects on these fishes (reproduction success and subsequent recruitment, e.g., bass and fall fish nests) in available and utilized habitat, and how the quantity and quality of these shallow water habitats are effected by project operational manipulation/alteration, as currently permitted or proposed.

The PAD provides lists of plant and wildlife species whose native ranges overlap with the project area, but it does not provide any baseline information on known occurrences of these species in the wetlands, riparian, littoral and shallow water habitats, within or adjacent to, the project area. Plant and wildlife occurring in these habitats may benefit from protection, mitigation, and enhancement (PMEs) measures, given the potential effects of continuing the current semiautomatic peaking operating regime. In addition, a large scale sediment discharge from NMPS resulted in regulatory actions by FERC, the EPA and MADEP in 2010. Continuing and as yet unresolved management plan measures relative to sediment and NMPS project operations, are further concerns for shallow water, littoral zone, and wetland habitats.

The Atlantic States Marine Fisheries Commission, Atlantic Coast Diadromous Fish Habitat: A Review of utilization, threats, recommendations for conservation, and research needs (ASMFC 2009), contains a review of habitat information for these species. Recommendations in this report include: Maintain water quality and suitable habitat for all life stages of diadromous species in all rivers with populations of diadromous species.

Nexus to Project Operations and Effects

Water level fluctuations due to project operations could affect EAV and SAV habitat as well as the quantity and quality littoral and shallow water habitat. These operational water level fluctuation effects are expected to impact fish species use of these habitats and may affect spawning fishes reproductive success and subsequent population recruitment including but not limited to American shad, blueback herring, sea lamprey, fall fish, and bluegill, which spawn in mid to late spring through early summer in areas subject to daily or more frequent water level fluctuations.

The current operating mode, as well as the unknowns with proposed upper reservoir expansion, may affect wetland riparian, littoral and other shallow water habitats and promote the introduction and expansion of invasive plant species through fluctuating water levels. A study that explains the relationship between the proposed mode of operation and the type and quantity or wetland, riparian, littoral, shallow water habitats, and invasive species affected would help inform a decision on the need for protection and/or control of these resources in the license.

Methodology Consistent with Accepted Practice

The PAD currently contains maps portraying general wetland types from the Cabot Station tailrace upstream to the Vernon Dam. In addition, we understand that the detailed bathymetry exists for the Turners Falls impoundment. The proposed study should utilize this existing information in conjunction with field surveys designed to describe the characteristics of each mapped wetland, riparian, littoral and shallow water habitat including plant species composition, relative abundance/density, habitat quality, and land use. These surveys should be conducted to describe these habitats at the lowest water level operational range permitted on a daily operation schedule, under low flow conditions. Information collected should include:

Plant species composition, and their relative abundance/density and condition/structure (e.g., seedlings);

Structured data, including estimates of average heights and aerial cover of each vegetation layer (specifically denoting invasive species);

Aquatic habitat substrate composition, quantity (i.e., percent types and area), wood structure (relative abundance measure applied by area), water depths (inundated, exposed, and water less than one foot);

Predominate land use(s) associated with each cover type;

Wildlife sightings should be noted;

Field verified wetland, riparian, and littoral and shallow water habitats and invasive species occurrences, should be geo-referenced as polygons and overlain on orthophoto at a suitable scale.

7. Level of Effort/Cost, and Why Alternative Studies will not suffice

In the PAD, First Light identified impacts of the project operations on wetlands, riparian and littoral zone habitat as a potential issue to be addressed in relicensing, and proposed wetland vegetation mapping. However, additional analysis as described above is needed to understand the impacts of the project on these resources and habitats.

A wetlands, riparian, littoral/shallow water, invasive species inventory, of the scope envisioned, would likely require 6-8 months to complete and cost $40,000 to $50,000.

Literature Cited:

Atlantic States Marine Fisheries Commission. 2009. Atlantic coast diadromous fish habitat: A review of utilization, threats, recommendations, for conservation, and research needs. Habitat Management Series #9. Washington, D.C.

Study Request 16: Impacts of the Vernon, Bellows Falls and Wilder Project Impoundment Water Fluctuations on Resident Fish Spawning (FERC NOs. 1904, 1855, 1892)

Goals and Objectives

The goal of this study is to determine if the full range of water level fluctuations in the Vernon, Bellows Falls and Wilder Hydroelectric Projects negatively impact resident fish species (smallmouth bass, largemouth bass, yellow perch, black crappie, common sunfish, bluegill, chain pickerel, northern pike, golden shiner, common white sucker, spottail shiner, walleye and fallfish) in the impoundments, and if impacts are found to occur, to develop appropriate mitigation measures.

Specific objectives include:

1) Conduct field studies in the mainstem, tributaries and backwaters of project affected areas to assess timing and location of fish spawning. Nesting locations should be mapped.
2) Conduct field studies in the mainstem, tributaries and backwaters of project-affected areas to evaluate potential impacts of impoundment fluctuation on spawning habitat, nest abandonment, spawning fish displacement and egg dewatering. The study should also evaluate if changes in impoundment fluctuation range would mitigate for identified impacts and if other mitigative measures would lessen these impacts.

Resource Management Goals

A mission of both the New Hampshire Fish and Game Department (NHFGD) and the Vermont Fish and Wildlife Department is to protect and conserve fish and their habitats. Resident fish species are an important component of the river's ecology and in some cases are the basis for a sport fishery. This requested study will help protect and conserve resident fish species by ensuring project operations do not negatively impact their spawning success.

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)].

Regarding flow, Env-Wq 1703.01(d) states that "unless the flows are caused by naturally occurring conditions, surface water quantity shall be maintained at levels adequate to protect existing and designated uses."

Regarding Biological and Aquatic Community Integrity, Env-Wq 1703.01 states the following:

(i) The surface waters shall support and maintain a balanced, integrated, and adaptive community of organisms have a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region.

(j) Differences from naturally occurring conditions shall be limited to non-detrimental differences in community structure and function.

Resident riverine fish are important components of the ecology of the Connecticut River. Fish populations and habitats in the areas affected by the project should be studied to demonstrate compliance with Env-Wq 1703.19.

A mission of the NHFGD relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.
2 New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.
3 New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

This study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

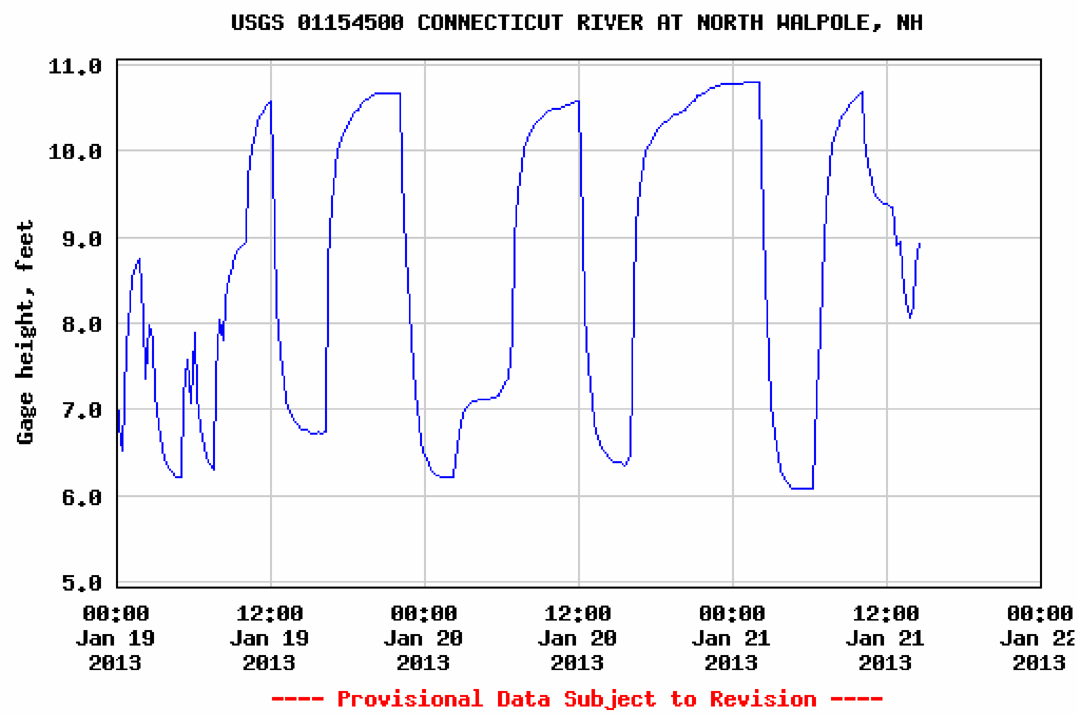
Public Interest

The requestor is a state natural resource agency.

Existing Information

To our knowledge, no information exists related to this requested study.

An example of the water level fluctuations due to hydropower generation that occur in the Lower Connecticut River downstream of the Bellows Falls Project is shown below.



Nexus to Project Operations and Effects

Project operations have the potential to impact fish species by influencing spawning success and spawning habitat quality and quantity. For example, water level changes due to project operations could create conditions where fish eggs are exposed to air, where quality spawning habitat is dewatered, and/or where fish abandon nests containing eggs. The New Hampshire Fish and Game Department has received several calls in past springs regarding "acres" of yellow perch eggs being dewatered in the Bellows Falls Impoundment.

The projects operate within normal, permitted and flood-condition reservoir fluctuation limits that include during high flow events, the dropping of stantion bays that cannot be raised without a subsequent drawdown of the impoundment beyond normal project operating ranges. The full range of reservoir fluctuations, including periodic drawdowns for stantion bay replacement, need to be addressed in this study.

Methodology Consistent with Accepted Practice

Common tools to evaluate fish spawning and habitat would be used including, but not limited, electrofishing, visual observations, telemetry and habitat measurements. The study area for this request includes all impounded waters, including tributaries and backwaters, within the project-affected areas of the Wilder, Bellows Falls and Vernon Hydroelectric Projects. A second year of study may be required if first year data collection is limited due to environmental or other conditions, if river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values), or if river temperatures are atypical during the study period.

Level of Effort/Cost, and Why Alternative Studies will not suffice

TransCanada does not propose any studies to meet this need. Estimated cost for the study is moderate to high but is dependent on the amount of field study that is needed.

Literature Cited:

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Study Request 17: Impacts of the Vernon, Bellows Falls and Wilder Project Operations on Tributary and Backwater Area Access and Habitats. (FERC NOs. 1904, 1855, 1892)

Goals and Objectives

One goal of this study is to determine if water level fluctuations from the Vernon, Bellows Falls and Wilder Hydroelectric Projects result in a barrier(s) to fish movement in and out of tributaries and backwaters to the impoundments and riverine reaches below dams.

A second goal is to determine if water level fluctuations in the Vernon, Bellows Falls and Wilder Project impoundments impact water levels, available fish habitat and water quality in tributaries and backwaters to the impoundments and riverine reaches below dams, and if impacts are found, to ascertain how spatially far reaching they are and develop mitigation measures.

Results of this study may also be used to help determine the adequacy of existing downstream minimum flow requirements.

Specific objectives include:

1) Conduct a field study of tributaries and backwaters, including water velocity and habitat data where appropriate, to evaluate potential impacts of impoundment fluctuation on fish access to tributaries and backwater areas. The study should also evaluate if changes in impoundment fluctuation range would mitigate for any identified impacts and if other mitigative measures would improve access.

2) Conduct a field study to examine potential impacts of impoundment fluctuations on water levels, available habitat and water quality in tributaries and backwaters. The evaluation should also evaluate if changes in impoundment fluctuation range would mitigate for identified impacts and if other mitigative measures would lessen these impacts.

Resource Management Goals

A mission of both the New Hampshire Fish and Game Department (NHFGD) and the Vermont Fish and Wildlife Department is to protect and conserve fish and their habitats. Diadromous and resident riverine fish species are an important component of the river's ecology and in some cases are the basis for a sport fishery. Furthermore, two of the states' Species of Greatest Conservation Need (SGCN) that would potentially be impacted have been documented in the project-affected areas.

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)].

Regarding flow, Env-Wq 1703.01(d) states that “unless the flows are caused by naturally occurring conditions, surface water quantity shall be maintained at levels adequate to protect existing and designated uses.”

Regarding Biological and Aquatic Community Integrity, Env-Wq 1703.01 states the following:

(k) The surface waters shall support and maintain a balanced, integrated, and adaptive community of organisms have a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region.

(l) Differences from naturally occurring conditions shall be limited to non-detrimental differences in community structure and function.

Diadromous and resident riverine fish are important components of the ecology of the Connecticut River. Fish populations and habitats in the areas affected by the Project should be studied to demonstrate compliance with Env-Wq 1703.19. This study request will inform the 401 water quality certification process and help ensure that State water quality standards will be met.

This requested study will help promote tributary and backwater access and protect valuable fish habitat and maintain appropriate water quality conditions for diadromous and riverine fish species in project-affected areas. Maintaining connectivity between the mainstem of the Connecticut River and tributaries and backwaters is vital to the fish populations in these systems, as many fish species utilize these areas for spawning, rearing, refuge, and feeding.

A mission of the NHFGD relevant to this study request is to conserve, manage and protect the state’s fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD’s 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.
2 New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.
3 New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

This study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

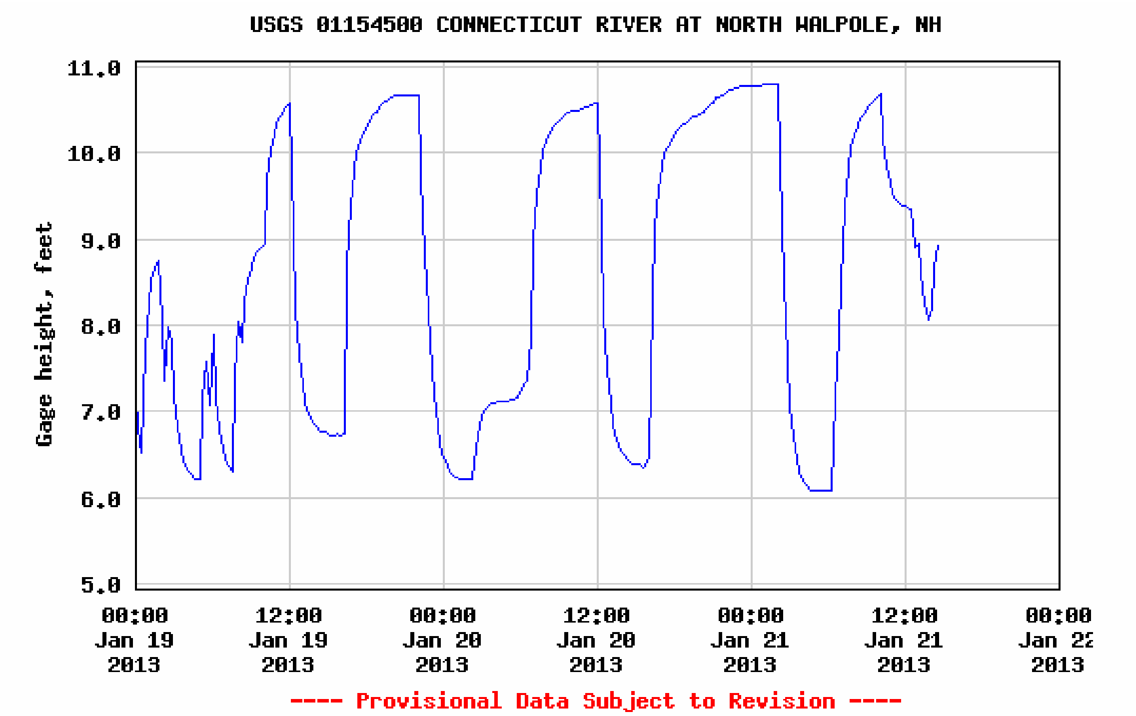
Public Interest

The requestor is a state natural resource agency.

Existing Information

To our knowledge, no information exists related to this requested study.

An example of the water level fluctuations due to hydropower generation that occur in the Lower Connecticut River downstream of the Bellows Falls Project is shown below.



Nexus to Project Operations and Effects

Project operations have the potential to impact fish species life history requirements, biological interactions, and habitat quantity and quality. For example, water level changes due to project operations could create conditions that could impede free movement of fish between tributaries/backwaters and the mainstem of the Connecticut River, thus limiting access to spawning habitat and/or growth opportunities. Additionally, water level changes could also alter tributary and backwater fish habitat quality, quantity, and also water quality, thus decreasing productivity and available habitat. Furthermore, two of New Hampshire and Vermont's SGCN that could be impacted have been documented in the project-affected areas.

Methodology

Common tools to evaluate water level impacts would be used including: bathymetric mapping, substrate, depth and velocity measurements, and water quality information (dissolved oxygen, temperature, turbidity, and pH). Studies should be conducted throughout the year. The study area for tributary and backwater fish sampling should cover all tributaries and backwaters within the project-affected areas of the Vernon, Bellows Falls and Wilder Hydroelectric Projects. A second year of study may be required if first year data collection is limited due to environmental or other conditions, or if river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period.

Level of Effort/Cost

TransCanada does not propose any studies to meet this need. Estimated cost for the study is relatively low.

Literature Cited:

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Study Request 18: Impingement and Entrainment of Resident Fish Species at the Wilder, Bellows Falls and Vernon Intakes (FERC NOs 1892, 1855 and 1904)

Goals and Objectives

The goal of this study is to assess the adequacy of the intakes at Bellows Falls, Wilder, and Vernon projects to minimize fish mortality resulting from impingement and entrainment of resident fishes residing in the Connecticut River, and to recommend appropriate mitigative measures as necessary.

Specific objectives include:

- Describe the configuration of the intake at each project, including the forebay characteristics, size of the intakes, trashrack spacing and extent of coverage if the intakes, approach velocities and the influence of trashrack debris and cleaning protocols.
- Estimate the mortality rates for resident fish species and life stages that may result from impingement on project trashracks.
- Estimate the mortality rates for resident fish species and life stages that may result from entrainment and passage through the project turbines. Review existing Vermont Fish and Wildlife Department's (VTFWD) fish passage data to increase sample size and gain a better understanding of temporal variability.
- Determine structural and operational measures that could be reduce resident fish mortality.

Resource Management Goals

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)]. This study request will inform the 401 water quality certification process and help ensure that State water quality standards will be met.

Regarding flow, Env-Wq 1703.01(d) states that "unless the flows are caused by naturally occurring conditions, surface water quantity shall be maintained at levels adequate to protect existing and designated uses."

Regarding Biological and Aquatic Community Integrity, Env-Wq 1703.01 states the following:

(m) The surface waters shall support and maintain a balanced, integrated, and adaptive community of organisms have a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region.
(n) Differences from naturally occurring conditions shall be limited to non-detrimental differences in community structure and function.

Vermont Water Quality Standards (VWQS) seek to provide high quality aquatic habitat necessary to support healthy aquatic communities and the associated uses such as fishing.

The Vermont Fish and Wildlife Department's goals related to aquatic natural resources and pertinent to this study request are to:

1. Provide for healthy, self-sustaining fish communities.
2. Minimize the potential negative effects of project operation on resident fish populations, and mitigate for losses.

A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.
2 New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.
3 New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

This study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The requestor is a state natural resource agency.

Existing Information

The Connecticut River and the project impoundments support a variety of resident fish species as well as angling. However, there is no information about resident fish mortality and the population effects resulting from project impingement and entrainment. The project PADs contain almost no information about the project trashracks. During the ILP site visits held in October 2012 the Agency was informed that the rack spacing was in most cases four inches (on center) and as much as six inches in some cases.

Further, these trashracks do not cover the entire intake area in all cases. No information on approach velocities has been provided. Mortality rates of resident fish passing through the turbines are not known.

Nexus to Project Operations and Effects

The Bellows Falls, Wilder and Vernon dams span across the Connecticut River, acting as a physical impediment to fish passage. Fishes living in the impoundments will at times enter project forebays and come in close proximity to project intakes. Impingement or entrainment is certainly occurring but the extent of this impact is unknown. The wide rack spacing is likely to result in entrainment. The projects include downstream fish passage facilities but their use and effectiveness for resident fish species is unknown. These facilities are operated seasonally and therefore will not mitigate impingement and entrainment at all times.

Methodology Consistent with Accepted Practice

Impingement, entrainment and turbine mortality studies have been conducted at numerous other hydropower projects and can be used to assess potential fish mortality based on results from other projects with similar configurations. Approach velocities can be calculated and actual measurements can be taken to quantify variability by location and verify calculated results. Turbine mortality should be assessed by releasing tagged fish for downstream recovery. The details of this type of study should be addressed during the study plan stage. The contribution of existing downstream fish passage facilities to reducing impingement and entrainment of resident fishes should also be assessed.

Level of Effort/Cost

The expected level of effort and anticipated costs will be comparable or less than those experienced on similar FERC projects of this size.

Literature Cited:

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Study Request 19: Assessment of Adult Sea Lamprey (*Petromyzon marinus)* Spawning within the Wilder, Bellows Falls, and Vernon Project Areas. (FERC NOs 1904, 1855, and 1892)

Perform a study to investigate potential impacts of the Wilder, Bellows Falls and Vernon Project's operations on sea lamprey spawning success.

Goals and Objectives

Assess the level of spawning activity by sea lamprey in the Wilder, Bellows Falls, and Vernon project areas and determine whether operations of these Projects are affecting the success (i.e survival to emergence) of this activity.

Identify areas within the Wilder, Bellows Falls, and Vernon project areas where suitable spawning habitat exists for sea lamprey.

Conduct a telemetry study of sea lamprey during their upstream migration period in the spring, focusing on areas of suitable spawning habitat, and areas of known spawning.

Conduct spawning ground surveys to observe the utilization of this habitat for spawning purposes, and hence, confirm suitability.

Obtain data on redd characteristics including location, size, substrate, depth and velocity.

Determine if the operations at the Wilder, Bellows Falls and Vernon projects are adversely affecting these spawning areas (i.e. if flow alterations are causing dewatering and/or scouring of sea lamprey redds). If it is determined that the operations of the projects are adversely affecting the spawning success of sea lamprey, identify operational regimes that will reduce and minimize impacts to sea lamprey spawning habitat and spawning success within the project area.

Resource Management Goals

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)]. This study request will inform the 401 water quality certification process and help ensure that State water quality standards will be met.

Regarding flow, Env-Wq 1703.01(d) states that "unless the flows are caused by naturally occurring conditions, surface water quantity shall be maintained at levels adequate to protect existing and designated uses."

Regarding Biological and Aquatic Community Integrity, Env-Wq 1703.01 states the following:

(o) The surface waters shall support and maintain a balanced, integrated, and adaptive community of organisms have a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region.

(p) Differences from naturally occurring conditions shall be limited to non-detrimental differences in community structure and function.

The sea lamprey (*Petromyzon marinus*), within the Connecticut River drainage, is one of New Hampshire and Vermont's Species of Greatest Conservation Need (SGCN). The conservation status of sea lamprey in New Hampshire is listed as "vulnerable." One of the threats identified in Vermont's Wildlife Action Plan (Kart et al. 2005) is degraded spawning habitat, which is second to habitat fragmentation.

As outlined in Vermont's Wildlife Action Plan (Kart et al. 2005), research and monitoring needs for SGCN include monitoring and assessing populations and habitats for current conditions and future changes, and identifying and monitoring problems for species and their habitats.

One of the conservation strategies identified in the Vermont Wildlife Action Plan, is protecting and restoring aquatic and riparian habitats through improved water quality; flow, water level and temperature regimes; sediment reduction; establishment of streamside buffers; and suitable aquatic habitat structure, diversity and complexity.

In support of conservation strategies and research needs listed above, identifying potential impacts that the Wilder, Bellows Falls, and Vernon Projects have on sea lamprey spawning is paramount. Results of the study will be used to develop flow-related license requirements and/or other mitigation measures that will optimize spawning habitat for a New Hampshire and Vermont SGCN.

A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.
2 New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.
3 New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

This study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The requestor is a state natural resource agency.

Existing Information

It is known that sea lamprey spawn in the Connecticut River main stem at least as far upstream as Wilder Dam, as well as tributary waters including the West, Williams, Black and White Rivers (Kart et al. 2005).

The PAD discusses sea lamprey distribution as: "FWS (2012) lists the current upstream extent of sea lamprey range as Bellows Falls Dam, noting, however, that reproduction has been documented as far north as the White River, Vermont, in the Wilder Project area. In certain years hundreds to thousands of sea lamprey have been recorded passing upstream of Bellow Falls dam, and in at least one year (2008) sea lamprey were documented passing upstream via the Wilder Dam fish ladder. In 2008 surveys, Yoder et al. (2009) documented sea lamprey just downstream of the confluence of the White River ."

In 2012 at total of 99 sea lamprey were observed passing the Bellows Falls Dam, and a total of 696 sea lamprey were observed passing the Vernon Dam.

To date no studies have been conducted that aim to identify spawning habitat and spawning activity of sea lamprey within in the Wilder, Bellows Falls, and Vernon project areas and whether Project operations are affecting these activities.

Nexus to Project Operations and Effects

The operation of the Wilder, Bellows Falls and Vernon projects including minimum flows and large and rapid changes in flow releases from the dam have the potential to cause direct adverse effects on spawning habitat and spawning activity downstream of the dam. If adult sea lampreys are actively spawning in the project area, it is important to assess whether operations of the projects are having any adverse effects (i.e. dewatering and scouring) on these activities.

Methodology Consistent with Accepted Practice

Although a relatively new practice, the tagging and tracking of adult Pacific lamprey to determine final destination, has been successfully conducted in the Columbia River (Noyes et al. 2012). Similarly, from 2005-2009, radio telemetry was used to determine adult lamprey overwintering and spawning habitats, and spawn timing in the lower Deschutes River Subbasin (Fox et al. 2009).

In Vermont, factors affecting sea lamprey survival were examined (Smith and Marsden 2009). It was found that predation, water currents, and displacement of eggs from the nest, played a role in survival. As part of the Wells Hydroelectric project (FERC No. 2149), Pacific lamprey spawning ground surveys were conducted to determine project effects on spawning success.

In 2010, redd surveys were completed in Shitike and Beaver Creeks to identify recent redds for placement of an experimental redd cap. The purpose of capping lamprey redds was to enumerate emerging larvae and to document timing of emergence with respect to estimated date of redd construction and water temperature (Fox et al. 2010). Therefore, to determine project effects on the spawning success of sea lamprey methods should follow Fox et al. (2010).

Level of Effort/Cost

The estimated level of effort and costs for this recommended study is expected to be moderate to high. The applicant did not propose any alternative studies in its PAD to address this specific issue.

Literature Cited

Fox, M. J.C. Graham, and S. Frank. 2009. Determining Adult Pacific Lamprey Abundance and Spawning Habitat in the Lower Dechutes River Sub-Basin, Oregon. Department of Natural Resources Confederated Tribes of the Warm Springs Reservation, Oregon

Fox, M. J.C. Graham, and S. Frank. 2010. Determining Adult Pacific Lamprey Abundance and Spawning Habitat in the Lower Dechutes River Sub-Basin, Oregon. Department of Natural Resources Confederated Tribes of the Warm Springs Reservation, Oregon

Kart, J., R. Regan, S.R. Darling, C. Alexander, K. Cox, M. Ferguson, S. Parren, K. Royar, B. Popp, editors. 2005. Vermont's Wildlife Action Plan. Vermont Fish & Wildlife Department. Waterbury, Vermont. http://www.vtfishandwildlife.com/swg_cwcs_report.cfm. (Accesse September 10, 2012).

Le, Bao and S. Kreiter. 2008. An assessment of Adult Pacific Lamprey Spawning within the Wells Project. Wells Hydroelectric Project NO. 2149.

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Noyes, C.J., C.C. Caudill, T.S. Clabough, D.C. Joosten, E.L. Johnson, M.L. Keefer, and G.P. Naughton. 2011. Adult Pacific lamprey migration behavior and escapement in the Bonneville Reservoir and Lower Columbia River monitored using the juvenile salmonid acoustic telemetry system (JSATS). Technical Report 2012-4-Draft

Smith, S. J. and J. E. Marsden. 2009. Factors Affecting Sea Lamprey Egg Survival. North American Journal of Fisheries Management 29:859–868.

Study Request 20: Determine Upstream Passage Needs for Riverine Fish Species in the Bellows Falls, Wilder and Vernon Fishways (FERC NOs. 1904, 1855, and 1892)

Goals and Objectives

The goal of this study is to determine the adequacy of the existing Bellows Falls, Wilder, and Vernon fish ladders in passing riverine species and determine the appropriate operation period for these fishways to pass riverine and diadromous fish.

Specific objectives include:

- Identify the utilization and temporal distribution, of passage through the Bellows Falls, Wilder, and Vernon fishways by riverine and diadromous fish species
- Review existing Vermont Fish and Wildlife Department's (VTFWD) fish passage data to increase sample size and gain a better understanding of temporal variability.
- Operate and monitor the fishways year-round (or until otherwise infeasible) to assess fishway use over a longer period than the fishways have traditionally been operated to:
    1. Determine the appropriate operating windows of the fishways for riverine species
    2. Determine the appropriate operating windows of the fishways for diadromous species such as American eel and sea lamprey.

Resource Management Goals

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)]. This study request will inform the 401 water quality certification process and help ensure that State water quality standards will be met.

Regarding flow, Env-Wq 1703.01(d) states that "unless the flows are caused by naturally occurring conditions, surface water quantity shall be maintained at levels adequate to protect existing and designated uses."

Regarding Biological and Aquatic Community Integrity, Env-Wq 1703.01 states the following:

(q) The surface waters shall support and maintain a balanced, integrated, and adaptive community of organisms have a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region.

(r) Differences from naturally occurring conditions shall be limited to non-detrimental differences in community structure and function.

The VTFWD's mission is "the conservation of all species of fish, wildlife, and plants and their habitats for the people of Vermont" (Vermont's Wildlife Action Plan 2005). Two of the Department's planning goals are:

1. Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.
2. Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

Vermont Fish and Wildlife Department's Strategic Plan (2002 -2010) focuses towards four major areas of concern: resource conservation, fish and wildlife-based recreation and use, human health and safety, efficient operations, and effective management.

A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.
2 New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.
3 New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

In order to be consistent with both Department's missions and goals, and to promote healthy fish populations, connectivity within a river system is important. By allowing fish to move through the fishway during different times of the year, and during different life history stages, access to available riverine aquatic habitat is increased. Fish are able to seek the best available habitat and food resources, as well as avoid predator interactions. Furthermore, movement within a river system promotes genetic diversity. Currently upstream resident fish passage at the Bellows Falls, Wilder, and Vernon dams is precluded most of the year due to fishway closure.

This study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The requestor is a state natural resource agency.

Existing Information

No such information exists that will allow for a comprehensive assessment of existing year round fishway utilization by resident species. The VTFWD has several years (2007-2012) of seasonal passage data that have not yet been analyzed. These data are in the form of .avi files, but only include the spring and summer months (typically May- July).

The PAD acknowledges that "Resident species have also been recorded using the Bellows Falls and Wilder fish ladder". Those data are available from the Vermont Fish & Wildlife Department. Fish passage video data that have been processed should be available for distribution in the future (Lael Will, Vermont Fish & Wildlife, personal communication)". Although not comprehensive, analysis of these data would assist in filling this data gap.

In 2012, VTFWD staff documented resident species passage at the Vernon fishway. Species observed utilizing the fishway included bluegill (N = 555), common carp (N = 209), channel catfish (N = 37), trout sp. (N = 2), walleye (N = 54), white sucker (N = 102), and American eel (N =262). However, these analyses were conducted during one year and did not include any monitoring outside of the spring spawning run.

Nexus to Project Operations and Effects

The Bellows Falls, Wilder and Vernon dams span across the Connecticut River, acting as a physical impediment to fish passage. Therefore, the project has a direct impact on fish passage and limits fish from accessing available aquatic habitat located upstream of the dam. The PAD acknowledges that "river fragmentation can reduce or obstruct fish and aquatic community connectivity and therefore genetic diversity and stock structure. However, those impacts are reduced by the provision of fish passage and the length of the impoundment. Upstream and downstream fish passages, designed for Atlantic salmon, are likely used by other migratory and resident species, providing connectivity; however, fish counts are limited, unknown or unavailable for resident species". In fact, it is known that riverine and diadromous species use the fishways, but there has been limited analysis of this data and fishway monitoring was limited to spring period.

Therefore, in order to determine the level of riverine fish passage through the existing fishways, and the appropriate operation period for the fishway , review of existing data and , further monitoring of the fishways is warranted.

Methodology

Fishway monitoring has been conducted annually by VTFWD dating back to 1985. Monitoring was focused on Atlantic salmon, American shad and American eel. Resident species were recorded periodically, but were not monitored outside the spring anadromous fish migration period

Fishway monitoring has been used to assess existing and proposed project operations, and to develop appropriate operating windows for fisheries resources. In addition to fish window count data, monitoring should include monitoring of the hydraulic conditions in the fishways and fishway entrances, and periodic fish observations should be made over the length of the fishways. If count data or observations of the fishways indicate the need for fishway operation changes or for more specific information on fish movement through the fishways, changes to the monitoring plan for year 2 monitoring would need to be implemented.

Level of Effort/Cost, and Why Alternative Studies will not suffice

This study will require video monitoring equipment, appropriate software (e.g. salmon soft), and personal to read to files, and manage the equipment. Some information already exists in the form of .avi files and past count data and are readily available from VTFWD. No other tool (e.g. radio telemetry) is more appropriate or cost effective for these types of assessments. Cost is relatively low.

Literature Cited:

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Study Request 21a: Wilder Hydroelectric Project: Shoreline and downstream erosion from water level fluctuation in the impoundment and downstream from peaking operations (FERC NO.1892)

Goals and Objectives

The goal of this study is to determine how project operations contribute to the shoreline erosion and riverbank failure within the impoundment and downstream of the Wilder Hydro Project.

The objectives of this study are to:

1. determine how water level fluctuations within the minimum and maximum operating range and discharges from peaking operations at the Wilder hydroelectric project contribute to shoreline erosion;

2. identify and determine the effects of shoreline bank erosion and riverbank failure on other resources (i.e. riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, etc.);

3. identify techniques that could be used to mitigate the effects of project operations or other mitigation techniques that could be developed to reduce on riverbank erosion within the impoundment and downstream of the tailrace.

2. Resource Management Goals

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)]. New Hampshire’s surface water quality regulations state that “unless the flows are caused by naturally occurring conditions, surface water quantity shall be maintained at levels adequate to protect existing and designated uses.” (Env-Wq 1703.01(d)). The specific New Hampshire water quality criteria for turbidity in Class B waters is not to exceed naturally occurring conditions by more than 10 NTUs (Env-Wq 1703.11). This study request will inform the 401 water quality certification process and help ensure that State water quality standards will be met.

The Connecticut River is considered Class B water by the states of Vermont and New Hampshire. Vermont lists the section of the Connecticut River below the Wilder dam on the Section 303(d) impaired water list due to flow alterations resulting in the destabilization and eroding of shoreline impairing aquatic life and habitat. In Class B waters, Vermont's water quality standards state that water level fluctuation and flow alterations can only occur to the extent that it supports all uses and does not lead to degradation of the water resource or habitat.

A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.
2 New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.
3 New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

This study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest Consideration

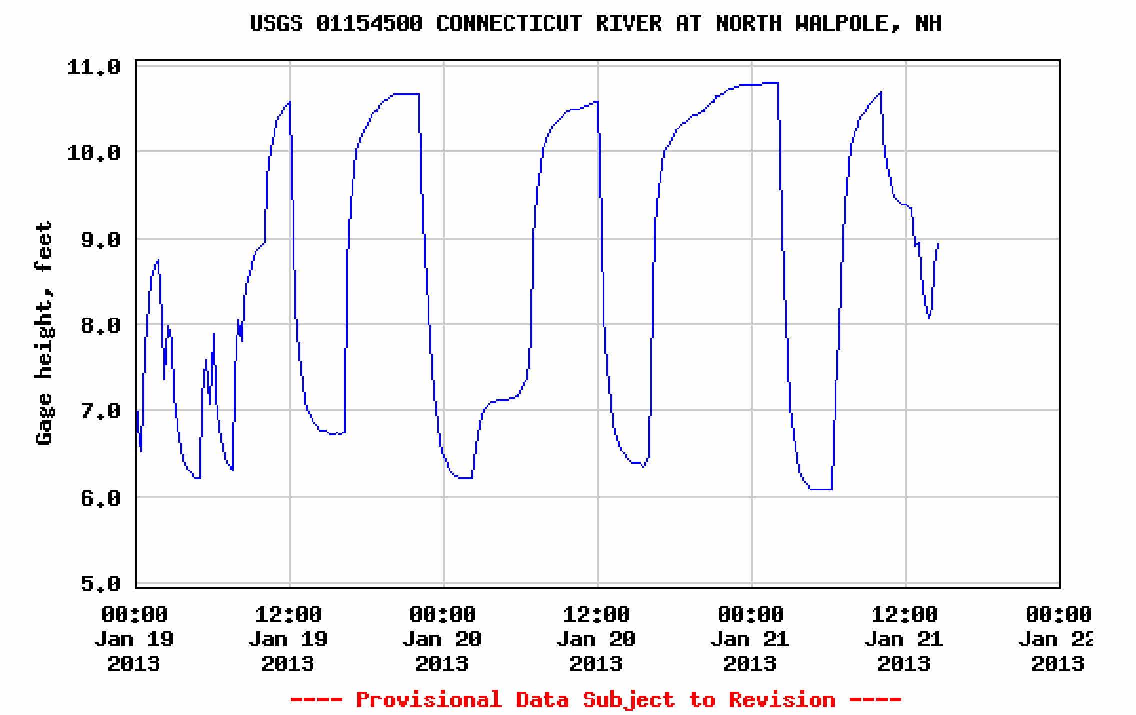
The requestor is a state natural resource agency.

Existing Information

The PAD references several studies pertaining to shoreline erosion within the Connecticut River, including the study by US Army Corp of Engineers (Simion et al. 1979). This study evaluated the shoreline within the Wilder impoundment and identified water level fluctuation and periodic high flow events. The PAD also discusses the erosion survey that TransCanada initiated in 2010 to inventory sites where erosion is occurring within the Wilder impoundment (Kleinschmidt 2011). Bank slumping was identified as the major type of shoreline erosion within the project impoundment. Bank slumping can occur when fluvial erosional forces act on the toe of the bank slope. The PAD did not address how project related operations contribute to shoreline erosion, could be changed to mitigate impacts on shoreline erosion, or discuss the impacts of shoreline erosion on other resources (i.e. riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, etc.).

Repetitive water level fluctuations and flow alterations caused by hydroelectric peaking operations are known to be a major contributor to shoreline erosion (Lawson 1985). Sediment from shoreline erosion and riverbank failure is one of the major contributors negatively affecting water quality and habitat by increasing turbidity and sedimentation, smothering aquatic habitat in the United States. Vermont Surface Water Management Strategy identifies sediment from excessive channel erosion as a stressor on Vermont

water and aquatic habitat. Additionally, Vermont lists this section of the Connecticut River on the Vermont Section 303(d) impaired water list due to flow alterations resulting from the destabilization and eroding of shoreline impairing aquatic life and habitat.
An example of the water level fluctuations that occur in Lower Connecticut River due to hydropower generation downstream of the Bellow Falls Project is shown below.



Project Nexus

Wilder Hydroelectric Project operations currently result in daily water level fluctuation in the impoundment by as much as 2.5 feet, which has the potential to affect shoreline erosion in the impoundment. The project is currently permitted to water level fluctuation in the impoundment by 5 feet. Additionally the project "peaking" operation could contribute to bank erosion downstream of the dam by increasing the shear stress on the bank toe. Furthermore, river profile operations during high flow events minimize overland flow by drawing down the impoundment prior to high flows containing high velocity flows to the river channel, possibly increasing shoreline erosion rate within the impoundment. TransCanada is not proposing any changes to project operations.

Proposed Methodology

Kleinschmidt (2011) conducted a shoreline erosion survey on the Connecticut River, from which we have data on the spatial locations, lengths and heights of such erosion. However, this study did not investigate whether the practice of flow modification is a causative agent to this erosion. Consequently we recommend TransCanada further investigate sites on the Connecticut River to evaluate the processes that are active along banks. This investigation should build on the erosion survey that was previously completed by determining the process causing erosion at a site, the extent erosion is negatively affecting other resources (i.e. riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, etc.), and determining how erosion could be stabilized or mitigated by changing project operations. This investigation can be completed performing the following tasks.

Task 1: Determine erosion and riverbank failure process at identified sites

Shoreline erosion areas and riverbank failure sites were identified during the Kleinschmidt (2011) survey. A survey similar to Kleinschmidt (2011) should be conducted to document if any additional erosion has occurred, and identify new sites[3] of erosion within the impoundment, given the occurrence of Tropical Storm Irene since the Kleinschmidt survey. For each erosion site, the following erosion process element will be identified by determining soil type and subsoil characteristics (i.e. depth to bedrock, texture, rock content, signs of soil piping), reservoir water levels at the time of observation, water level fluctuation, climatic conditions, ground water seepage, wind-driven waves, boat waves, and recreation. Additional site characteristic to identify and record in the erosion survey will include but not be limited to an estimate of the length and average height of the erosional area, slope of the site, dominant vegetation cover types present, associated vegetation cover types present, an ocular estimate of total plant cover and total cover by plant class (tree, shrub, herbaceous) in surrounding undisturbed areas. Data from each shoreline erosion site will be recorded on a field form and entered into a database. In addition, a photograph or photographs will be taken of each site. Sites. should be visited when water levels are lowest.

Erosion processes will be determined by field observations and applying site appropriate geology, geomorphic and hydrological principles. To evaluate the relative influence of water level fluctuations on existing shoreline erosion, a minimum of six select sites[3] (three in the impoundment and three downstream of the dam) will be identified for more detailed measurements and observations. In aid of site selection, comparison of successive aerial photographs will be conducted to identify sites that have experienced visible bank movement. Data from erosion surveys will be examined to identify sites with varying conditions of riparian buffer, vegetation type and bank slope. The sites selected for detailed evaluation will represent different combinations of bank movement, riparian buffer, vegetation type and bank slope. In those bank sites that are selected, rebar pins will be inserted into the banks in a grid at varying heights with each rebar being horizontally level. Initial rebar pin installation will take place when the water level in the impoundment is at its authorized lowest elevation. Each rebar pin will be assigned an individual number and photographed, with the distance from the end of the pin to the bank material measured. A survey will also be conducted of each bank along several bank transects in the vicinity of each site to accurately document bank shape as well as the location and elevation of each rebar and the water surface elevation at the beginning and end of each site visit. Pressure transducers (one in the air and one in the water) will also be installed at each site to automatically record how water surface elevation at each site varies with time.

Biweekly for a period of one year, each of the six sites will be revisited. During each revisit, the bank and each rebar pin will be photographed and the distance from the end of the pin to the bank material will be measured. Any slumping of a pin will be noted. If a pin is found dislodged or removed during a site visit, a new rebar pin will be reinstalled in the approximate location of the previously existing pin.. In addition,

[3] Representatives from the City of Lebanon have informed the NH Department of Environmental Services that they are particularly concerned with the damage and erosion caused by Tropical Storm Irene below the Wilder project in the vicinity of the White River confluence. They want to understand the impacts of Project operations and discharge from the Whiter River on channel and riverbank destabilization in this area and identify strategies to minimize their effects. This should be one of the areas studied as part of this study request.

a survey of the bank and rebars will be conducted. Surveys will always be conducted in the same manner and will use the same benchmark each site visit. Data from pressure transducers will be downloaded and analyzed each site visit to ensure they are working properly. When this dataset is related to the flow record from existing stream gauges in the river segment, this evaluation will allow for a determination as to whether the erosion is Project related, and if so, how Project operations may be impacting the sites.

Task 2: Determining the effects of erosion on other resources

The effects of shoreline erosion and riverbank failure on other resources should be determined. This will required coordination between studies to determine the effects of erosion on riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, and recreation. Erosion sites identified as having an impact on resources will be assess to determine if project operations are causing erosion and a mitigation plan to protect the resource of interest should be developed.

Task 3: Development of a Shoreline Management Plan

The information that is collected during the study should be used to develop a Shoreline Management Plan for the impoundment. If results from the erosion evaluation suggest that Project operations are impacting erosion within the impoundment, further evaluation should be undertaken to determine if there is a feasible way to reduce impacts. This feasibility analysis will be based on field observations and knowledge of current erosion control and slope failure stabilization methods that may be suitable for sites. The analysis will provide a preliminary list of potential control measures necessary to reduce erosion at these sites. Detailed analyses for final design and construction of erosion and slope stabilization control measures will not be part of the study. As part of this process, the landowner should be identified for each of the erosion sites and future mitigation and stabilization techniques should be presented.

The study area for the shoreline erosion study should extend from the upstream end of the impoundment above the Wilder Dam to the beginning of the impoundment below the Wilder Dam. Water level fluctuations caused by the Project may affect not only the impoundment but also the downstream river reaches below the dam.

Level of Effort and Cost

The cost and effort of this study will be moderate, but is important to document the potential impact project operations on shoreline erosion and riverbank failure, and to determine how this may impact other resources.

Literature Cited

Kleinschmidt (Kleinschmidt Associates, Inc.). 2011. Lower Connecticut River Shoreline Survey Report – 2010: Bellows Falls Project (FERC No. 1855), Wilder Project (FERC No. 1892), Vernon Project (FERC No. 1904). Draft Report March 2011. Prepared for TransCanada Hydro Northeast Inc.,Westborough, MA.

Lawson, D.E., 1985, Erosion of northern reservoir shores: An analysis and application of pertinent literature: US Army Corps of Engineers Cold Regions Research and Engineering Laboratory Monograph 85-1, 198 p.

Simons, D.B., Andrews, J.W., Li, R.M., and Alawady, M.A. 1979. Connecticut River Streambank Erosion Study Massachusetts, New Hampshire, and Vermont. Prepared for USACE, New England Division.

Study Request 21b: Bellows Falls Hydroelectric Project: Shoreline and downstream erosion from water level fluctuation in the impoundment and downstream from peaking operations (Docket Number p-1855)

Goals and Objectives

The goal of this study is to determine how project operations contribute to the shoreline erosion and riverbank failure within the impoundment and downstream of the Bellows Falls Hydroelectric Project.

The objectives of this study are to:

1. determine how water level fluctuations within the minimum and maximum operating range and discharges from peaking operations at the Bellows Falls hydroelectric project contribute to shoreline erosion;

2. identify and determine the effects of shoreline bank erosion and riverbank failure on other resources (i.e. riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, etc.);

3. identify techniques that could be used to mitigate the effects of project operations or other mitigation techniques that could be developed to reduce on riverbank erosion within the impoundment and downstream of the tailrace.

Resource Management Goals

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)]. New Hampshire’s surface water quality regulations state that “unless the flows are caused by naturally occurring conditions, surface water quantity shall be maintained at levels adequate to protect existing and designated uses.” (Env-Wq 1703.01(d)). The specific New Hampshire water quality criteria for turbidity in Class B waters is not to exceed naturally occurring conditions by more than 10 NTUs (Env-Wq 1703.11). This study request will inform the 401 water quality certification process and help ensure that State water quality standards will be met.

The Connecticut River is considered Class B water by the states of Vermont and New Hampshire. Vermont lists the section of the Connecticut River below the Wilder dam on the Section 303(d) impaired water list due to flow alterations resulting in the destabilization and eroding of shoreline impairing aquatic life and habitat. In Class B waters, Vermont's water quality standards state that water level fluctuation and flow alterations can only occur to the extent that it supports all uses and does not lead to degradation of the water resource or habitat.

A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.
2 New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.
3 New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

This study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest Consideration

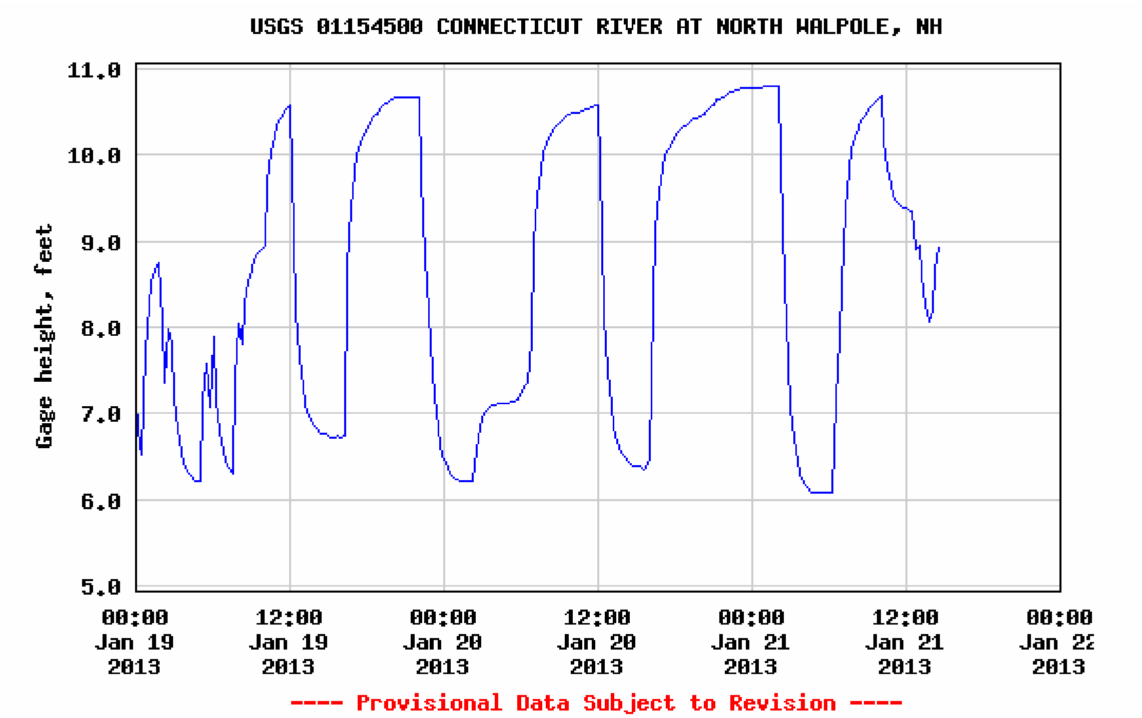
The requestor is a state natural resource agency.

Existing Information

The PAD references several studies pertaining to shoreline erosion within the Connecticut River, including the study by US Army Corp of Engineers (Simion et al. 1979). This study evaluated the shoreline within the Wilder impoundment and identified water level fluctuation and periodic high flow events. The PAD also discusses the erosion survey that TransCanada initiated 2010 to inventory sites where erosion is occurring within the Bellows Falls impoundment (Kleinschmidt 2011). Bank slumping was identified as the major type of shoreline erosion within the project impoundment. Bank slumping can occur when fluvial erosional forces act on the toe of the bank slope. The PAD did not address how project related operations contribute to shoreline erosion, could be changed to mitigate impacts on shoreline erosion, or discuss the impacts of shoreline erosion on other resources (i.e. riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, etc.).

Repetitive water level fluctuations and flow alterations caused by hydroelectric peaking operations are known to be a major contributor to shoreline erosion (Lawson 1985). Sediment from shoreline erosion and riverbank failure is one of the major contributors negatively affecting water quality and habitat by increasing turbidity and sedimentation, smothering aquatic habitat in the United States. Vermont Surface Water Management Strategy identifies sediment from excessive channel erosion as a stressor on Vermont water and aquatic habitat. Additionally, Vermont lists this section of the Connecticut River on the Vermont Section 303(d) impaired water list due to flow alterations resulting from the destabilization and eroding of shoreline impairing aquatic life and habitat.

An example of the water level fluctuations that occur in Lower Connecticut River due to hydropower generation downstream of the Bellows Falls Project is shown below.



Project Nexus

Bellows Falls Hydroelectric Project operations currently result in daily water level fluctuation in the impoundment by approximately 2 feet, which has the potential to affect shoreline erosion in the impoundment. The project is currently permitted to water level fluctuation in the impoundment by 3 feet. Additionally the project "peaking" operation could contribute to bank erosion downstream of the dam by increasing the shear stress on the bank toe. Furthermore, river profile operations during high flow events minimize overland flow by drawing down impoundment prior to high flows containing high velocity flows to the river channel, possibly increasing shoreline erosion rate within the impoundment. TransCanada is not proposing any changes to project operations.

Methodology

Kleinschmidt (2011) conducted a shoreline erosion survey on the Connecticut River, from which we have data on the spatial locations, lengths and heights of such erosion. However, this study did not investigate whether the practice of flow modification is a causative agent to this erosion. Consequently we recommend TransCanada further investigate sites on the Connecticut River to evaluate the processes that are active along banks. This investigation should build on the erosion survey that was previously completed by determining the process causing erosion at a site, the extent erosion is negatively affecting other resources (i.e. riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, etc.), and determining how erosion could be stabilized or mitigated by changing project operations. This investigation can be completed performing the following tasks.

Task 1: Determine erosion and riverbank failure process at identified sites

Shoreline erosion areas and riverbank failure sites were identified during the Kleinschmidt (2011) survey. A survey similar to Kleinschmidt (2011) should be conducted to document if any additional erosion has occurred, and identify new sites of erosion within the impoundment, given the occurrence of Tropical Storm Irene since the Kleinschmidt survey. For each erosion site, the following erosion process element will be identified by determining soil type and subsoil characteristics (i.e. depth to bedrock, texture, rock content, signs of soil piping), reservoir water levels at the time of observation, water level fluctuation, climatic conditions, ground water seepage, wind-driven waves, boat waves, and recreation. Additional site characteristic to identify and record in the erosion survey will include but not be limited to an estimate of the length and average height of the erosional area, slope of the site, dominant vegetation cover types present, associated vegetation cover types present, an ocular estimate of total plant cover and total cover by plant class (tree, shrub, herbaceous) in surrounding undisturbed areas. Data from each shoreline erosion site will be recorded on a field form and entered into a database. In addition, a photograph or photographs will be taken of each site. Sites. should be visited when water levels are lowest.

Erosion processes will be determined by field observations and applying site appropriate geology, geomorphic and hydrological principles. To evaluate the relative influence of water level fluctuations on existing shoreline erosion, a minimum of six select sites (three in the impoundment and three downstream of the dam) will be identified for more detailed measurements and observations. In aid of site selection, comparison of successive aerial photographs will be conducted to identify sites that have experienced visible bank movement. Data from erosion surveys will be examined to identify sites with varying conditions of riparian buffer, vegetation type and bank slope. The sites selected for detailed evaluation will represent different combinations of bank movement, riparian buffer, vegetation type and bank slope. In those bank sites that are selected, rebar pins will be inserted into the banks in a grid at varying heights with each rebar being horizontally level. Initial rebar pin installation will take place when the water level in the impoundment is at its authorized lowest elevation. Each rebar pin will be assigned an individual number and photographed, with the distance from the end of the pin to the bank material measured. A survey will also be conducted of each bank along several bank transects in the vicinity of each site to accurately document bank shape as well as the location and elevation of each rebar and the water surface elevation at the beginning and end of each site visit. Pressure transducers (one in the air and one in the water) will also be installed at each site to automatically record how water surface elevation at each site varies with time.

Biweekly for a period of one year, each of the six sites will be revisited. During each revisit, the bank and each rebar pin will be photographed and the distance from the end of the pin to the bank material will be measured. Any slumping of a pin will be noted. If a pin is found dislodged or removed during a site visit, a new rebar pin will be reinstalled in the approximate location of the previously existing pin.. In addition, a survey of the bank and rebars will be conducted. Surveys will always be conducted in the same manner and will use the same benchmark each site visit. Data from pressure transducers will be downloaded and analyzed each site visit to ensure they are working properly. When this dataset is related to the flow record from existing stream gauges in the river segment, this evaluation will allow for a determination as to whether the erosion is Project related, and if so, how Project operations may be impacting the sites.

Task 2: Determining the effects of erosion on other resources

The effects of shoreline erosion and riverbank failure on other resources should be determined. This will required coordination between studies to determine the effects of erosion on riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, and recreation. Erosion sites identified as having an impact on resources will be assess to determine if project operations are causing erosion and a mitigation plan to protect the resource of interest should be developed.

Task 3: Development of a Shoreline Management Plan

The information that is collected during the study should be used to develop a Shoreline Management Plan for the impoundment. If results from the erosion evaluation suggest that Project operations are impacting erosion within the impoundment, further evaluation should be undertaken to determine if there is a feasible way to reduce impacts. This feasibility analysis will be based on field observations and knowledge of current erosion control and slope failure stabilization methods that may be suitable for sites. The analysis will provide a preliminary list of potential control measures necessary to reduce erosion at these sites. Detailed analyses for final design and construction of erosion and slope stabilization control measures will not be part of the study. As part of this process, the landowner should be identified for each of the erosion sites and future mitigation and stabilization techniques should be presented.

The study area for the shoreline erosion study should extend from the upstream end of the impoundment above the Bellows Falls Dam to the beginning of the impoundment below the Bellows Falls Dam. Water level fluctuations caused by the Project may affect not only the impoundment but also the downstream river reaches below the dam.

Level of Effort and Cost

The cost and effort of this study will be moderate, but is important to document the potential impact project operations on shoreline erosion and riverbank failure, and to determine how this may impact other resources.

Literature Cited

Kleinschmidt (Kleinschmidt Associates, Inc.). 2011. Lower Connecticut River Shoreline Survey Report – 2010: Bellows Falls Project (FERC No. 1855), Wilder Project (FERC No. 1892), Vernon Project (FERC No. 1904). Draft Report March 2011. Prepared for TransCanada Hydro Northeast Inc.,Westborough, MA.

Lawson, D.E., 1985, Erosion of northern reservoir shores: An analysis and application of pertinent literature: US Army Corps of Engineers Cold Regions Research and Engineering Laboratory Monograph 85-1, 198 p.

Simons, D.B., Andrews, J.W., Li, R.M., and Alawady, M.A. 1979. Connecticut River Streambank Erosion Study Massachusetts, New Hampshire, and Vermont. Prepared for USACE, New England Division.

Study Request 21c: Vernon and Turners Falls Hydroelectric Projects: Shoreline and downstream erosion from water level fluctuation in the impoundment and downstream from peaking operations in New Hampshire (FERC NOs. 1904 and 1889)

Goals and Objectives

The goal of this study is to determine how project operations contribute to the shoreline erosion and riverbank failure within the impoundment and downstream of the Vernon Hydroelectric Project and in the portion of the Turners Falls impoundment in New Hampshire.

The objectives of this study are to:

1. determine how water level fluctuations within the minimum and maximum operating range and discharges from peaking operations at the Vernon hydroelectric project contribute to shoreline erosion;

2. identify and determine the effects of shoreline bank erosion and riverbank failure on other resources (i.e. riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, etc.);

3. identify techniques that could be used to mitigate the effects of project operations or other mitigation techniques that could be developed to reduce on riverbank erosion within the impoundment and downstream of the tailrace.

Resource Management Goals

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)]. New Hampshire's surface water quality regulations state that "unless the flows are caused by naturally occurring conditions, surface water quantity shall be maintained at levels adequate to protect existing and designated uses." (Env-Wq 1703.01(d)). The specific New Hampshire water quality criteria for turbidity in Class B waters is not to exceed naturally occurring conditions by more than 10 NTUs (Env-Wq 1703.11). This study request will inform the 401 water quality certification process and help ensure that State water quality standards will be met.

The Connecticut River is considered Class B water by the states of Vermont and New Hampshire. Vermont lists the section of the Connecticut River below the Wilder dam on the Section 303(d) impaired water list due to flow alterations resulting in the destabilization and eroding of shoreline impairing aquatic life and habitat. In Class B waters, Vermont's water quality standards state that water level fluctuation and flow alterations can only occur to the extent that it supports all uses and does not lead to degradation of the water resource or habitat.

A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.

2 New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.

3 New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.

4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

This study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq*.).

Public Interest Consideration

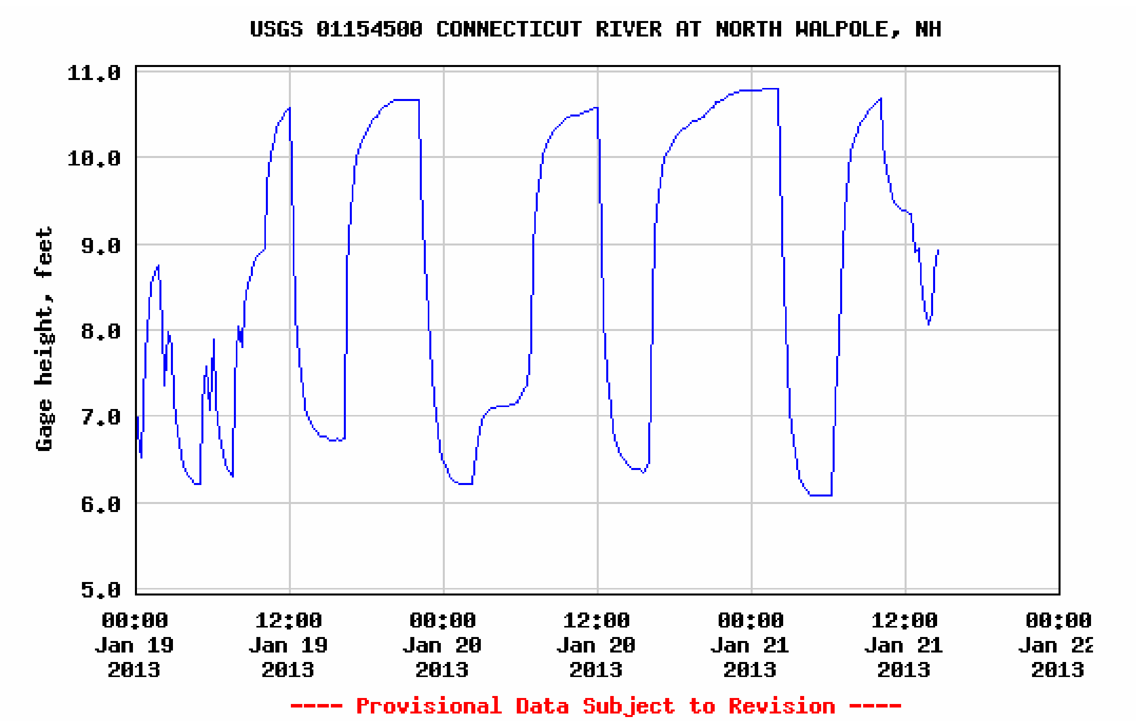
The requestor is a state natural resource agency.

Existing Information

The PAD references several studies pertaining to shoreline erosion within the Connecticut River, including the study by US Army Corp of Engineers (Simion et al. 1979). This study evaluated the shoreline within the Wilder impoundment and identified water level fluctuation and periodic high flow events. The PAD also discusses the erosion survey that TransCanada initiated 2010 to inventory sites where erosion is occurring within the Bellows Falls impoundment (Kleinschmidt 2011). Bank slumping was identified as the major type of shoreline erosion within the project impoundment. Bank slumping can occur when fluvial erosional forces act on the toe of the bank slope. The PAD did not address how project related operations contribute to shoreline erosion, could be changed to mitigate impacts on shoreline erosion, or discuss the impacts of shoreline erosion on other resources (i.e. riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, etc.).

Repetitive water level fluctuations and flow alterations caused by hydroelectric peaking operations are known to be a major contributor to shoreline erosion (Lawson 1985). Sediment from shoreline erosion and riverbank failure is one of the major contributors negatively affecting water quality and habitat by increasing turbidity and sedimentation, smothering aquatic habitat in the United States. Vermont Surface Water Management Strategy identifies sediment from excessive channel erosion as a stressor on Vermont water and aquatic habitat. Additionally, Vermont lists this section of the Connecticut River on the Vermont Section 303(d) impaired water list due to flow alterations resulting from the destabilization and eroding of shoreline impairing aquatic life and habitat.

An example of the water level fluctuations that occur in Lower Connecticut River due to hydropower generation downstream of the Bellows Falls Project is shown below.



Project Nexus

Vernon Hydroelectric Project operations currently result in daily water level fluctuation in the impoundment of approximately 2 feet, with a maximum permitted fluctuation of 8 feet. Turners Falls Hydroelectric Project operations currently result in daily water level fluctuation in the impoundment of approximately 3.7 feet, with a maximum permitted fluctuation of 9 feet. Both projects have the potential to affect shoreline erosion in their respective impoundments.. Additionally the project “peaking” operation could contribute to bank erosion downstream of the dams by increasing the shear stress on the bank toe

Methodology

Kleinschmidt (2011) conducted a shoreline erosion survey on the Connecticut River, from which we have data on the spatial locations, lengths and heights of such erosion. However, this study did not investigate whether the practice of flow modification is a causative agent to this erosion. Consequently, the Vermont Agency of Natural Resources and the New Hampshire Department of Environmental Services recommend TransCanada further investigate sites on the Connecticut River to evaluate the processes that are active along banks. This investigation should build on the erosion survey that was previously completed by determining the process causing erosion at a site, the extent erosion is negatively affecting other resources (i.e. riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, etc.), and determining how erosion could be stabilized or mitigated by changing project operations. This investigation can be completed performing the following tasks.

Task 1: Determine erosion and riverbank failure process at identified sites

Shoreline erosion areas and riverbank failure sites were identified during the Kleinschmidt (2011) survey. A survey similar to Kleinschmidt (2011) should be conducted to document if any additional erosion has occurred, and identify new sites of erosion within the impoundment, given the occurrence of Tropical Storm Irene since the Kleinschmidt survey. For each erosion site, the following erosion process element will be identified by determining soil type and subsoil characteristics (i.e. depth to bedrock, texture, rock content, signs of soil piping), reservoir water levels at the time of observation, water level fluctuation, climatic conditions, ground water seepage, wind-driven waves, boat waves, and recreation. Additional site characteristic to identify and record in the erosion survey will include but not be limited to an estimate of the length and average height of the erosional area, slope of the site, dominant vegetation cover types present, associated vegetation cover types present, an ocular estimate of total plant cover and total cover by plant class (tree, shrub, herbaceous) in surrounding undisturbed areas. Data from each shoreline erosion site will be recorded on a field form and entered into a database. In addition, a photograph or photographs will be taken of each site. Sites. should be visited when water levels are lowest.

Erosion processes will be determined by field observations and applying site appropriate geology, geomorphic and hydrological principles. To evaluate the relative influence of water level fluctuations on existing shoreline erosion, a minimum of six select sites (three in the impoundment and three downstream of the dam) will be identified for more detailed measurements and observations. In aid of site selection, comparison of successive aerial photographs will be conducted to identify sites that have experienced visible bank movement. Data from erosion surveys will be examined to identify sites with varying conditions of riparian buffer, vegetation type and bank slope. The sites selected for detailed evaluation will represent different combinations of bank movement, riparian buffer, vegetation type and bank slope. In those bank sites that are selected, rebar pins will be inserted into the banks in a grid at varying heights with each rebar being horizontally level. Initial rebar pin installation will take place when the water level in the impoundment is at its authorized lowest elevation. Each rebar pin will be assigned an individual number and photographed, with the distance from the end of the pin to the bank material measured. A survey will also be conducted of each bank along several bank transects in the vicinity of each site to accurately document bank shape as well as the location and elevation of each rebar and the water surface elevation at the beginning and end of each site visit. Pressure transducers (one in the air and one in the water) will also be installed at each site to automatically record how water surface elevation at each site varies with time.

Biweekly for a period of one year, each of the six sites will be revisited. During each revisit, the bank and each rebar pin will be photographed and the distance from the end of the pin to the bank material will be measured. Any slumping of a pin will be noted. If a pin is found dislodged or removed during a site visit, a new rebar pin will be reinstalled in the approximate location of the previously existing pin.. In addition, a survey of the bank and rebars will be conducted. Surveys will always be conducted in the same manner and will use the same benchmark each site visit. Data from pressure transducers will be downloaded and analyzed each site visit to ensure they are working properly. When this dataset is related to the flow record from existing stream gauges in the river segment, this evaluation will allow for a determination as to whether the erosion is Project related, and if so, how Project operations may be impacting the sites.

Task 2: Determining the effects of erosion on other resources

The effects of shoreline erosion and riverbank failure on other resources should be determined. This will required coordination between studies to determine the effects of erosion on riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, and recreation. Erosion sites identified as having an impact on resources will be assess to determine if project operations are causing erosion and a mitigation plan to protect the resource of interest should be developed.

Task 3: Development of a Shoreline Management Plan

The information that is collected during the study should be used to develop a Shoreline Management Plan for the impoundment. If results from the erosion evaluation suggest that Project operations are impacting erosion within the impoundment, further evaluation should be undertaken to determine if there is a feasible way to reduce impacts. This feasibility analysis will be based on field observations and knowledge of current erosion control and slope failure stabilization methods that may be suitable for sites. The analysis will provide a preliminary list of potential control measures necessary to reduce erosion at these sites. Detailed analyses for final design and construction of erosion and slope stabilization control measures will not be part of the study. As part of this process, the landowner should be identified for each of the erosion sites and future mitigation and stabilization techniques should be presented.

The study area for the shoreline erosion study should extend from the upstream end of the impoundment above the Vernon Dam to at least the New Hampshire / Massachusetts border. Water level fluctuations caused by the Project may affect not only the impoundment but also the downstream river reaches below the dam.

Level of Effort and Cost

The cost and effort of this study will be moderate, but is important to document the potential impact project operations on shoreline erosion and riverbank failure, and to determine how this may impact other resources.

Literature Cited

Kleinschmidt (Kleinschmidt Associates, Inc.). 2011. Lower Connecticut River Shoreline Survey Report – 2010: Bellows Falls Project (FERC No. 1855), Wilder Project (FERC No. 1892), Vernon Project (FERC No. 1904). Draft Report March 2011. Prepared for TransCanada Hydro Northeast Inc.,Westborough, MA.

Lawson, D.E., 1985, Erosion of northern reservoir shores: An analysis and application of pertinent literature: US Army Corps of Engineers Cold Regions Research and Engineering Laboratory Monograph 85-1, 198 p.

Simons, D.B., Andrews, J.W., Li, R.M., and Alawady, M.A. 1979. Connecticut River Streambank Erosion Study Massachusetts, New Hampshire, and Vermont. Prepared for USACE, New England Division

Study Request 22a: Continuous water temperature monitoring (15 minute intervals) at various locations within the Wilder Hydroelectric Project Impoundment and Tailrace, and Connecticut River downstream of the Wilder Dam (FERC NO. 1892)

Goals and Objectives

The goal of this study is to determine the potential impacts (both project specific and cumulative) of the Wilder Hydroelectric Project operations on hourly/daily temperature fluctuations and spatial thermal distribution within the Wilder Hydroelectric Project Impoundment and Tailrace**,** and the Connecticut River downstream of the Wilder Dam.

The objectives of this study are to:

1. Obtain continuous temperature data (every 15 minutes) at various locations and depths throughout the project impoundment, tailrace, and downstream Connecticut River using temperature loggers;

2. Analyze data for hourly/daily shifts in temperature regime and thermal distribution (aquatic isotherm maps) associated project specific and cumulative impacts associated with project operations; and

3. Determine if any shifts in hourly temperature regime or thermal distribution are impacting aquatic habitat within the project impoundment and tailrace and lower Connecticut River (e.g., thermal blocks to migration, thermal stress, habitat degradation).

Resource Management Goals

Temperature is an important habitat consideration for many aquatic species including migratory fish and rare, threatened, endangered species. Temperature influences the distribution, behavior, metabolism, growth, reproduction, and survival of fishes (Diana 2004).

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)].

Regarding flow, Env-Wq 1703.01(d) states that "unless the flows are caused by naturally occurring conditions, surface water quantity shall be maintained at levels adequate to protect existing and designated uses."

Regarding Biological and Aquatic Community Integrity, Env-Wq 1703.01 states the following:

(s) The surface waters shall support and maintain a balanced, integrated, and adaptive community of organisms have a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region.

(t) Differences from naturally occurring conditions shall be limited to non-detrimental differences in community structure and function.

This study request will inform the 401 water quality certification process and help ensure that State water quality standards such as Env-Wq 1703.19 will be met.

The Connecticut River is considered a Class B waters cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Additionally the Vermont Water Quality Standards states that in Class B cold water fish habitat, the total increase in from any activity or discharge should not result in a temperature increase that exceeds 1.0°F.

A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.
2 New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.
3 New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

This study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The requestor is a state natural resource agency.

Existing Information

The PAD provides limited information on impacts of project operations ("daily run-of-river") on temperature in the project impoundment, tailrace or lower Connecticut River. Hourly/daily temperature shifts associated with project operations at Wilder Dam can impact aquatic habitat rendering it unsuitable for some organisms. The information in the PAD does not define the spatial extent of temperatures (aquatic isotherm map) within the impoundment, lower Connecticut River. The PAD mainly indicates that in general, temperature did increase from upstream to downstream while dissolved oxygen decreased, reflecting the impacts of the impoundment.

Nexus to Project Operations and Effects

The project impounds 45 miles of river that would otherwise be free flowing. It currently operates in a peaking mode, with allowable impoundment fluctuations of up to 5 feet, with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (675 cfs). Water temperature can be affected by the operating mode of a hydropower project. The impounded water increases the water surface area of the river reach containing the project. The increased surface acts as a large solar radiation collector and the thermal mass of the impounded water acts a heat sink storing heat from solar radiation. At night the increased surface area may act as convective radiator that releases heat. Together these attributes may contribute to unnatural thermal properties in the project impoundment that may impact natural temperature regime and influence habitat conditions for fish, wildlife and plant resources (temperature tolerance, life cycle timing (e.g., reproduction or migration), and food availability). The project discharges regulated Connecticut River flows ("daily run-of-river") from the impoundment to the downstream seventeen mile reach of the Connecticut River. The project can sporadically release large volumes of impoundment water that may be of a different temperature than the receiving water downstream of the dam. Unnatural and rapid shifts in temperature regimes in the downstream water can impact fish, wildlife and plant resources and instream habitat. The NHFGD requests that more recent temperature data is collected in a more intensive, systematic and scientific manner in order to assess project specific and cumulative impacts on fish, wildlife and plant resources at the project. Results from this study may be used to directly inform the evaluation of project effects on related resources, such as a fish and other aquatic species.

Methodology Consistent with Accepted Practice

Use of temperature loggers to gain information on thermal trends has been a standard technique to look at impacts of water storage associated with hydroelectric projects. We recommend that transects be established in the upper, middle, and lower project impoundment, as well as in the tailrace and downstream project. An additional transect should be established in the free flowing section of river above the impoundment to serve as a "reference site". Inexpensive temperature loggers should be deployed along each transects at a minimum of three locations: at depths of 1 meter subsurface, mid-depth, and 1 meter off the bottom (on buoy lines) where water depths permit. The temperature loggers should be deployed from April 1 – November 15 and be set to record temperature at 15 minute intervals. The temperature loggers should be checked and the data downloaded on the monthly basis. The data from the loggers should then be used to develop hourly/daily aquatic isotherm maps, and temperature change and distribution as a result of project and cumulative impacts should be assessed.

Level of Effort/Cost, and Why Alternative Studies will not suffice

The effort and cost of this study is expected to be moderate to high, but the potential project specific and cumulative thermal alteration impacts have never been studied in a comprehensive manner and their potential impacts to aquatic habitat and fish, wildlife, and resources has not been adequately studied.

Literature Cited

Diana, J.S. 2004. Biology and Ecology of Fishes. 2nd edition. Biological Sciences Press.

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Study Request 22b: Continuous water temperature monitoring (15 minute intervals) at various locations within the Bellows Falls Hydroelectric Project Impoundment and Tailrace, and Connecticut River downstream of the Bellows Falls Dam (FERC NO. 1855)

Goals and Objectives

The goal of this study is to determine the potential impacts (both project specific and cumulative) of the Bellows Falls Hydroelectric Project operations on hourly/daily temperature fluctuations and spatial thermal distribution within the Bellows Falls Hydroelectric Project Impoundment and Tailrace**,** and the Connecticut River downstream of the Bellows Falls Dam.

The objectives of this study are to:

1. Obtain continuous temperature data (every 15 minutes) at various locations and depths throughout the project impoundment, tailrace, and downstream Connecticut River using temperature loggers;

2. Analyze data for hourly/daily shifts in temperature regime and thermal distribution (aquatic isotherm maps) associated project specific and cumulative impacts associated with project operations; and

3. Determine if any shifts in hourly temperature regime or thermal distribution are impacting aquatic habitat within the project impoundment and tailrace and lower Connecticut River (e.g., thermal blocks to migration, thermal stress, habitat degradation).

Resource Management Goals

Temperature is an important habitat consideration for many aquatic species including migratory fish and rare, threatened, endangered species. Temperature influences the distribution, behavior, metabolism, growth, reproduction, and survival of fishes (Diana 2004).

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)].

Regarding flow, Env-Wq 1703.01(d) states that "unless the flows are caused by naturally occurring conditions, surface water quantity shall be maintained at levels adequate to protect existing and designated uses."

Regarding Biological and Aquatic Community Integrity, Env-Wq 1703.01 states the following:

(u) The surface waters shall support and maintain a balanced, integrated, and adaptive community of organisms have a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region.

(v) Differences from naturally occurring conditions shall be limited to non-detrimental differences in community structure and function.

This study request will inform the 401 water quality certification process and help ensure that State water quality standards such as Env-Wq 1703.19 will be met.

The Connecticut River is considered a Class B waters cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Additionally the Vermont Water Quality Standards states that in Class B cold water fish habitat, the total increase in from any activity or discharge should not result in a temperature increase that exceeds 1.0°F.

A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.
2 New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.
3 New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

This study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the Clean Water Act (33 U.S.C. §1251 *et seq*.).

Public Interest

The requestor is a state natural resource agency.

Existing Information

The PAD provides limited information on impacts of project operations ("daily run-of-river") on temperature in the project impoundment, tailrace or lower Connecticut River. Hourly/daily temperature shifts associated with project operations at Bellows Falls Dam can impact aquatic habitat rendering it unsuitable for some organisms. The information in the PAD does not define the spatial extent of temperatures (aquatic isotherm map) within the impoundment, lower Connecticut River. The PAD mainly indicates that in general, temperature did increase from upstream to downstream while dissolved oxygen decreased, reflecting the impacts of the impoundment.

Nexus to Project Operations and Effects

The project impounds 26 miles of river that would otherwise be free flowing. It currently operates in a peaking mode, with allowable impoundment fluctuations of up to 3 feet, with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (1083 cfs). Water quality can be affected by the operating mode of a hydropower project. The PAD provides limited information on how project operations affect water quality within the project impoundment, bypass reach and tailrace. Water temperature can be affected by the operating mode of a hydropower project. The impounded water increases the water surface area of the river reach containing the project. The increased surface acts as a larger solar radiation collector and the thermal mass of the impounded water acts a heat sink storing heat from solar radiation. At night the increased surface area may act as convective radiator that releases heat. Together these attributes may contribute to unnatural thermal properties in the project impoundment that may impact natural temperature regime and influence habitat conditions for fish, wildlife and plant resources (temperature tolerance, life cycle timing (e.g., reproduction or migration), and food availability).

The project discharges regulated Connecticut River flows ("daily run-of-river") from the impoundment to the downstream seventeen mile reach of the Connecticut River. The project can sporadically release large volumes of impoundment water that may be of a different temperature than the receiving water downstream of the dam. Unnatural and rapid shifts in temperature regimes in the downstream water can impact fish, wildlife and plant resources and instream habitat. The NHFGD requests that more recent temperature data is collected in a more intensive, systematic and scientific manner in order to assess project specific and cumulative impacts on fish, wildlife and plant resources at the project. Results from this study may be used to directly inform the evaluation of project effects on related resources, such as a fish and other aquatic species.

Methodology Consistent with Accepted Practice

Use of temperature loggers to gain information on thermal trends has been a standard technique to look at impacts of water storage associated with hydroelectric projects. We recommend that transects be established in the upper, middle, and lower project impoundment, as well as in the tailrace and downstream project. An additional transect should be established in the free flowing section of river above the impoundment to serve as a "reference site". Inexpensive temperature loggers should be deployed along each transects at a minimum of three locations: at depths of meter subsurface, mid-depth, and 1 meter off the bottom (on buoy lines) where water depths permit. The temperature loggers should be deployed from April 1 – November 15 and be set to record temperature at 15 minute intervals. The temperature loggers should be checked and the data downloaded on the monthly basis. The data from the loggers should then be used to develop hourly/daily aquatic isotherm maps, and temperature change and distribution as a result of project and cumulative impacts should be assessed.

Level of Effort/Cost, and Why Alternative Studies will not suffice

The effort and cost of this study is expected to be moderate to high, but the potential project specific and cumulative thermal alteration impacts have never been studied in a comprehensive manner and their potential impacts to aquatic habitat and fish, wildlife, and resources has not been adequately studied.

Literature Cited

Diana, J.S. 2004. Biology and Ecology of Fishes. 2nd edition. Biological Sciences Press.

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Study Request 22c: Continuous water temperature monitoring (15 minute intervals) at various locations within the Vernon Hydroelectric Project Impoundment and Tailrace, and Connecticut River downstream of the Vernon Dam (FERC NO. 1904)

Goals and Objectives

The goal of this study is to determine the potential impacts (both project specific and cumulative) of the Vernon Hydroelectric Project operations on hourly/daily temperature fluctuations and spatial thermal distribution within the Vernon Hydroelectric Project Impoundment and Tailrace**,** and the Connecticut River downstream of the Vernon Dam.
The objectives of this study are to:

1. Obtain continuous temperature data (every 15 minutes) at various locations and depths throughout the project impoundment, tailrace, and downstream Connecticut River using temperature loggers;

2. Analyze data for hourly/daily shifts in temperature regime and thermal distribution (aquatic isotherm maps) associated project specific and cumulative impacts associated with project operations; and

3. Determine if any shifts in hourly temperature regime or thermal distribution are impacting aquatic habitat within the project impoundment and tailrace and lower Connecticut River (e.g., thermal blocks to migration, thermal stress, habitat degradation).

Resource Management Goals

Temperature is an important habitat consideration for many aquatic species including migratory fish and rare, threatened, endangered species. Temperature influences the distribution, behavior, metabolism, growth, reproduction, and survival of fishes (Diana 2004).

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)].

Regarding flow, Env-Wq 1703.01(d) states that "unless the flows are caused by naturally occurring conditions, surface water quantity shall be maintained at levels adequate to protect existing and designated uses."

Regarding Biological and Aquatic Community Integrity, Env-Wq 1703.01 states the following:

(w) The surface waters shall support and maintain a balanced, integrated, and adaptive community of organisms have a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region.

(x) Differences from naturally occurring conditions shall be limited to non-detrimental differences in community structure and function.

This study request will inform the 401 water quality certification process and help ensure that State water quality standards such as Env-Wq 1703.19 will be met.

The Connecticut River is considered a Class B waters cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Additionally the Vermont Water Quality Standards states that in Class B cold water fish habitat, the total increase in from any activity or discharge should not result in a temperature increase that exceeds 1.0°F.

A mission of the New Hampshire Fish and Game Department (NHFGD) relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.
2 New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.
3 New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

This study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The requestor is a state natural resource agency.

Existing Information

The PAD provides limited information on impacts of project operations ("daily run-of-river") on temperature in the project impoundment, tailrace or lower Connecticut River. Hourly/daily temperature shifts associated with project operations at Bellows Falls Dam can impact aquatic habitat rendering it unsuitable for some organisms. The information in the PAD does not define the spatial extent of temperatures (aquatic isotherm map) within the impoundment, lower Connecticut River. The PAD mainly indicates that in general, temperature did increase from upstream to downstream while dissolved oxygen decreased, reflecting the impacts of the impoundment.
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Nexus to Project Operations and Effects

The project impounds 26 miles of river that would otherwise be natural free-flowing. It currently operates in a peaking mode, with allowable impoundment fluctuations of up to 8 feet, with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (1250 cfs). Water temperature can be affected by the operating mode of a hydropower project. The impounded water increases the water surface area of the river reach containing the project. The increased surface acts as a larger solar radiation collector and the thermal mass of the impounded water acts a heat sink storing heat from solar radiation. At night the increased surface area may act as convective radiator that releases heat. Together these attributes may contribute to unnatural thermal properties in the project impoundment that may impact natural temperature regime and influence habitat conditions for fish, wildlife and plant resources (temperature tolerance, life cycle timing (e.g., reproduction or migration), and food availability).

The project discharges regulated Connecticut River flows ("daily run-of-river") from the impoundment to the downstream seventeen mile reach of the Connecticut River. The project can sporadically release large volumes of impoundment water that may be of a different temperature than the receiving water downstream of the dam. Unnatural and rapid shifts in temperature regimes in the downstream water can impact fish, wildlife and plant resources and instream habitat. The NHFGD requests that more recent temperature data is collected in a more intensive, systematic and scientific manner is needed to assess project specific and cumulative impacts on fish, wildlife and plant resources at the project. Results from this study may be used to directly inform the evaluation of project effects on related resources, such as a fish and other aquatic species.

Methodology Consistent with Accepted Practice

Use of temperature loggers to gain information on thermal trends has been a standard technique to look at impacts of water storage associated with hydroelectric projects. We recommend that transects be established in the upper, middle, and lower project impoundment, as well as in the tailrace and downstream project. An additional transect should be established in the free flowing section of river above the impoundment to serve as a "reference site". Inexpensive temperature loggers should be deployed along each transects at a minimum of three locations: at depths of meter subsurface, mid-depth, and 1 meter off the bottom (on buoy lines) where water depths permit. The temperature loggers should be deployed from April 1 – November 15 and be set to record temperature at 15 minute intervals. The temperature loggers should be checked and the data downloaded on the monthly basis. The data from the loggers should then be used to develop hourly/daily aquatic isotherm maps, and temperature change and distribution as a result of project and cumulative impacts should be assessed.

Level of Effort/Cost, and Why Alternative Studies will not suffice

The effort and cost of this study is expected to be moderate to high, but the potential project specific and cumulative thermal alteration impacts have never been studied in a comprehensive manner and their potential impacts to aquatic habitat and fish, wildlife, and resources has not been adequately studied.

Literature Cited

Diana, J.S. 2004. Biology and Ecology of Fishes. 2nd edition. Biological Sciences Press.

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Study Request 23: Project Effects on Populations of Tessellated Darter, *Etheostoma olmstedi* (FERC NO. 1904, 1855 and 1892)

Goals and Objectives

The goal of this study is to evaluate the effects of project operations on populations of tessellated darter (*Etheostoma olmstedi*), a New Hampshire species of greatest conservation concern and known host species for the federally-endangered dwarf wedgemussel (*Alasmidonta heterodon*). The specific objectives of the study are to:

> Objective 1: Determine the distribution and abundance of tessellated darter within project-affected areas; and
>
> Objective 2: Determine the effects of project operations on the distribution and abundance of tessellated darter.

Relevant Resource Management Goals and Public Interest Considerations

The tessellated darter is one of only three fish species in the Upper Connecticut River that serve as hosts for the glochidia of the federally-endangered dwarf wedgemussel, the others being the slimy sculpin (*Cottus cognatus*) and the Atlantic salmon (*Salmo salar*) (Wicklow 2005). Tessellated darters may be the most important hosts for the dwarf wedgemussel in the Upper Connecticut for the following reasons:

- The USFWS has decided to end its program of stocking hatchery-reared salmon in the Connecticut River basin and accordingly it is unlikely that salmon parr will be available as potential hosts.
- The tessellated darter appears to be more widespread than the slimy sculpin in the Bellow Falls and Wilder project areas where the dwarf wedgemussel is known to exist. Yoder et. al. (2009) found the darter in the project areas upstream and downstream of both dams, while the sculpin was not found in either project area.

It is the goal of the USFWS to recover the dwarf wedgemussel so that it can be removed from the Endangered Species list in the future. Populations in the Upper Connecticut River are dependent on healthy tessellated darter populations, and therefore a better understanding of how dam operations affect the darter is crucial to the recovery of the dwarf wedgemussel.

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)].

Regarding flow, Env-Wq 1703.01(d) states that "unless the flows are caused by naturally occurring conditions, surface water quantity shall be maintained at levels adequate to protect existing and designated uses."

Regarding Biological and Aquatic Community Integrity, Env-Wq 1703.01 states the following:

(y) The surface waters shall support and maintain a balanced, integrated, and adaptive community of organisms have a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region.

(z) Differences from naturally occurring conditions shall be limited to non-detrimental differences in community structure and function.

This study request will inform the 401 water quality certification process and help ensure that State water quality standards such as Env-Wq 1703.19 will be met.

A mission of both the New Hampshire Fish and Game Department (NHFGD) and the Vermont Fish and Wildlife Department is to protect and conserve fish and wildlife and their habitats. Riverine fish species are an important component of the river's ecology. Tessellated darter is identified by New Hampshire as a Species of Greatest Concern.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.
2 New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.
3 New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

This study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Existing Information and Need for Additional Information

In the Preliminary Application Documents (PADs) for the Wilder, Bellows Falls, and Vernon projects, the applicant acknowledges that tessellated darter is one of the confirmed hosts of dwarf wedgemussel. It also identifies the occurrence of tessellated darter both upstream and downstream of each project. However, studies that specifically target small-bodied benthic species are lacking in project-affected areas. It is therefore likely that results of previous investigations are biased and underestimate true population size. An effective evaluation of project effects on a population will require robust, unbiased estimates of population parameters such as abundance or occupancy and similar estimates of population parameters under known conditions of low to no effect.

Existing literature indicates that tessellated darters may be found in a variety of habitats (Scott and Crossman 1979, Van Snik Gray and Stauffer 1999, Hartel 2002, Van Snik Gray et al. 2005, Henry and Grossman 2008), but these habitats are not necessarily equal in their ability to support the population or its function as host to dwarf wedgemussel. We cannot be certain that habitat use infers preference, nor that habitat use will be consistent from basin to basin. Therefore, habitat use within project-affected areas should be evaluated, and should be evaluated in concert with population parameters. By estimating population parameters (e.g., abundance, occupancy, extinction/colonization) as functions of habitat, we may determine whether habitat contributes to any differences in populations and if so, what specific habitat is preferred for stable and persistent populations.

Project Nexus

Operations at the Wilder, Bellows Falls, and Vernon projects alter natural river flow and consequently cause changes in the availability of instream habitat on which the tessellated darter and other lotic species depend. Habitat for tessellated darters is directly related to project operations in terms of flow (water depth and velocity, and their timing, duration, frequency, and rate of change) as well as the interactions of flow with other habitat variables such as substrata, vegetation, and cover. Operations both upstream (changes to the reservoir) and downstream (changes to the flow regime) may affect habitat, and may consequently lead to changes in the distribution, abundance, and behavior of tessellated darters that could in turn potentially affect the federally-endangered dwarf wedge mussel, for which the tessellated darter is a host species.

The information collected for this requested study will help determine whether project operations have a substantial effect on populations of tessellated darter, or whether population parameters are consistent with those of other populations in the region. If there is an effect of project operations on darter populations, study results will also permit identification of those habitat components related to operations that are most important for maintenance of stable and persistent populations of tessellated darter. This will in turn provide information that will assist the development of recommendations aimed to maintain populations of dwarf wedgemussel.

Proposed Methodology

Using an accepted and robust field sampling design (e.g., as described in Pollock et al. 2002 or MacKenzie et al. 2006) and accepted methods for collecting tessellated darters and other similar small-bodied fishes, conduct a field survey for tessellated darters within all projectaffected areas from the headwaters of the Wilder pool downstream to the Vernon dam, as well as in selected areas outside of the project-affected areas with known stable populations of tessellated darter and/or dwarf wedgemussel. Such a sampling design should include replicate samples for estimation of species detection probability. For each replicate sample, collect and record data that may be important for describing differences in populations of tessellated darter, such as presence or abundance of other species (e.g., dwarf wedgemussel, slimy sculpin *Cottuscognatus*), depth, velocity, water temperature, substrata, time of day, presence of cover, proportion of vegetation cover, size of individuals collected (juveniles may select different habitat; larger individuals may outcompete smaller individuals for preferred habitat), and other factors as determined by a qualified biologist. Include also as covariates any relevant flow characteristics (Zimmerman 2006) that may differ among sites.

Using methods as described by Kery et al. (2005), MacKenzie et al. (2006), or Wenger and Freeman (2008), determine whether population estimates of tessellated darter are different in project-affected areas and, if so, which measured factors or flow characteristics are most important in describing these differences.

Level of Effort and Cost

The cost for collecting the data for this study is entirely dependent on the number of sites, number of sample replicates, and the extent of the covariate data that are measured, all of which and should be determined during the development of the study plan in consultation with fishery agencies and other parties, and may be adjusted during the course of field sampling. In general, if a species is common and easily captured, few replicates and many sites produce the best estimates, whereas more replicates and fewer sites are preferable for rare species. In general, the more replicates added, the lower the errors in detection probability, and the more sites sampled, the lower the errors in population parameters. The number of people required in the field will be dependent on the sampling method that is selected, but should be at least two individuals. Provided the collected data are of high quality, analysis and synthesis should take at most 5-10
days.

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Henry, B.E., and G.D. Grossman. 2008. Microhabitat use by blackbanded (*Percina nigrofasciata*), turquoise (*Etheostoma inscriptum*), and tessellated *(E. olmstedi*) dartersduring drought in a Georgia piedmont stream. Environmental Biology of Fishes 83:171-182.

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Zimmerman, J.K.H. 2006. Response of physical processes and ecological targets to altered hydrology in the Connecticut River basin. The Nature Conservancy, Connecticut River Program, Northampton, MA.

Study Request 24: Upstream American Eel Passage Assessment at Vernon, Bellows Falls and Wilder Projects (FERC NOs. 1904, 1855 and 1892)

Goals and Objectives

This study has two objectives:

1. Conduct systematic surveys of eel presence/abundance at tailrace and spillway locations at the Vernon, Bellows Falls, and Wilder projects to identify areas of concentration of eels staging in pools or attempting to ascend wetted structures that would potentially establish the most effective locations to place upstream eel passage facilities.

2. Collect eels with temporary trap/pass devices from areas identified from surveys as potential locations of eel concentration to assess whether eels can be collected/passed in substantial numbers, and whether locations are viable sites for permanent eel trap/pass structures.

Resource Management Goals

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)].

Regarding flow, Env-Wq 1703.01(d) states that "unless the flows are caused by naturally occurring conditions, surface water quantity shall be maintained at levels adequate to protect existing and designated uses."

Regarding Biological and Aquatic Community Integrity, Env-Wq 1703.01 states the following:

(aa) The surface waters shall support and maintain a balanced, integrated, and adaptive community of organisms have a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region.

(bb) Differences from naturally occurring conditions shall be limited to non-detrimental differences in community structure and function.

This study request will inform the 401 water quality certification process and help ensure that State water quality standards such as Env-Wq 1703.19 will be met.

The Atlantic States Marine Fisheries Commission has developed two documents related to the management of American eel:

1 Interstate Fishery Management Plan for American Eel. April 2000. Atlantic States Marine Fisheries Commission.
2 Addendum II to the Fishery Management Plan for American Eel. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

In addition, the Connecticut River Atlantic Salmon Commission (CRASC) developed the draft document: A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin in 2005. The goal of the plan is "to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem…" Management objectives in the plan include the following:

1 Protect and enhance eel populations where they currently exist;
2 Where practical, restore populations to waters where they had historical abundance;
3 Provide effective upstream and downstream fish passage around dams and other barriers within the species' range in the basin; and
4 Comply with all requirements of the Fishery Management Plan of the ASMFC.

Based on these plans, the New Hampshire Fish and Game Department (NHFGD) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the three projects. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to upstream passage of American eel, the NHFGD's goals are:

1. Minimize current and potential negative project operation effects that could hinder management goals and objectives.
2. Minimize project-related sources of upstream passage delay, injury, and stress in order to facilitate access to historical rearing habitat.

The American eel (*Anguilla rostrata*), is also one of New Hampshire and Vermont's Species of Greatest Conservation Need (SGCN). The status for conservation need in Vermont is listed as high priority (Kart et al. 2005), and the species is listed as "vulnerable" in New Hampshire. As identified in Vermont's Wildlife Action Plan (Kart et al. 2005), threats to the species include the construction of large dams on rivers which obstruct juvenile fish access to critical rearing habitats, as well as mortality associated with passing through hydroelectric facilities' turbines during their outmigration to sea.

As outlined in Vermont's Wildlife Action Plan (Kart et al. 2005), research and monitoring needs for this SGCN include determining their distribution and abundance, as the contribution of eels in northern regions to overall stock is unknown. One of the conservation strategies for this species is to support efforts to enhance access of American eels to Vermont waters by eliminating or minimizing impacts of dams and other obstructions along the Richelieu, St. Lawrence, and Connecticut Rivers.

A mission of the NHFGD relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1 New Hampshire has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.
2 New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.
3 New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.
4 Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

This study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The requestor is a state natural resource agency.

Existing Information

The PAD contains no information relative to areas where eels seeking to move upstream concentrate downstream of the three dams, or annual numbers of eels attempting to ascend past the dams. While eels have been known to ascend the Vernon and Bellows Falls fish ladders, their efficiency for passing eels is unknown, and they are only operated during the American shad passage season (from April 15 through July 15). Eels are currently able to pass Vernon, Bellows Falls, and Wilder dams (as evidenced by documented presence of eels upstream), but the total number of eels attempting to pass all three dams and the proportion successfully passing each project is unknown (but suspected to be low). The downstream Holyoke Project has operated upstream eel passage facilities since 2004. Last year these facilities passed over 40,000 juvenile eels. While the next dam upstream (the Turners Falls Project; FERC No. 1889) has no dedicated upstream eel passage facilities, eels have been known to ascend the Cabot Station fish ladder (A. Haro, U.S. Geological Survey, pers. comm.). Although there is rearing habitat in between the Turners Falls and Vernon dams, some eels will attempt to continue upstream, and passage needs to be provided so these fish can access historical habitat.

These information gaps need to be filled so resource agencies can determine the best locations to site upstream eel passage facilities and assess whether operating the existing anadromous ladders would be an effective mechanism to move juvenile eels upstream past the projects.

We also note that within the past seven years, the United States Fish and Wildlife Service (USFWS) has received two petitions to list the American eel under the Endangered Species Act. The first petition was received on November 18, 2004. On July 6, 2005 the USFWS issued a substantial 90-day finding on the petition and initiated a 12-month status review that concluded on February 2, 2007 with a finding that listing was not warranted. The second petition was filed on April 30, 2010 by the Council for Endangered Species Act Reliability. On September 29, 2011 the USFWS issued a substantial 90-day finding and initiated a 12-month status review. It is our understanding that the USFWS is still accepting new American eel information for the ongoing status review.

Nexus to Project Operations and Effects

The three projects generate hydropower on the head created by the Vernon, Bellows Falls, and Wilder dams. These dams create barriers to upstream migrating eels. While some eels are able to pass dams, some are not, and the passability of a given dam depends on factors such as its height, hydraulics, presence of climbable surfaces, presence of predators, risk of exposure to heat or drying while climbing a dam, etc. All three dams are high (Vernon: 58 ft. high; Bellows Falls: 30 ft. high; and Wilder: 60 ft. high), and the majority of the dam faces are dry during most of the upstream eel passage season. Design of the dams is not currently amenable to passage of eels by climbing. As mentioned earlier, the existing anadromous passage facilities are not designed to pass eels, and even if some eels are able to ascend the ladders, they may incur delays (in attraction or passage rates), be size-selective (e.g. velocity barrier for small eels presented by ~8 ft/sec flow through weirs and orifices), present a potential predation risk (predators in or near the fishways), and are not operated throughout the upstream eel passage season.

Methodology Consistent with Accepted Practice

1. Objective 1: Systematic Surveys

   Surveys of eel presence and relative abundance should be conducted at regular intervals throughout the eel upstream migratory season (~1 May to ~15 October, or when river temperatures exceed 10 C). Surveys should consist of visual inspection and trapping in likely areas where eels may concentrate as they attempt to climb structures wetted by significant spill or leakage flow below the dams and associated structures. These locations include: the upstream fish ladders at all three projects (dewatered state) and leakage or overflow points along the downstream faces of all three dams, including spillways. Methods should include visual surveys (on foot, from a boat, or snorkeling) and trapping using small mesh (< 1/8" clear opening) baited eel pots. Visual surveys should be performed once per week, at night, preferentially during precipitation events. Trap sets should be performed once per week, with an overnight soak time. Recorded data should include location, observation of eels (presence, absence, relative numbers, relative sizes, behaviors, time/date of observation), and survey method.

2. Objective 2: Trap/Pass Collections

   Areas identified from Systematic Surveys as having significant number of eels present should be targeted as potential areas for permanent eel trap/passes, and should be initially assessed using temporary/portable trap passes. At a minimum (regardless of survey results), temporary trap passes should be installed at stilling basins and/or lower sections of fishways supplied with minimal attraction flow (0.5-1.0 cfs) during dewatered conditions at all three projects , as these locations may be supplemented with additional attraction flow and have high potential for being concentration points for upstream migrant eels. Similarly, traps should also be placed at spillway or bypass channel locations where eels have a potential to climb wetted (e.g., via leakage) flow zones, at the highest points where eels are able to climb to, or where otherwise feasible. Temporary trap/passes should be purpose-designed and built for each location, and operated throughout the eel upstream migratory season (~1May to 15 October, or when river temperatures exceed 10° C). Ramp-type traps with supplementary attraction flow are preferred temporary trap/pass designs. Traps should operate daily, with catches quantified every 2-3 days. Recorded data should include location, trapping interval, absolute numbers of eels trapped, relative eel sizes, and hydraulic and environmental conditions during the trapping period.

All collected eels from surveys should be released at their point of capture; those eels collected from trap/pass collections should be transported to and released into the headponds upstream of where they were collected.

These methodologies are consistent with accepted practice.

Level of Effort/Cost

The level of cost and effort for the survey component of the study would be low for each individual project (moderate for all three projects combined); a minimal number of personnel may be able to conduct the weekly surveys. The trap/pass component would require low to moderate cost and effort.
We are not aware of any previously conducted or ongoing studies related to upstream eel passage. The applicant did not propose any studies to meet this need in the PAD.

Literature Cited

Kart, J., R. Regan, S.R. Darling, C. Alexander, K. Cox, M. Ferguson, S. Parren, K. Royar, B. Popp, editors. 2005. Vermont's Wildlife Action Plan. Vermont Fish & Wildlife Department. Waterbury, Vermont. http://www.vtfishandwildlife.com/swg_cwcs_report.cfm. (Accessed September 10, 2012).

NHFGD 1998. New Hampshire Fish and Game Department Strategic Plan (1998-2010). Concord, NH.

Study Request 25a: Wilder Hydroelectric Project: Water quality monitoring within the project impoundment and tailrace (FERC NO. 1892)

Goal and Objective

The goal of this study is to determine if the operational impacts of the Wilder Hydroelectric Project are causing or contributing to violations of New Hampshire and/or Vermont state water quality standards.

The objective of this study will be to collect water temperature, dissolved oxygen, specific conductance, pH, turbidity, nutrients, and chlorophyll-a data at multiple locations in the project area. This monitoring effort will consist of both instantaneous measurements and continuous data collected via multi-parameter dataloggers. Data should be collected under normal and peak operating conditions and ambient conditions that include periods of low flow and higher water temperatures. Turbidity readings can provide an approximation of the total suspended solids concentration and therefore of erosion due to peaking operations. Dataloggers equipped with turbidity probes should be deployed at locations up and downstream of the dam to help document the effects of peaking operations on bank erosion and should be coordinated with other study requests regarding bank erosion. Weekly profiles and grab samples should reflect various flow conditions. The water quality data will be compared to both Vermont and New Hampshire water quality standards to determine if the project is causing or contributing to water quality standard violations.

Resource Management Goals

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)].

New Hampshire surface water criteria for Biological and Aquatic Community Integrity, Env-Wq 1703.01 states the following:

> (a) The surface waters shall support and maintain a balanced, integrated, and adaptive community of organisms have a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region.Differences from naturally occurring conditions shall be limited to non-detrimental differences in community structure and function.

New Hampshire surface water criteria for turbidity are provided in Env-Wq 1703.11.

This study request will inform the 401 water quality certification process and help ensure that State water quality standards will be met.

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Vermont lists the section of the Connecticut River below the Wilder dam on the Section 303(d) impaired water list due to flow alterations aquatic life and habitat.

All sections of the Connecticut River related to the project are classified by New Hampshire as Class B. It should be noted that although the classification name is the same as Vermont's, New Hampshire surface water criteria for Class B waters, are in some cases, different from Vermont's.

Public Interest Consideration

The requestor is a state natural resource agency.

Existing Information

The PAD contains information on water quality monitoring that was completed between June 20, 2012 and September 11, 2012 in the tailrace and just upstream of the dam. The data indicated that Vermont Water Quality Standards for dissolved oxygen were not met during a seven day period in August and New Hampshire dissolved oxygen standards were close to being violated (average daily percent saturation of 77.5 percent at W-01 as compared to the criterion of 75% average daily percent saturation and 5.66 mg/L as compared to the instantaneous minimum criterion of 5.0 mg/L). The PAD does not provide information on the water quality throughout the impoundment or how water quality is affected by project operations. The PAD does indicate that in general temperature, specific conductance, and pH did increase from upstream to downstream while dissolved oxygen decreased, reflecting the impacts of the impoundment. To our knowledge, no turbidity data was collected.

Project Nexus

The project impounds 45 miles of river that would otherwise be free flowing. It currently operates in a peaking mode, with allowable impoundment fluctuations of up to 5 feet, with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (675 cfs). Water quality can be affected by the operating mode of a hydropower project. The PAD provides limited information on how project operations affect water quality within the project impoundment and tailrace.

Operations of the project must conform to Vermont and New Hampshire water quality standards. The Vermont Agency of Natural Resources and the New Hampshire Department of Environmental Services request a study that will provide the data needed to determine if the Connecticut River in the vicinity of the Wilder Hydroelectric Project is or is not attaining the water quality standards of both states.

Proposed Methodology

The methodology for this study should be similar to TransCanada's water quality monitoring in 2012 including weekly vertical profiles within the impoundment, weekly water quality samples of nutrients and chlorophyll-a for laboratory analysis and the deployment of multi-parameter continuous dataloggers at multiple locations within the impoundment and tailrace. An additional site should be monitored in the free flowing section of the river above the impoundment to serve as a “reference site”. At each designated datalogger monitoring location at least 10 days of data should be collected at 15 minute increments during a period of low flow ($\leq$3 x 7Q10) and high temperatures (preferably over 23 degrees C) between June 1 and September 30. Dataloggers deployed in the impoundment should be set at the bottom of the epilimnion (if stratified) or at 25% depth if not stratified. A vertical dissolved oxygen and water temperature profile should be conducted at the time of deployment of dataloggers in the impounded section to determine if river is stratified and thus the appropriate depth for deployment. Dataloggers equipped with turbidity probes should be deployed at locations up and downstream of the dam for several months to help document the effects of peaking operations on bank erosion. Placement of dataloggers with turbidity probes should be coordinated with other studies regarding erosion. Water quality results should be graphically compared to both state water quality standards and project operations, including the generation status, impoundment elevation, and discharge.

If low flow conditions are not met the first year of the study, a second year of data may be necessary.

It is preferable that the water quality monitoring for all projects be coordinated so that sampling can occur at each location within each project during the same period of time and under the same operational, flow, and environmental conditions.

Level of Effort and Cost

The cost and effort of this study will be moderate, but is important to document the potential impact operations have on water quality and determine if they meet Vermont and New Hampshire water quality standards.

Study Request 25b: Bellow Falls Hydroelectric Project: Water quality monitoring within the project impoundment, bypass, and tailrace (FERC NO. 1855)

Goal and Objective

The goal of this study is to determine if the operational impacts of the Bellows Falls Hydroelectric Project are causing or contributing to violations of New Hampshire and/or Vermont state water quality standards.

The objective of this study will be to collect water temperature, dissolved oxygen, specific conductance, pH, turbidity, nutrients, and chlorophyll-a data at multiple locations in the project area. This monitoring effort will consist of both instantaneous measurements and continuous data collected via multi-parameter dataloggers. Data should be collected under normal and peak operating conditions and ambient conditions that include periods of low flow and higher water temperatures. Turbidity readings can provide an approximation of the total suspended solids concentration and therefore of erosion due to peaking operations. Dataloggers equipped with turbidity probes should be deployed at locations up and downstream of the dam to help document the effects of peaking operations on bank erosion and should be coordinated with other study requests regarding bank erosion. Weekly profiles and grab samples should reflect various flow conditions. The water quality data will be compared to both Vermont and New Hampshire water quality standards to determine if the project is causing or contributing to water quality standard violations.

Resource Management Goals

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)].

New Hampshire surface water criteria for Biological and Aquatic Community Integrity, Env-Wq 1703.01 states the following:

> (a) The surface waters shall support and maintain a balanced, integrated, and adaptive community of organisms have a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region.Differences from naturally occurring conditions shall be limited to non-detrimental differences in community structure and function.

New Hampshire surface water criteria for turbidity are provided in Env-Wq 1703.11.

This study request will inform the 401 water quality certification process and help ensure that State water quality standards will be met.

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Vermont lists the section of the Connecticut River below the Wilder dam on the Section 303(d) impaired water list due to flow alterations aquatic life and habitat.

All sections of the Connecticut River related to the project are classified by New Hampshire as Class B. It should be noted that although the classification name is the same as Vermont's, New Hampshire surface water criteria for Class B waters, are in some cases, different from Vermont's.

Public Interest Consideration

The requestor is a state natural resource agency.

Existing Information

The PAD contains information on water quality monitoring that was completed between June 20, 2012 and September 12, 2012 in the tailrace, bypass reach and just upstream of the dam. Additionally, weekly water column profiles were collected at three locations within the impoundment. The data indicated that Vermont and New Hampshire water quality standards for dissolved oxygen were not met in the bypass reach and in the impoundment. Furthermore, pH readings collected in water profile measurements indicated that in two different locations during two separate events in the impoundment did not meet Vermont and New Hampshire water quality standards. Continuous monitoring at BF-01 recorded a maximum pH of 8.53 which can be indicative of algal growth (the growth of which can be exacerbated by the higher temperatures typically found in impoundments. The PAD does not provide information on the continuous water quality throughout the impoundment or how water quality is affected by project operations. The PAD indicates that in general temperature, specific conductance, and pH did increase from upstream to downstream while dissolved oxygen decreased, reflecting the impacts of the impoundment.

Project Nexus

The project impounds 26 miles of river that would otherwise be free flowing. It currently operates in a peaking mode, with allowable impoundment fluctuations of up to 3 feet, with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (1083 cfs). Water quality can be affected by the operating mode of a hydropower project. The PAD provides limited information on how project operations affect water quality within the project impoundment, bypass reach and tailrace. Operations of the project must conform to Vermont and New Hampshire water quality standards. The NHFGD requests a study that will provide the data needed to determine if the Connecticut River in the vicinity of the Bellows Falls Hydroelectric Project is or is not attaining the water quality standards of both states.

Proposed Methodology

The methodology for this study should be similar to TransCanada's water quality monitoring in 2012 including weekly vertical profiles within the impoundment, weekly water quality samples of nutrients and chlorophyll-a for laboratory analysis and the deployment of multi-parameter continuous dataloggers at multiple locations within the impoundment, tailrace and bypass reach. An additional site should be monitored in the 17 mile free flowing section of the river above the impoundment to serve as a "reference site". At each designated datalogger monitoring location at least 10 days of data should be collected at 15 minute increments during a period of low flow (≤3 x 7Q10) and high temperatures (preferably over 23 degrees C) between June 1 and September 30. Dataloggers deployed in the impoundment should be set at the bottom of the epilimnion (if stratified) or at 25% depth if not stratified. A vertical dissolved oxygen and water temperature profile should be conducted at the time of deployment of dataloggers in the impounded section to determine if river is stratified and thus the appropriate depth for deployment. Dataloggers equipped with turbidity probes should be deployed at locations up and downstream of the dam for several months to help document the effects of peaking operations on bank erosion. Placement of dataloggers with turbidity probes should be coordinated with other studies regarding erosion. Water quality results should be graphically compared to both state water quality standards and project operations, including the generation status, impoundment elevation, and discharge.

If low flow conditions are not met the first year of the study, a second year of data may be necessary.

It is preferable that the water quality monitoring for all projects be coordinated so that sampling can occur at each location within each project during the same period of time and under the same operational, flow, and environmental conditions.

Level of Effort and Cost

The cost and effort of this study will be moderate, but is important to document the potential impact operations have on water quality and determine if they meet Vermont and New Hampshire water quality standards.

Study Request 25c: Vernon Hydroelectric Project: Water quality monitoring within the Vernon project impoundment and tailrace and in the Turner Falls Impoundment in New Hampshire (FERC NOs. 1904 and 1889)

Goal and Objective

The goal of this study is to determine if the operational impacts of at the Vernon and Turners Falls Projects are causing or contributing to violations of New Hampshire and/or Vermont state water quality standards.

The objective of this study will be to collect water temperature, dissolved oxygen, specific conductance, pH, turbidity, nutrients, and chlorophyll-a data at multiple locations in the project area. This monitoring effort will consist of both instantaneous measurements and continuous data collected via multi-parameter dataloggers. Data should be collected under normal and peak operating conditions and ambient conditions that include periods of low flow and higher water temperatures. Turbidity readings can provide an approximation of the total suspended solids concentration and therefore of erosion due to peaking operations. Dataloggers equipped with turbidity probes should be deployed at locations up and downstream of the dam to help document the effects of peaking operations on bank erosion and should be coordinated with other study requests regarding bank erosion. Weekly profiles and grab samples should reflect various flow conditions. The water quality data will be compared to both Vermont and New Hampshire water quality standards to determine if the project is causing or contributing to water quality standard violations.

Resource Management Goals

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)].

New Hampshire surface water criteria for Biological and Aquatic Community Integrity, Env-Wq 1703.01 states the following:

> (a) The surface waters shall support and maintain a balanced, integrated, and adaptive community of organisms have a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region.Differences from naturally occurring conditions shall be limited to non-detrimental differences in community structure and function.

New Hampshire surface water criteria for turbidity are provided in Env-Wq 1703.11.

This study request will inform the 401 water quality certification process and help ensure that State water quality standards will be met.

The Connecticut River is classified by the state of Vermont as Class B cold water fish habitat. Vermont Water Quality Standards state that Class B waters should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat. Vermont lists the section of the Connecticut River below the Wilder dam on the Section 303(d) impaired water list due to flow alterations aquatic life and habitat.

All sections of the Connecticut River related to the project are classified by New Hampshire as Class B. It should be noted that although the classification name is the same as Vermont's, New Hampshire surface water criteria for Class B waters, are in some cases, different from Vermont's.

Public Interest Consideration

The requestor is a state natural resource agency.

Existing Information

The Vernon PAD contains information on water quality monitoring that was completed between June 20, 2012 and September 11, 2012 in the tailrace and just upstream of the dam. Temperature data indicated that it reached levels that would be critical threshold for salmonids, and above the natural regime for the river. The PAD does not provide information on the water quality throughout the impoundment or how water quality is affected by project operations. The PAD does indicates that in general temperature, specific conductance, and pH did increase from upstream to downstream while dissolved oxygen decreased, reflecting the impacts of the impoundment on increased travel time in the river. The Turners Falls PAD references monitoring conducted in 2004 by DES which was not that comprehensive. More recent data is needed in the Turners Falls impoundment that is collected in the same manner and during the same time period as the Vernon Project. To our knowledge, no turbidity data has been collected for either project.

Project Nexus

The Vernon project impounds 26 miles of river that would otherwise be natural free-flowing. It currently operates in a peaking mode, with allowable impoundment fluctuations of up to 8 feet, with proposals to continue as such. The below-project flow requirement is equal to 0.20 csm (1250 cfs). The impoundment for the Turners Falls impoundment extends approximately 5.7 miles into New Hampshire. It also operates in a peaking mode, with allowable impoundment fluctuations of up to 9 feet. Water quality can be affected by the operating mode of a hydropower project. The PAD provides limited information on how project operations affect water quality within the project impoundment and tailrace.

Operations of the project must conform to Vermont and New Hampshire water quality standards . The Vermont Agency of Natural Resources and the New Hampshire Department of Environmental Services request a study that will provide the data needed to determine if the Connecticut River in the vicinity of the Wilder Hydroelectric Project is or is not attaining the water quality standards of both states.

Proposed Methodology

The methodology for this study should be similar to TransCanada's water quality monitoring in 2012 including weekly vertical profiles within the impoundment, weekly water quality samples of nutrients and chlorophyll-a for laboratory analysis and the deployment of multi-parameter continuous dataloggers at multiple locations within the impoundment and tailrace. An additional site should be monitored in the 17 mile free flowing section of the river above the impoundment to serve as a "reference site". At each designated datalogger monitoring location at least 10 days of data should be collected at 15 minute increments during a period of low flow ($\leq$3 x 7Q10) and high temperatures (preferably over 23 degrees C) between June 1 and September 30. Dataloggers deployed in the impoundment should be set at the bottom of the epilimnion (if stratified) or at 25% depth if not stratified. A vertical dissolved oxygen and water temperature profile should be conducted at the time of deployment of dataloggers in the impounded section to determine if river is stratified and thus the appropriate depth for deployment. Dataloggers equipped with turbidity probes should be deployed at locations up and downstream of the dam for several months to help document the effects of peaking operations on bank erosion. Placement of dataloggers with turbidity probes should be coordinated with other studies regarding erosion. Water quality results should be graphically compared to both state water quality standards and project operations, including the generation status, impoundment elevation, and discharge.

If low flow conditions are not met the first year of the study, a second year of data may be necessary.

It is preferable that the water quality monitoring for all projects be coordinated so that sampling can occur at each location within each project during the same period of time and under the same operational, flow, and environmental conditions.

Level of Effort and Cost

The cost and effort of this study will be moderate, but is important to document the potential impact operations have on water quality and determine if they meet Vermont and New Hampshire water quality standards.

Study Request 26: Impact of Vernon Project Operations on Downstream Migration of Juvenile American Shad (FERC NO. 1904)

Conduct a field study of juvenile American shad outmigration at the Vernon Dam to determine if project operations negatively impact juvenile shad survival and production.

Goals and Objectives

Determine if project operations affect juvenile American shad outmigration survival, recruitment, and production. The following objectives will address this request:

- Assess project operation effects of Vernon Dam on the timing, routes, migration rates, and survival of juvenile shad;
- Determine the proportion of juvenile shad that as a downstream passage route choose or are directed to existing downstream bypass structures, gate structures, or are entrained into the station turbines and assess delay, survival, timing, and related impacts with these locations under a full range of operational conditions, over the period of outmigration;
- Determine survival rates for juvenile shad entrained into Vernon Station units.
-

If it is determined that the project operations or related effects are adversely affecting juvenile shad survival, migration timing, or other deleterious population effects are noted, identify operational solutions or other solutions that will reduce and minimize impacts, within the project affected area. This study will require two years of field data to capture inter-annual variability of river discharge, water temperature, and variability in run size and juvenile production (and timing of developmental stages) and variability in outmigration timing which may relate to spring, summer and fall conditions.

Resource Management Goals

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)].

New Hampshire surface water criteria for Biological and Aquatic Community Integrity, Env-Wq 1703.01 states the following:

(a) The surface waters shall support and maintain a balanced, integrated, and adaptive community of organisms have a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region. Differences from naturally occurring conditions shall be limited to non-detrimental differences in community structure and function.

This study request will inform the 401 water quality certification process and help ensure that State water quality standards, such as Env-Wq 1703.01, will be met.

The Connecticut River Atlantic Salmon Commission developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following:

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.
2. Maximize outmigrant survival for juvenile and spent adult shad.

The Atlantic States Marine Fisheries Commission Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010 includes the following objective:

1. Maximize the number of juvenile recruits emigrating from freshwater stock complexes.

The New Hampshire Fish and Game Department (NHFGD) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:
1) Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2) Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to American shad, the NHFGD's goals are:
1. Minimize current and potential negative project operation effects on juvenile American shad survival, production, and recruitment.

A mission of the NHFGD relevant to this study request is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources.

Four goals from the NHFGD's 1998-2010 Strategic Plan (NHFGD 1998) which are relevant to this study request are:

1) New Hampshire has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.
2) New Hampshire has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.
3) New Hampshire has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.
4) Human activities and land uses are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

This study request is intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *e seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), and the Clean Water Act (33 U.S.C. §1251 *et seq.*).

Public Interest

The requestor is a state natural resource agency.

Existing Information

Adult shad are counted annually as they pass the Vernon Dam. Juvenile American shad production has been monitored upstream of the Vernon Dam and immediately downstream of that dam by Vermont Yankee Nuclear as part of an annual monitoring program using both boat electrofishing (since 1991) and beach seining (since 2000). A seasonal average annual index of juvenile American shad standing crop in Vernon reservoir has been calculated since 2000. Estimates of juvenile shad growth rates in the Vernon impoundment have been calculated annually beginning in 2004, and also in a study conducted in 1995 (Smith and Downey 1995).

Although there were numerous studies of downstream passage facilities at the Vernon Project for Atlantic salmon smolts, passage studies for American shad were limited to tests in 1991 and 1992 of a high frequency sound field to guide fish to the fish pipe, the primary downstream fishway (RMC 1993). Although the studies were deemed incomplete, the technology indicated some level of response by juvenile shad. However, despite that conclusion, there is no indication that this technology or other downstream passage studies with juvenile shad were subsequently pursued.

Nexus to Project Operations and Effects

Juvenile American shad production occurs in the river reach between the Vernon Dam and the Bellows Falls Dam, which is thought to be the historic upstream limit of the shad migration in the Connecticut River. Juvenile American shad require safe and timely downstream passage measures to have the opportunity to contribute to the restoration target population size.

There is little information available regarding the total impact of the Vernon project on downstream migration of juvenile shad. Migration delays, increased predation, mortality during passage over the dam or through turbines, and changes in route selection under different flow conditions are potential influences of the Vernon Dam on the juvenile shad population in the upper Connecticut River. Effective upstream and downstream passage and successful in-river spawning and juvenile production are necessary to help achieve shad management restoration goals for the Connecticut River, particularly in the upstream reaches. Delays in juvenile American shad outmigration may affect survival rates in the transition to the marine environment (Zydlewski et al. 2003).

Methodology Consistent with Accepted Practice

The impact to juvenile shad outmigrants would be best studied by a combination of approaches including hydroacoustics, radio telemetry (including passive integrated transponder (PIT) telemetry), and turbine balloon tags. Project discharge adjustments at the dam should be examined relative to timing, duration, and magnitude of juvenile shad migration to and through the dam, with hydroacoustic equipment for natural/wild fish information. In addition, study fish should be collected and tagged (PIT, radio, balloon) to then empirically determine rates of survival for fish passed through the project under varied operations, from minimum flows up to full spill conditions. The release of tagged fish (radio, PIT) at a number of potential sites will provide data on delay and route selection as juvenile shad move through the Vernon project area. The number and location of release sites will depend on the availability of tagged fish.

Additional hydroacoustic assessment immediately upstream and downstream of the Vernon Dam will provide information on the timing of migration to and through this area. A more focused survival study, using balloon tags, PIT tags, or other appropriate methods, should be conducted in the second year based upon the first year of study findings relative to the frequency, magnitude, timing, and route selection of juvenile American shad through the Vernon project.

Level of Effort/Cost, and Why Alternative Studies will not suffice

TransCanada does not propose any studies to meet this need. Estimated cost for the study is expected to be high with the majority of costs associated with equipment (hydroacoustic gear, radio tags, radio receivers, and PIT readers) and related fieldwork labor.

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Study Request 27: Climate Change as it Relates to Continued Operation of the Vernon, Bellows Falls, Wilder, Northfield Mountain Pumped Storage, and Turners Falls Projects (FERC NOs. 1904, 1855, 1892, 2485, and 1889)

Goals and Objectives

The goal of this study is to determine how climate change relates to the continued operation of the Vernon, Bellows Falls, Wilder, Northfield Mountain Pumped Storage (NFMPS), and Turners Falls projects. The NFMPS and Turners Falls projects impact the Turners Falls impoundment, a portion of which (5.7 miles) is in New Hampshire. These projects are therefore included in this request.

The objectives of this study are:

1. Quantify the amount of thermal loading contributed by each respective impoundment (including the NMPS upper reservoir).
2. Using climate change prediction models, calculate how much warmer the project impoundments are projected to get in the next 30-50 years.
3. Model the effect of various project modifications on river temperature under current conditions and climate change predictions (e.g., converting to run-of-river, deep-water releases, dam removal, large-scale riparian revegetation, etc.).
4. Using climate change prediction models, determine if the projects actually provide an environmental benefit with respect to mitigating against climate change impacts (vis a vis warming of air and water temperatures) by producing low greenhouse gas emitting energy. The Northfield Mountain Pump Storage assessment must be based on net energy production (i.e., NMPS generates1,143,038 MWh annually, but consumes 1,567,506 in its pumping operations; for a net generation of 424,468 MWh annually).
5. Determine how climate change predictions will impact management of high and low flow events at the projects and evaluate if changes to dam structures would mitigate adverse impacts of the existing flood management protocols.

Resource Management Goals

The New Hampshire Department of Environmental Services (DES) is responsible for issuing federal Clean Water Act § 401 water quality certifications (401 certifications) in New Hampshire. State statutory authority for issuing 401 certifications is provided in RSA 485-A:12, III. DES is also responsible for establishing and administering surface water quality standards for New Hampshire. Surface water quality standards include designated uses, criteria to protect the designated uses and antidegradation provisions to protect and maintain existing uses and to minimize degradation of high quality surface waters. Surface water quality standards are included in statute (RSA 485-A:8) and in the State surface water quality regulations (Env-Wq 1700). Designated uses for surface waters include aquatic life, fish consumption, shellfish consumption (tidal waters only), drinking water supply after adequate treatment, primary and secondary contact recreation and wildlife. State surface waters are classified as either class A or B [Env-Wq 1703.01(a)]. The Connecticut River in the vicinity of the hydroelectric projects is Class B. DES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env-Wq 1703.01 (b)].

New Hampshire surface water criteria for Biological and Aquatic Community Integrity, Env-Wq 1703.01 states the following:

(a) The surface waters shall support and maintain a balanced, integrated, and adaptive community of organisms have a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region. Differences from naturally occurring conditions shall be limited to non-detrimental differences in community structure and function.

Impacts of climate change on flow and temperature can impact aquatic life and other uses. This study request will inform the 401 water quality certification process and help ensure that State water quality standards, such as Env-Wq 1703.01, will be met.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures consistent with the Department's 2010-2015 Strategic Plan that was released in the fall of 2010. The Plan includes two goals and several sub-goals that relate to climate change and shifting environmental conditions in the future. Those goals and sub-goals are as follows:

N.H. Department of Environmental Services Strategic Plan (2010 - 2015)

Goal 1: DES and its partners address climate change through effective mitigation and adaptation strategies and efforts to foster the transition to a clean energy economy.

1.1 DES will work in partnership with other state agencies to institutionalize climate change mitigation and adaptation throughout state operations

1.1.1 DES will consider and integrate climate change mitigation and adaptation across all existing DES program areas. (Target: Commence in 2010, and Ongoing)

1.2 DES will work in partnership with state, regional, and national organizations to integrate and coordinate mitigation and adaptation efforts.

1.2.2 DES will continue to take part in regional and national initiatives to advance the transition to a clean energy economy. (Target: Commence by 2010, and Ongoing)

1.2.3 DES will continue to participate in regional and national initiatives to better prepare for the impacts of climate change. (Target: Commence by 2010, and Ongoing)

1.3 DES will monitor, inventory and report climate change emissions and impacts.

1.3.2 DES will work with state research universities and other institutions and organizations to track the indicators and the impacts of climate change, and to support periodic reporting to policymakers and the public. (Target: Commence in 2010, and Ongoing)

1.4 DES will conduct comprehensive mitigation and adaptation education and outreach.

1.4.3 DES will collaborate with partners to support the provision of resources for technical assistance to communities and organizations that are seeking to incorporate adaptation measures into their projects and plans. (Target: Commence in 2010, and Ongoing)

The United States. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to climate change, the Service's goals are:

1. Minimize current and potential negative project operation effects that could hinder management goals and objectives.
2. Minimize deep headpond drawdowns associated with the loss of stanchion logs during high flow events, which are predicted to increase due to climate change.
3. Minimize project-related sources of thermal increases to Connecticut River waters to mitigate against predicted climate change impacts.

The Service, along with the National Oceanic and Atmospheric Administration (NOAA) and the Association of Fish and Wildlife Agencies developed a draft *National Fish, Wildlife and Plants Climate Adaptation Strategy* in 2012. The public comment period closed on March 5, 2012, and the agencies are working to finalize the document. Goal #7 of the Strategy calls for reducing non-climate stressors to help fish, wildlife, plants, and ecosystems adapt to a changing climate. The Strategy notes that some stressors (such as habitat loss and fragmentation and pollution) "are not only some of the things decision makers can control, they are also likely to interact with climate change to magnify negative impacts on fish, wildlife, and plants."

Goal #7 contains a number of strategies and associated actions, including:
Strategy 7.1: Slow and reverse habitat loss and fragmentation
Actions:

- Consider application of offsite habitat banking linked to climate change habitat priorities as a tool to compensate for unavoidable onsite impacts and to promote habitat conservation or restoration in desirable locations
- Identify options for redesign and removal of existing structures/barriers where there is the greatest potential to restore natural processes.

Strategy 7.2: Slow, mitigate, and reverse where feasible ecosystem degradation from anthropogenic sources through…water resource planning, pollution abatement…
Actions:

- Work with ….water resource…planners to identify potentially conflicting needs and opportunities to minimize ecosystem degradation resulting from development and land and water use.
- Reduce existing pollution and contaminants and increase monitoring of air and water pollution.
- Increase restoration, enhancement, and conservation of riparian zones and buffers in agricultural and urban areas to minimize non-point source pollution.

This study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), and the Federal Power Act (16 U.S.C. §791a, *et seq.*).

Public Interest

The requester is a state natural resource agency.

Existing Information

The PADs contains no information relative to climate change and how climate change predictions may impact future operation of the hydroelectric plants, nor of how the projects either mitigate for or exacerbate predicted climate change impacts to freshwater ecosystems.

TransCanada's PADs provide a summary of water quality data collected in 2012. Table 1 below is a synthesis of the temperature data collected by TransCanada. It should be noted that the upper and mid-impoundment stations at each project represent the average of temperature readings taken over the entire water column, while the continuous loggers (Lower Cont. and TR) were located near the water surface. These data indicate that from the upstream end of the Wilder headpond to the Vernon tailrace, water temperature increased approximately 6°C.

Table 1. Median water temperature at monitoring stations located within the impoundments and tailraces of the threehydropower projects.

	Median Water Temperature °C			
Project	Upper Imp.	Mid-Imp.	Lower Cont.	TR
Wilder	20.86	21.83	24.08	23.59
BF	22.43	23.67	24.86	24.38
Vernon	23.81	24.49	26.73	26.35

Relative to existing flood management protocols at each station, TransCanada's PADs identify that all three dams utilize stanchion bays (two at Vernon, three at Bellows Falls, and four at Wilder). When inflows to each dam reach certain levels, the stanchion bays are removed, and cannot be replaced until inflows subside. The depth of these bays and the flows they are removed at are outlined in Table 2, below.

Table 2. Summary of pertinent stanchion bay. Information for the Vernon, Bellows Falls, and Wilder projects.

Project	Stanchion Height (feet)	Flow Triggering Complete Stanchion Removal
Wilder	17	145,000 cfs
BF	13	50,000 cfs
Vernon	10	105,000 cfs

The PADs provide no information on the history of stanchion removal at any of the projects (frequency, duration, timing), nor a discussion of how predicted climate change might alter management of the stanchion bays in the future (with respect to the frequency and seasonality of occurrence). There also is no discussion of potential impacts to headpond resources that occurs as a result of stanchion bay removal. These information gaps need to be filled so resource agencies can assess the relative and cumulative impact of project operations with respect to the Service's management goals and objectives, including those identified in the Climate Adaptation Strategy document.

Data provided by the National Oceanic and Atmospheric Administration, Climate Data Center, illustrates long-term increasing air temperatures in the Northeast (Figure 1). Long-term, monthly mean water temperature data for the Vernon Dam impoundment, monitored by Vermont Yankee, has shown significant differences over time (ANOVA analyses, P < 0.05) that when plotted and further analyzed by linear regression, show a significant increasing trend for the period 1974 – 2011 for the months of January, September, and October (Figure 2). These analyses were performed with data from Vermont Yankee, analyzed by the Massachusetts Department of Environmental Protection.

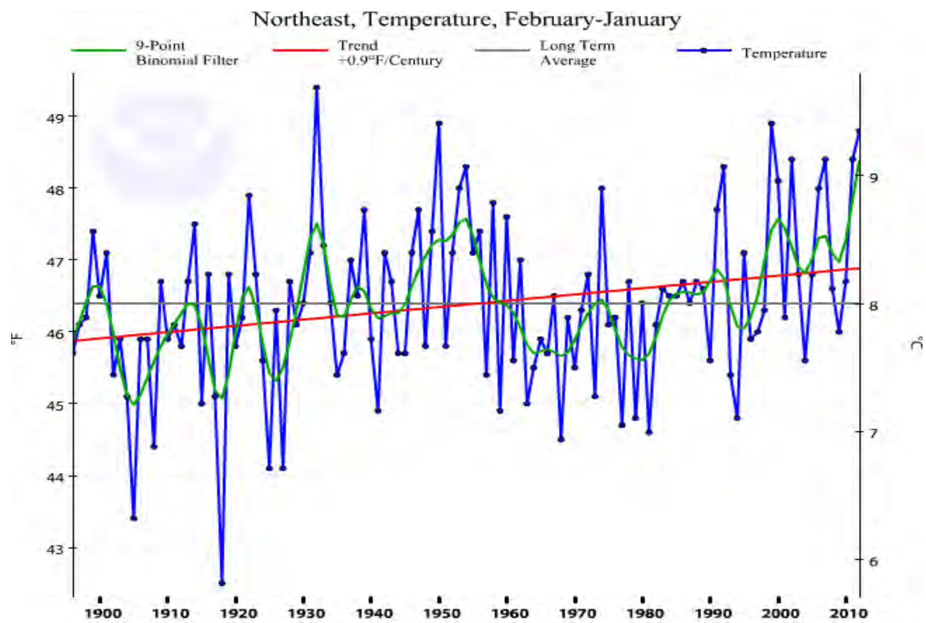

Figure 1. NOAA National Climate Data Center, Northeast 12-month average temperature for the period 1896 through 2012 (October).

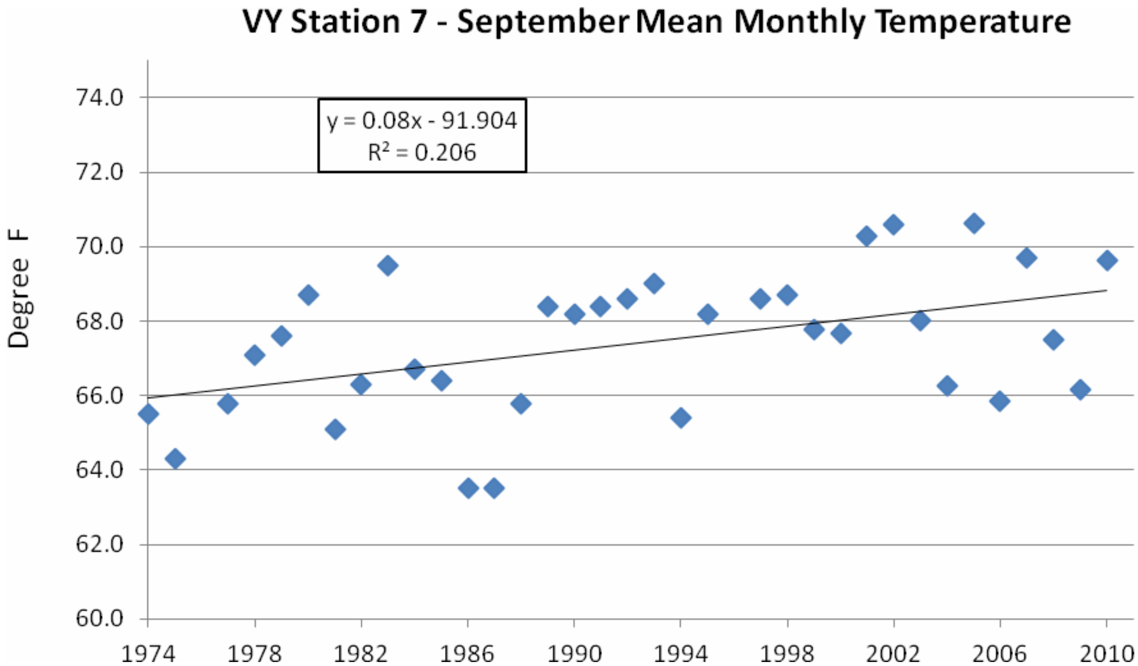

Figure 2. A plot of September's mean temperatures for Vermont Yankees' Station 7 (excludes outlier 1996 data point) for the period 1974 through 2011.

The PAD for Turners Falls and Northfield Mountain Pump Storage projects provides a summary of existing water quality data compiled by FirstLight, including water temperature data obtained from the Service. The PAD also notes a 1991 study by the former licensee that modeled thermal effects of pumping to the upper reservoir. That model reported a maximum temperature difference attributable to NMPS operation of 0.21°C in the Turners Falls reach of the Connecticut River in low flow (4,000 CFS) simulation.

Nexus to Project Operations and Effects

The four mainstem projects have very long impoundments capable of storing large volumes of water (Table 3, below). These impoundments effectively have converted large portions of the Connecticut River into a series of in-river "lakes." Because water velocities slow in these impounded sections of river, it allows for increased thermal loading and resultant higher water surface temperatures than in free-flowing sections of river.

Table 3. Relevant characteristics of the reservoirs behind the Wilder, Bellows Falls, Vernon, Turners Falls dams and NMPS.

Project	Headpond Length (miles)	Gross Storage Volume (acre-ft.)	Average Depth (ft.)	Surface Area (acres)	Flushing Rate (days)
Wilder	45	34,350	11	3,100	3
BF	26	26,900	10	2,804	<2
Vernon	26	40,000	16	2,550	2
Turners	20	21,500		2,110	
NMPS	n.a.	17,,050		246	n.a.

Depending on where the hydropower intakes withdraw water, these warmer surface waters may be discharged downstream, raising the temperature of those waters as well (the data in Table 1 above suggest that the projects do draw water from the upper levels of the reservoirs). This effect may be felt for miles downstream. If there are a series of impoundments (like on the Connecticut River), the cumulative impact is an overall warming of the river. Even small run-of-river dams have been shown to elevate downstream water temperature (Lessard and Hayes 2003; Saila et al. 2005). The most recent climate change prediction models specific to the northeast forecast warmer air temperatures, more frequent high precipitation events, more heat waves, and an increase in the incidence of short term droughts (Karl et al. 2009).

Resource concerns related to this project effect include the potential impacts to populations (reductions in abundance, structure, condition) or loss of species not tolerant of increases in temperature and other effects related to physiology such as energetic costs with warmer temperatures (Leggett 2004). As one example, American shad restoration target numbers for fish passage at mainstem dams into upstream historic habitat could be negatively impacted from artificially increased water temperatures. Water temperature has been identified as a factor in the timing (i.e., duration) of this species migration, as well as its role in gonad development and spawning (Glebe and Leggett 1981; Leggett 2004). These factors can be logical reasoned to potentially result in accelerated rates of energy reserve use and a reduced migration window, possibly reducing the ability of fish to reach up-river habitats and further reducing the ability to survive downstream outmigration.

With respect to project operations during high flow events, all TransCanada projects have stanchion bays that are used to manage water during high flow events. Each time these stanchion bays are removed, the headponds are lowered substantially (from 10 to 17 feet, depending on the project) and must remain lowered until inflows subside. Depending on the timing and duration of these deep drawdowns, headpond resources could be negatively impacted.

All of the dams also contain other mechanisms for managing flows, such as tainter gates, sluice gates, roller gates, skimmer gates and hydraulic flood gates. All of these gates have an advantage over stanchion bays in that they do not require flows to subside significantly before they can be closed to return impoundment levels back to normal. One climate change prediction for the northeast is that we will see more frequent high precipitation events which will result in high flow conditions on rivers. Therefore, it is likely that the stanchion bay removal protocol will have to be employed more frequently in the future.

Methodology Consistent with Accepted Practice

1. In order to quantify the amount of thermal loading contributed by each respective impoundment, detailed bathymetry will need to be collected. This bathymetry, combined with storage volume,

tributary hydrology, and project operations, should be used to calculate the thermal loading of each headpond. The individual and cumulative increase in surface water temperature due to the impoundments should then be used to predict future warming based on climate change models.
2. Analyze different mitigation strategies to understand which have the greatest benefit in terms of building resilience against the impacts of climate change on water temperature. Potential scenarios to analyze include converting the projects to run-of-river, implementing deep-water releases, removing one or more dams, conducting large-scale riparian revegetation, etc.).
3. Input to climate change models the amount of GHG emissions that would be generated if fossil fuel plants were producing the equivalent amount of net energy as the five hydropower projects to determine the impact on air and surface water temperatures.
4. Climate change prediction model output should be assessed to determine if the frequency and timing of high flow events is likely to change in the future. If high flow events that necessitate initiating the stanchion bay removal protocol are predicted to increase in frequency and/or shift in timing, the applicant should evaluate structural and/or operational alternatives that would mitigate adverse impacts of the existing flood management protocols.

Level of Effort/Cost, and Why Alternative Studies will not suffice

The level of cost and effort for the thermal loading analysis would be low to moderate. Collecting bathymetry in the three TransCanada headponds would take two staff less than one week to collect (it took the Kansas Biological Survey two days to collect bathymetry at a 3,500 acre lake; Jakubauskas et al. 2011). Bathymetry for the Turners Falls pool and NMPS upper reservoir already exist. The remaining work would be desk-based; loading relevant information into an appropriate thermal loading model to compute the estimated thermal loading of each headpond and then comparing this information to surface water data from climate change prediction models.

The high flow flood protocol study is a desktop analysis that should require low cost and effort. Climate change models already exist and that output would be downloaded and analyzed. The remaining analysis requires a review of alternative means of managing flows without the use of stanchion bays.

The applicants did not propose any studies to meet this need in the PAD.

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March 1, 2013

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

Subject: Comments on Scoping Document 1 and Study Requests for the Wilder (FERC No. 1892-026), Bellows Falls (FERC No. 1855-045), Vernon (FERC No. 1904-073), and Turners Falls (FERC No. 1889-081) hydroelectric projects, and the Northfield Mountain Pumped Storage Project (FERC No. 2485-063)

Dear Secretary Bose:

The Nature Conservancy is submitting this letter in response to the December 21, 2012 Federal Energy Regulatory Commission (Commission) filing of the Notice of Intent to File License Application, Filing of Pre-Application Document (PAD), Commencement of Pre-Filing Process, and Scoping; Request for Comments on the PAD and Scoping Document, and Identification of Issues and Associated Study Requests for the Wilder, Bellows Falls, Vernon, and Turners Falls hydroelectric projects, and the Northfield Mountain Pumped Storage Project.

The Nature Conservancy (Conservancy) is a private, non-profit 501(c)3 organization with approximately 1 million members worldwide. The Conservancy has been working in the Connecticut River basin for over 50 years, officially establishing the Connecticut River Program in 2003 with a vision to protect and conserve the lands and waters of this important watershed in a way that allows both human and natural communities to thrive.

The Conservancy is a science-based organization that works with partners to identify and implement solutions to complex conservation challenges. Specifically, the staff of the Conservancy's Connecticut River Program has expertise in managing complex issues that correspond to effects of altered hydrological regimes on natural river hydrology, floodplain forest communities, and aquatic species assemblages, as well as expertise in developing management and conservation solutions for complex multiple-use river systems.

The Conservancy is interested in providing information and expertise that will assist the Commission in conducting a thorough and balanced analysis of the issues and effects surrounding the relicensing of the five hydropower projects on the Connecticut River. Because much of the information that we will provide applies to multiple projects, we are submitting this single document to comment and to address issues for all five of the Connecticut River projects. The comments and information herein are based on a review of the three Pre-Application Documents (PADs) submitted by TransCanada and the single PAD submitted by FirstLight on October 31, 2012, as well as the Commission's Scoping Document 1 (SD1) issued December 21, 2012, and the content of the scoping meetings held January 29-31, 2013.

COMMENTS ON SCOPING DOCUMENT 1

Section 3.0: Proposed Action and Alternatives

The SD1 states that "Commission staff will consider and assess all alternative recommendations for operational or facility modifications, as well as PM&E measures identified by the Commission, the agencies, Indian tribes, NGOs, and the public." Operational or facility modifications that the Conservancy recommends will support our overall goal to provide more natural flows in the Connecticut River that support floodplain forests, riparian invertebrates, freshwater mussels, and resident and migratory fish. In recognition of the importance of hydropower as a reliable and clean (i.e., having low carbon emissions) energy source, the Conservancy also seeks license recommendations that balance and optimize the competing values of both hydropower and ecosystem flow requirements.

In partnership with the U.S. Army Corps of Engineers, the University of Massachusetts Amherst (UMass), and the U.S. Geological Survey, the Conservancy is nearing completion of the federally-sponsored Connecticut River Watershed Study. The goal of the Study is to develop a series of models that seek to find optimal solutions for managing flows in the Connecticut River Watershed – solutions that balance both societal needs for water and power as well as natural flows that support ecological needs. As part of the Connecticut River Watershed Study, UMass has developed an hourly-based hydrological optimization model that, in concert with an operational simulation model, will provide the basis for the Conservancy's recommendations for alternative operational modifications to the five Connecticut River relicensed facilities. We propose that the Commission evaluate the alternative(s) that the Conservancy recommends based on model results; we anticipate these results will be further improved by data gathered during the First and Second Study Seasons of the relicensing process.

Furthermore, because of the uncertain and dynamic nature of ecological systems, we suggest that after completion of the two Study Seasons, the Commission recommend a course of adaptive management in those cases where the links between project operations and ecological benefit remain uncertain, or when results demonstrate that climate change effects will alter the nature of these links. An adaptive approach to management is beneficial to meeting ecosystem requirements, but also minimizes the risk of adopting an operational regime that results in loss of power generation or operational flexibility while also failing to meet ecological goals, a possible scenario in an uncertain and dynamic system. An adaptive-type approach to finding operational solutions will ultimately benefit all competing system objectives – both those of power generation and those of ecological needs.

Section 3.6.3: Project Decommissioning

The SD1 states that "[t]here would be significant costs involved with decommissioning the project and/or removing any project facilities. The project provides a viable, safe, and clean renewable source of power to the region. With decommissioning, the project would no longer be authorized to generate power." We concur with these statements; however, whereas there may be significant costs to decommissioning and removing project facilities, it is not clear whether these costs outweigh any potential resulting ecological benefits. Furthermore, project removal does not necessarily require a net loss of energy production. For example, dam removal on the Penobscot River in Maine has been accompanied by an increase in energy production capacity at other facilities (FERC 2004).

The SD1 also states that "No party has suggested project decommissioning would be appropriate in this case, and we have no basis for recommending it." We would like to note that before the scoping meetings and the issuance of the SD1, there was no formal avenue to suggest decommissioning in the FERC relicensing process. Therefore, the alternative of decommissioning should not be removed from consideration because of lack of prior suggestion. The Conservancy does not necessarily support decommissioning, especially without adequate study as to its benefits. However, eliminating this alternative from consideration limits the scope for finding solutions that balance the values and uses of the Connecticut River.

Section 4.1.1: Resources that could be cumulatively affected

As stated in the SD1 "…a cumulative effect is the effect on the environment that results from the incremental effect of the action when added to other past, present and reasonably foreseeable future actions…" The SD1 identified the following as potential cumulatively affected resources: water quality and quantity, fishery resources, and rare, threatened, and endangered species. The Conservancy agrees with this assessment and also suggests adding freshwater mussels and floodplain communities to this list. Support and justification for the inclusion of water quantity, fishery resources, freshwater mussels, and floodplain communities in the assessment of cumulatively-affected resources follows below.

Water quantity – For the context of the relicensing of the five Connecticut River hydropower projects, we suggest that water quantity be defined as a multi-dimensional resource; that is, it should not be defined simply by volume of water (flow magnitude), but also by how often (flow frequency), how long (flow duration), when (flow timing), and how quickly (rate of change in flow) these volumes of water move through the system (Poff et al. 1997). These water quantity characteristics are important not only as components of a natural flow regime, but also with regard to hydropower operational flows, being essential for both optimizing hydropower production and for meeting requirements of the riverine-dependent ecosystem.

Water quantity may be regarded as a cumulatively-affected resource because of flow modifications by upstream hydropower and flood control projects, impacts of relicensed projects on downstream water quantity, land use activities within the drainage area, and potential climate-induced changes in flow. Furthermore, because water quantity is a cumulatively-affected resource, then it logically follows that any resource directly dependent upon water quantity and its descriptive characteristics (see above) must therefore also be a cumulatively-affected resource. The most simple and direct example of this is that of power production, as energy production is directly related to the volume of water that passes through a hydropower turbine. There are other resources that are dependent upon water quantity that are also important, though the dependencies may be more complex, including fishery resources, freshwater mussels, and floodplain communities.

Fishery resources – The cumulative nature of the effects on migratory fish species is relatively clear: the effects of one project or barrier to upstream or downstream migration will be influenced by the effects of previous barriers along the migration route. Furthermore, multiple additional factors may affect migratory fish, including commercial fishing and conditions in the marine environment. Equally important is the cumulative nature of the effects on non-migratory resident fish species. Resident fish species may be considered cumulatively-affected for at least two reasons. First, because all riverine-dependent species have life-history characteristics that are dependent on the natural patterns of the flow regime (Poff and Ward 1990; Poff et al. 1997; Bunn and Arthington 2002), and because flow regime (water quantity and its descriptive characters) is a cumulatively-affected resource, then as stated above, any flow-dependent ecological resource must also be cumulatively-affected. Second, the definition of the biologically- or ecologically-relevant unit for a resource will determine whether that resource is cumulatively affected, at least on a spatial scale. For example, if we define the biologically-relevant unit of a particular fish species to be the population within a project reservoir, then the degree to which this resource is cumulatively affected is much less than if we defined the population to include all individuals of the species within the Connecticut River basin. If we choose to use the latter definition, then spatial cumulative effects would include modified flows from dams within the watershed, habitat fragmentation, land use, and invasive species, among other effects. We suggest that in the present context, the biologically-relevant unit for each species of non-migratory fish should include the population of all individuals of each species within the project-affected areas[1] for all five relicensed projects. With this definition, cumulative effects would include effects of the individual relicensed facilities, as well as upstream and tributary modified flows, habitat fragmentation, thermal effects from Vermont Yankee, and land use activities within the project-affected areas, among other potential effects.

There are at least two benefits to considering biologically-relevant units on this suggested larger scale. First, doing so expands the decision context and presents more opportunities for meeting broader ecological objectives, such as minimizing overall extinction risk or maximizing long term population stability. Managing flows at multiple facilities will present more opportunities to meet these broad scale objectives than managing flows at independent facilities for fragments of a larger population. The second benefit to considering populations on a broader scale is that the degree of information obtained and therefore the strength of conclusions will be greater than it would on a smaller scale. The conclusions made about the effects of one project on a resource will be made stronger by examining the effects of similar projects. Furthermore, without understanding the larger context, it becomes more difficult to elicit other non-project-related effects, such as unrelated thermal effects or land use activities. By considering populations on a broader scale and by examining the cumulative impacts on these populations, more information and better decisions can be made regarding whole-system management.

Freshwater mussels – Using the same rationale as described above for resident fish species, we propose that the Commission include freshwater mussels in its assessment of cumulatively-affected resources. In addition, we propose that the biologically-relevant unit for each mussel species be defined as the population that includes all individuals within the project-affected areas for all five relicensed projects.

Floodplain communities – We also propose that the Commission consider floodplain communities in its assessment of cumulatively-affected resources. In a comprehensive regional analysis, alluvial wetlands, such as floodplain forests and river marshes, emerged as the wetland type of greatest concern; 27 percent of their historic extent has been converted, mostly to agriculture. Although 15 percent of the historic area is now secured, only 6 percent is secured

[1] The project-affected area for each project is here considered the full longitudinal (upstream) and lateral (tributary) extent of the project impoundment, as well as the riverine reaches downstream of each project that are affected by the operational flow regime.

primarily for nature, so conversion exceeds securement for nature 5:1 (Anderson and Olivero Sheldon 2011). Flood-dependent tree species like silver maple and black willow occur only in low floodplain forests, while some tree species such as northern hackberry are nearly absent from the Connecticut River basin except on the rich soils of high floodplain terraces (C. Marks, The Nature Conservancy, personal communication). These communities depend on specific inundation regimes that are impacted by management of project reservoirs and potentially downstream flow management as well. If we consider the biologically-relevant unit to be the vegetative communities of the 100-year floodplain (as defined by the Federal Emergency Management Agency, FEMA) adjacent to project-affected areas for all five relicensed projects, cumulative effects on this resource include reservoir and flow management of each relicensed project, upstream and tributary modified flows, invasive species, and land use activities, among other potential effects.

Section 4.1.2: Geographic scope

The Conservancy suggests that in terms of water resources, the downstream geographical extent of a cumulative effects analysis should extend to, and include discharge from, Holyoke Dam in Holyoke, Massachusetts.

In terms of resident fish species and freshwater mussels, we suggest that the geographical extent of cumulative effects should include at minimum the entire project-affected area, from the upstream extent of Wilder reservoir downstream to Sunderland, Massachusetts. However, it is possible that the geographical extent of analysis will need to be lengthened in order to draw any conclusions regarding effect, given the limited riverine habitat within the project-affected areas.

We suggest that the geographical extent of cumulative effects on floodplain communities should include the 100-year floodplain (as defined by FEMA) adjacent to the project-affected area from the upstream extent of the Wilder reservoir downstream to the Route 116 bridge in Sunderland, Massachusetts.

Section 4.1.3: Temporal scope

We suggest that the temporal scope of cumulative effects include potential impacts of future climate change on a 30-50 year time frame. As part of the Connecticut River Watershed Study, researchers at the University of Massachusetts at Amherst have developed models that estimate predicted climate-impacted flows throughout the Connecticut River basin (Polebitski et al. 2012). We suggest that these models be used to evaluate temporal cumulative effects on the resources mentioned above with regard to climate-induced changes in the flow regime.

Section 5.0: Proposed Studies

In each of their PADs, and as noted in SD1, TransCanada has proposed to "[d]evelop a system operations model to assist in the evaluation of project effects." Whereas we recognize the necessity and value for the licensees to develop independent models, we suggest that because water quantity is a cumulatively-affected resource, evaluation of effects should also be considered on a whole-system scale (encompassing all relicensed facilities) and/or in a modeling framework that is consistent across all relicensed facilities (for example, in a framework such as that developed by the Connecticut River Watershed Study).

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Anderson, M.G. and A. Olivero Sheldon. 2011. Conservation Status of Fish, Wildlife, and Natural Habitats in the Northeast Landscape: Implementation of the Northeast Monitoring Framework. The Nature Conservancy, Eastern Conservation Science. 289 pp.

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STUDY REQUESTS

In response to the request for information and studies presented in the SD1, the Conservancy offers the following study requests to provide pertinent information for the preparation of the Environmental Impact Statement and for potential development of new license requirements. In addition, we strongly support the studies requested by the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, the Connecticut River Watershed Council, and the State resource management agencies in Vermont, New Hampshire, and Massachusetts, including the various study requests focused on improving fish passage at each of the projects. The following study requests are reflective of those areas of study in which the Conservancy has particular interest and expertise, but we acknowledge the likely need for additional studies in these and other research areas.

Requested Study 1: Evaluation of Project Effects on Impoundment Water Surface Elevations and River Flow Regime

Projects: Wilder (FERC No. 1892-026), Bellows Falls (FERC No. 1855-045), Vernon (FERC No. 1904-073), and Turners Falls (FERC No. 1889-081) hydroelectric projects, and the Northfield Mountain Pumped Storage Project (FERC No. 2485-063)

Goals and Objectives

§5.9(b)(1) – *Describe the goals and objectives of each study proposal and the information to be obtained*.

The goal of this study is to evaluate the effects of current and potential future project operations of the Wilder, Bellows Falls, Vernon, Turners Falls, and Northfield Mountain Pumped Storage hydroelectric projects on impoundment water surface elevations and the river flow regime.

Specific objectives of this study include:

1. To develop hourly hydrological simulation models of project operations for the Wilder, Bellows Falls, Vernon, Turners Falls, and Northfield Mountain Pumped Storage hydroelectric projects.
2. To evaluate the effects of existing operations for all five projects, including minimum flow, water level fluctuation restrictions (maximum and minimum pool levels), and other operational requirements on:

   a. Hourly reservoir water surface elevations of the Wilder, Bellows Falls, Vernon, and Turners Falls impoundments;
   b. Hourly discharge from the Wilder, Bellows Falls, Vernon, Turners Falls, and the Northfield Mountain Pumped Storage projects;
   c. Hourly withdrawals of the Northfield Mountain Pumped Storage project from the Turners Falls impoundment;
   d. Hourly reservoir water surface elevations of the Holyoke hydroelectric project (FERC No. 2004); and
   e. Hourly discharge from the Holyoke hydroelectric project (FERC No. 2004).
3. To evaluate and compare the effects of potential operational and flow modifications on items 2a-2e above; potential modifications will include:
   a. Recommendations for operational and flow modifications that result from studies conducted during the first and second Study Seasons;
   b. Recommendations for operational and flow modifications put forth by the Commission, federal, state, or local resource agencies, Native American tribes, non-governmental organizations, or the public; and
   c. Recommendations for operational and flow modifications based on optimization model results of the Connecticut River Watershed Study, a joint study of the Conservancy, UMass, U.S. Army Corps of Engineers, and the U.S. Geological Survey.
4. To evaluate the potential effects of climate-altered flows on current and potential project operations and corresponding effects on items 2a-2e above.

Relevant Resource Management Goals and Public Interest Considerations

§5.9(b)(2) – *If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied*

Not applicable.

§5.9(b)(3) – *If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.*

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a given project is located. In making its license decision, the Commission must equally consider the environmental, recreational, fish and wildlife, and other non-developmental values of a project, as well as power and developmental values.

The mission of The Nature Conservancy is to conserve the lands and waters on which all life depends. We have over 30,000 members in the Connecticut River Basin and have assisted in the protection of 350,000 acres in the watershed, currently managing approximately 13 preserves. Through the relicensing process, the Conservancy will seek solutions that will restore natural patterns of the Connecticut River's flow regime to support floodplain forests, riparian invertebrates, freshwater mussels, and resident and migratory fish. Natural patterns of river flow are critical to the life history of all riverine-dependent organisms and to the structure and function of riverine-dependent communities. Providing flows that mimic natural hydrological patterns will lead to healthier and more persistent populations and communities. Understanding project effects on the river's natural flow regime is necessary to understand project effects on the river ecosystem. Therefore, ensuring that the effects of project operations on the river flow regime are considered in a reasoned way is relevant to the Commission's public interest determination.

Existing Information and Need for Additional Information

§5.9(b)(4) – *Describe the existing information concerning the subject of the study proposal, and the need for additional information.*

The information available in the PADs does not indicate how project operations have altered river hydrology, which may affect resident and migratory fish, macroinvertebrates, rare, threatened and endangered species, aquatic plants, and other biota and natural processes in the Connecticut River. It is also unclear how project operations at one facility affect the operations at another.

Project Nexus

§5.9(b)(5) – *Explain any nexus between project operations and effects (direct, indirect, or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.*

The Wilder, Bellows Falls, Vernon, and Turners Falls projects are each currently operated with required minimum flows. The Turners Falls project is also operated with a seasonally-varying minimum bypass flow; there is presently no required minimum flow for the bypassed reach of the Bellows Falls project. Each of these projects operates as a daily peaking facility, such that flows can vary between the minimum required flows and total hydraulic capacity on a daily basis. In addition, Northfield Mountain pumped storage project operates by withdrawing water from the Turners Falls pool and releasing it back into the reservoir during peak generation hours. Furthermore, project operations and potential changes in operations to mitigate impacts at each facility are influenced by inflows and operations of upstream projects.

The operations of these five projects may affect riverine-dependent biota and associated habitat both upstream and downstream of each project by altering the natural patterns of the river's hydrological regime. Study results will provide necessary information regarding the extent of project effects on river hydrology, potential modifications to discharge and reservoir elevation operations, how such changes may be constrained by inflows and upstream project operations, and how these changes may impact natural hydrological patterns. This information may then be used to develop flow-related license requirements and/or other mitigation measures.

Proposed Methodology

§5.9(b)(6) – *Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.*

Hourly hydrological operations modeling and river hydrology analyses are commonly employed at hydroelectric projects to assess implications of project operations on the river environment. As stated in the PADs, both licensees have developed or are planning to develop hydrological operations models for the relicensed projects. Whereas it is valuable to have separate models for the sake of comparison, given the cumulative nature of project effects on river hydrology, this study would ideally be done within the same modeling framework (for example, in a framework such as that developed by the Connecticut River Watershed Study). Modeled inflows should reflect current operational regimes if applicable (e.g., Fifteen Mile Falls, FERC No. 2007). Climate-altered flows should be based on the output of the Connecticut River Watershed Study variable infiltration capacity (VIC) models (Polebitski et al. 2012).

Level of Effort and Cost

§5.9(b)(7) – *Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.*

Level of effort and cost of model development are expected to be moderate as much of the baseline modeling has already been completed, but evaluation of various operational scenarios will be needed throughout the relicensing process to assess the implications of changes to the hydrological regime. The modeling exercise will also require coordination and cooperation between both licensees to assure that the modeling framework is consistent and compatible among the relicensed projects.

We would anticipate that the expected level of effort and anticipated costs will be comparable to that experienced on similar FERC relicensing projects.

Literature Cited

Polebitsi, A., K. O'Neil, and R. Palmer. 2012. Connecticut River Basin variable infiltration capacity model. Report prepared for The Nature Conservancy, Connecticut River Program, Northampton, MA.

Requested Study 2: Instream Flow Habitat Assessment

Projects: Wilder (FERC No. 1892-026), Bellows Falls (FERC No. 1855-045), Vernon (FERC No. 1904-073), and Turners Falls (FERC No. 1889-081) hydroelectric projects

Goals and Objectives

§5.9(b)(1) – *Describe the goals and objectives of each study proposal and the information to be obtained*.

The goal of this study is to evaluate the effects of project operations on the availability and persistence of habitat for high-priority/target aquatic resources below the Wilder, Bellows Falls, Vernon, and Turners Falls projects, including the bypassed reaches of the Bellows Falls and Turners Falls projects, and to identify appropriate flow regimes that will protect and enhance the habitat for these aquatic resources.

Specifically, the objective of this study is to conduct an instream flow habitat study that will

1. Identify optimal habitat for target species; and
2. Determine the effects of the full range of project operations on the spatial and temporal availability and persistence of this habitat.

Relevant Resource Management Goals and Public Interest Considerations

§5.9(b)(2) – *If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied*

Not applicable.

§5.9(b)(3) – *If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.*

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a given project is located. In making its license decision, the Commission must equally consider the environmental, recreational, fish and wildlife, and other non-developmental values of a project, as well as power and developmental values.

The mission of The Nature Conservancy is to conserve the lands and waters on which all life depends. We have over 30,000 members in the Connecticut River Basin and have assisted in the protection of 350,000 acres in the watershed, currently managing approximately 13 preserves. Through the relicensing process, the Conservancy will seek solutions that will restore natural patterns of the Connecticut River's flow regime to support floodplain forests, riparian invertebrates, freshwater mussels, and resident and migratory fish. Natural patterns of river flow are critical to the life history of all riverine-dependent organisms, in large part because river flow is responsible for the patterns of habitat persistence and availability required for refuge, feeding, reproduction, and juvenile rearing of riverine-dependent organisms. Consequently, providing flows that mimic natural hydrological patterns will lead to healthier and more persistent populations and communities. Understanding project effects on the availability and persistence of critical habitat for target species is necessary to understand project effects on the river ecosystem. Therefore, ensuring that these effects on critical habitat are considered in a reasoned way is relevant to the Commission's public interest determination.

Existing Information and Need for Additional Information

§5.9(b)(4) – *Describe the existing information concerning the subject of the study proposal, and the need for additional information.*

In the PADs for the Wilder, Bellows Falls, and Vernon projects, TransCanada notes that an evaluation of aquatic macrohabitat was conducted in conjunction with the Yoder et al. (2009) fish assemblage study (p. 3-66, p. 3-77, and p. 3-96 in the Wilder, Bellows Falls, and Vernon PAD, respectively). However, this evaluation was qualitative and was not linked to project operations. Furthermore, there has been no evaluation of aquatic habitat in the Bellows Falls bypassed reach.

According to the PAD for the Turners Falls and Northfield Mountain Projects, FirstLight "conducted a characterization and mapping of aquatic mesohabitat (habitat classes) in the bypass reach from Turners Falls Dam to the Cabot Station discharge and the approximately 30 mile long segment of the Connecticut River from Cabot Station down to the vicinity of Dinosaur Footprints

Reservation." Whereas study results may be useful for some purposes, the resulting information is not sufficient to fully evaluate the effects of project operations on aquatic habitat for target species. The habitat designations in the FirstLight study were qualitative, were evaluated under only a single discharge regime, and were not directly linked to habitat requirements for target species. To adequately assess the effects of project operations on aquatic habitat, an instream habitat study should be quantitative, should be tied directly to specific known or hypothesized habitat requirements for target species, and should be conducted under conditions that characterize the full range of operational flows.

The Wilder, Bellows Falls, and Vernon projects, and Cabot Station at the Turners Falls project are each operated as daily peaking facilities, such that flows can vary between the minimum required flows and total hydraulic capacity on a daily basis. Except for the seasonally-varying minimum flow in the Turners Falls bypassed reach, which is intended to facilitate movement of migratory fish and provide some protection for shortnose sturgeon, the PADs for these projects do not indicate how minimum flow requirements were established or what specific ecological resources they are intended to benefit. None of the established minimum flows, including those provided in the Turners Falls bypassed reach, have been based on quantitative, rigorous scientific studies. However, some information does exist regarding minimum flows necessary for shortnose sturgeon spawning and rearing at the Rock Dam in the bypassed reach (Kynard et al. 2012). Spawning success was observed at the Rock Dam when discharge was between 2,500 and 22,000 cfs during the spawning period of April 27 through May 22 (Kynard et al. 2012, chapter 3). This data would suggest that current minimum flows in the Turners Falls bypassed reach are not sufficient to support the continued success of shortnose sturgeon in this river reach.

Other than the observations regarding sturgeon spawning success, we are not aware of any other studies that have evaluated the adequacy of the minimum flows in the Turners Falls bypassed reach, or of the minimum flows at Cabot Station or any of the upstream projects, in protecting aquatic resources and habitat downstream of these projects. Nor are we aware of any studies that have evaluated project effects of daily hydropeaking on the riverine habitat in these river reaches. Therefore, in order to fill this important information gap, an empirical study is needed to provide information on the relationship between flow and habitat in the Connecticut River downstream of the Wilder, Bellows Falls, Vernon, and Turners Falls projects, including in the bypassed reaches of the Bellows Falls and Turners Falls projects.

Project Nexus

§5.9(b)(5) – *Explain any nexus between project operations and effects (direct, indirect, or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.*

The distance from the upstream end of the Wilder impoundment downstream to the Route 116 bridge in Sunderland, Massachusetts (the headwaters of the Holyoke pool) is 150 miles. A total of 117 miles (78%) of this segment is impounded. The remaining riverine habitat is within the 17 miles downstream of Wilder dam, the 6 miles downstream of Bellows Falls, the 10 miles downstream of Cabot Station (Turners Falls), and potentially a short distance downstream of Vernon Dam (at the scoping meetings, FirstLight indicated that their project assessment may provide evidence that the upstream extent of the Turners Falls impoundment may not reach all the way to Vernon Dam). Because most of the lotic (flowing water) habitat in this section of the Connecticut River has been converted to lentic (still water) habitat, the remaining lotic habitat is critical to sustaining the populations and communities of riverine-dependent species in these river reaches, including American shad and the federally-endangered shortnose sturgeon and dwarf wedgemussel. It follows that understanding the effects of project operations on this habitat is also critical to sustaining these populations and communities.

Additionally, there are two river reaches from which flows have been bypassed into power canals, a 3,500-foot long bypassed reach at the Bellows Falls Project and a 2.7-mile long bypassed reach at the Turners Falls Project. The current license of the Bellows Falls Project does not require any minimum flows in the bypassed reach, such that it only receives flow when inflow exceeds the project’s hydraulic capacity, about 30% of the time on an annual basis. These flows do not sufficiently protect the aquatic resources inhabiting or potentially inhabiting this reach of river. Furthermore, the channel morphology and substrate of the Bellows Falls bypass channel is complex and variable, consisting of coarse substrate of various sizes as well as jagged, irregular ledge. Such heterogeneous physical habitat could provide aquatic habitat conditions that are now rare in the Connecticut River due to extensive impoundment of lotic habitat, and are therefore of great conservation value.

Unlike the Bellows Falls bypassed reach, the Turners Falls bypassed channel is currently operated with a seasonally-varying minimum flow (200 cfs starting on May 1, increasing to 400 cfs when fish passage starts through to July 15, then reduced down to 120 cfs until river temperature drops below 7°C). However, these flows were not based on any quantitative, rigorous scientific studies. This section of the Connecticut River contains habitat that supports native riverine species, including spawning and rearing habitat for the federally endangered shortnose sturgeon. It is unlikely that the current minimum flow regime sufficiently protects the aquatic resources, including endangered species, inhabiting the bypassed reach.

The Wilder, Bellows Falls, Vernon, and Turners Falls (Cabot Station) projects are also currently operated with minimum flow releases that were not based on biological criteria or field study.

These continuous minimum flows are only equal to about 40% of the Aquatic Base Flow[2]. Given the variability that is characteristic of the natural flow regime upon which all riverine species depend (Poff et al. 1997, Bunn and Athington 2002), these minimum flows likely do not sufficiently provide the range of habitat requirements for downstream aquatic resources. Furthermore, these projects generate power in a peaking mode resulting in substantial within-day flow fluctuations between minimum flows and project capacity. Large and rapid changes in flow releases from peaking hydropower dams have been shown to cause adverse effects on downstream habitat and biota (Cushman 1985, Blinn et al. 1995, Freeman et al. 2001).

Understanding the effects of the range of operations at each of these facilities and in the bypassed reaches will assist in determining appropriate flow recommendations that will protect and/or enhance the aquatic habitat and the corresponding target species in the river downstream of each project.

Proposed Methodology

§5.9(b)(6) – *Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.*

Instream flow habitat assessments are commonly employed in developing operational flow regimes that will reduce the impacts to or enhance habitat conditions downstream of hydroelectric projects. We request that an instream flow habitat assessment be conducted in the following areas: in the approximately 17 miles between the Wilder Dam and the headwaters of the Bellows Falls pool, in the 3,500-foot long bypassed reach downstream of Bellows Falls Dam, in the approximately 6 miles between the Bellows Falls Project and the headwaters of the Vernon pool, in the approximately 1.5 miles between the Vernon Dam and the downstream end of Stebbins Island (or the upstream extent of the Turners Pool as determined by FirstLight, whichever river length is greater), in the 2.7-mile long bypassed reach downstream of Turners Falls Dam, and in the approximately 10 miles between Cabot Station and the Route 116 bridge in Sunderland, Massachusetts.

We suggest the use of a methodology similar to that of an Instream Flow Incremental Methodology (IFIM; Bovee et al. 1998) approach. A similar protocol was used during the

[2] The Aquatic Base Flow equates to the August Median Flow as determined using unregulated hydrography or on drainage area at the project site (0.5 cfs per square mile of drainage area) if unregulated hydrography is unavailable.

relicensing of the Housatonic River Project (FERC No. 2576)[3], and has been accepted by the Commission in other licensing proceedings[4].

The study design should involve collecting habitat data specific to the known or hypothesized habitat requirements of target species, including but not limited to depth, velocity, and substrate composition. Target species will include, but are not limited to, shortnose sturgeon, American shad, fallfish, white sucker, yellow perch, smallmouth bass, walleye, dwarf wedgemussel and other freshwater mussels, and benthic macroinvertebrates. Target species and measured habitat components should be determined during the development of the study plan in consultation with fishery agencies and other parties.

Habitat modeling using standard PHABSIM 1-dimensional modeling should be conducted in the deep, homogeneous, straight-channel areas of the specified river reaches mentioned above. Two-dimensional hydraulic modeling should be conducted in the sections of river with more heterogeneous habitat and complex features such as islands, braiding, falls, and shallow-water shoals. For example, 2-dimensional modeling should be conducted for the entire reach of the Bellows Falls bypassed channel, for the Turners Falls bypassed channel from the spillway and mouth of the Falls River to the point where the channel constricts, and for the reach downstream from Cabot Station to the railroad bridge below the mouth of the Deerfield River.

Measurements should be taken over a range of flows sufficient to model the full extent of the operational flow regime. In the Turners Falls bypassed reach this should include a range of flows that will allow for modeling flows up to 6,300 cfs. The upper range of flows for the Bellows Falls bypassed reach should be determined during the development of the study plan in consultation with fishery agencies and other parties. Collected information should then be synthesized to quantify habitat suitability (using mutually agreed-upon habitat suitability index (HSI) curves) over a range of flows for target species. Data should be collected in such a way that allows a dual-flow analysis and habitat time series or similar approaches that will permit assessment of how temporal and spatial availability and persistence of habitat for target species changes over the range of flows that occur as part of the operational flow regime.

Level of Effort and Cost

§5.9(b)(7) – *Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.*

[3] Housatonic River Project License Application, Volume 4, Appendix F. Connecticut Light and Power Company, August 1999.
[4] Glendale Project (FERC No. 2801) Final Bypass Reach Aquatic Habitat and Instream Flow Study in Glendale Hydroelectric Project Application for Subsequent License (FERC No. 2801), Volume 2, Appendix B, pages 7-8, October 2007.

Field work for instream flow studies can be extensive, but will depend on consultation with the applicant on study methodology and on-site decisions on locations for data collection and the number of collection locations. Use of laser measurements, GPS, and/or an Acoustic Doppler Current Profiler (ADCP, if available) can improve efficiency and accuracy of field measurements. Post-fieldwork data analysis would be of moderate cost and effort. We anticipate that the level of effort and cost will be comparable to that of other FERC relicensing projects of similar size to these projects.

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Requested Study 3: Impacts of Water Level Fluctuations on Floodplain, Wetland, Riparian, and Littoral Vegetation Communities and Habitats

Projects: Wilder (FERC No. 1892-026), Bellows Falls (FERC No. 1855-045), Vernon (FERC No. 1904-073), and Turners Falls (FERC No. 1889-081) hydroelectric projects, and the Northfield Mountain Pumped Storage Project (FERC No. 2485-063)

Goals and Objectives

§5.9(b)(1) – *Describe the goals and objectives of each study proposal and the information to be obtained*.

The goal of this study is to evaluate the effects of project operations on floodplain, wetland, riparian, and littoral vegetative communities and habitats both upstream and downstream of the Wilder, Bellows Falls, Vernon, and Turners Falls projects (and including the effects of the Northfield Mountain Pumped Storage project), and to identify appropriate project operations that will protect and enhance these communities and habitats.

Specifically, the objectives of this study are to:

1. Delineate, quantitatively describe, and map vegetative communities from the shoreline to the extent of the 100-year floodplain;
2. Delineate, quantitatively describe (e.g., substrate composition, vegetation type and extent of cover), and map littoral habitat types; and
3. Determine the effects of the full range of current and potential future operations of all five projects on the persistence of the communities and habitats described in items 1 and 2.

Relevant Resource Management Goals and Public Interest Considerations

§5.9(b)(2) – *If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied*

Not applicable.

§5.9(b)(3) – *If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.*

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a given project is located. In making its license decision, the Commission must equally consider the environmental, recreational, fish and wildlife, and other non-developmental values of a project, as well as power and developmental values.

The mission of The Nature Conservancy is to conserve the lands and waters on which all life depends. We have over 30,000 members in the Connecticut River Basin and have assisted in the protection of 350,000 acres in the watershed, currently managing approximately 13 preserves. Through the relicensing process, the Conservancy will seek solutions that will restore natural patterns of the Connecticut River's flow regime to support floodplain forests, riparian invertebrates, freshwater mussels, and resident and migratory fish. Natural patterns of river flow are critical to the life history of all riverine-dependent organisms and to the structure and function of riverine-dependent communities. Providing flows that mimic natural hydrological patterns will lead to healthier and more persistent populations and communities. Understanding project effects on the vegetative communities and habitats that depend on these patterns of flow is necessary to understand project effects on the river ecosystem. Therefore, ensuring that project effects on floodplain, wetland, riparian, and littoral vegetative communities and habitats are considered in a reasoned way is relevant to the Commission's public interest determination.

Existing Information and Need for Additional Information

§5.9(b)(4) – *Describe the existing information concerning the subject of the study proposal, and the need for additional information.*

Existing information in the TransCanada PADs regarding floodplain, wetland, riparian, and littoral vegetation and habitat is based on the National Wetlands Inventory, USGS landcover maps, and qualitative surveys and descriptions. As a result, some coarse delineation and mapping has been done and has been presented in the PADs. However, the mapping is too coarse to use to evaluate effects, and does not cover all habitat types in all areas. The PADs acknowledge that "[p]otential effects of the Project[s] on wetland, floodplain, riparian, and littoral resources can occur as a result of hydroelectric operations" (p. 3-104, p. 3-113, and p. 3-142 in the Wilder, Bellows Falls, and Vernon PADs, respectively). However at present, no studies have been done or are proposed to be done that examine the effects of project operations on these resources.

Existing information in the FirstLight PAD regarding floodplain, wetland, riparian, and littoral vegetation and habitat is based primarily on the National Wetlands Inventory and qualitative description of likely occurring community and habitat types. However, the delineations provided by the Wetlands Inventory are too course to use to evaluate project effects, and do not cover all habitat types. In the list of preliminary issues pertaining to the continued operation of the Turners Falls and Northfield Mountain, the FirstLight PAD notes the potential for project effects on botanical habitat (which includes floodplain communities) and wetland, riparian, and littoral zone habitat (p. 5-1). Additionally, the PAD documents a proposed study to conduct an inventory of botanical resources including a verification of the National Wetlands Inventory data. However at present, no studies have been done or are proposed to be done that examine the specific effects of project operations on these resources.

Project Nexus

§5.9(b)(5) – *Explain any nexus between project operations and effects (direct, indirect, or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.*

Because the structure and function of the vegetative communities that comprise floodplain, wetland, riparian, and littoral habitats are defined by the frequency, duration, depth, and timing of inundation, it follows that project operations that cause changes to patterns of inundation (by reservoir levels or downstream flows) could affect these communities and habitats. These effects would consequently impact the fish and wildlife species that depend on these habitats for spawning, juvenile rearing, feeding, and refuge. For example, when the shallow shoreline and bankside habitats of the littoral zone are regularly dewatered, juvenile fish are forced to occupy deeper, more open, and less productive habitat, resulting in slower growth and lower survival (McKinney et al. 2001, Korman and Campana 2009). An additional consequence to altered riparian vegetative communities is a reduction in the stability of underlying soils and sediments, potentially increasing the rate of bank erosion. Furthermore, operations may promote the introduction and expansion of invasive plant species through fluctuating water levels. A study that examines the effects of current and potential future project operations on the extent, duration, and persistence of floodplain, wetland, riparian, and littoral habitats will help inform license requirements to protect and enhance these resources.

Proposed Methodology

§5.9(b)(6) – *Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.*

Frequency, duration, depth and timing of inundation determine the composition and type of floodplain, wetland, riparian, and littoral vegetation communities. For example, there is a general gradient that follows a trend from high terrace floodplain forest, to low floodplain forest, shrub swamp, herbaceous emergent marsh, and then to submerged aquatic vegetation. The interaction of topography and impoundment water level or flow regime determines the distribution and relative abundance of these communities.

To evaluate the effects of project operations on these vegetative communities and habitats, the study methods should include the following:

1. Obtain an accurate digital elevation model (e.g. ArcGIS raster) of valley topography in project-affected areas with a minimum 1-foot vertical resolution, which is required to at minimum to distinguish wetland habitat from upland. Topography data should extend between the minimum and maximum of reservoir operations under all possible scenarios, including potential changes to operations. Data should be collected from the upper extent of the Wilder reservoir downstream to the Route 116 bridge in Sunderland, Massachusetts, and should extend laterally from the lowest water level permitted within the operational range to the boundary of the 100-year flood plain as defined by the Federal Emergency Management Agency (FEMA).
2. Quantify critical thresholds in inundation regime (frequency, duration, depth, and timing) limiting the extent of the vegetative communities on the inundation gradient described above (Metzler and Damman 1985, Nislow et al. 2002). See also TNC's Connecticut River watershed-wide study of floodplain forests (C. Marks, The Nature Conservancy, in preparation). Specific defined community types should be determined during the development of the study plan in consultation with resource agencies and qualified subject ecologists.
    a. Identify at least 5 occurrences of each defined community type in each project impoundment (Wilder, Bellows Falls, Vernon, and Turners Falls) and, if possible, at least 5 occurrences in the downstream riverine portion of each project, for a total of 40 occurrences for each community type. Identify at least 5 locations in each of the impoundments and at least 5 locations in the downstream riverine portion of each project that are periodically inundated but lack the target communities. Existing sources mentioned in the PAD should help with identifying appropriate study sites.
    b. At each of these locations survey the elevations where the different communities occur/do not occur, paying particular attention to transitions.
    c. Develop hydraulic models (e.g., HEC-RAS; Nislow et al. 2002) for downstream riverine locations.
    d. Quantify the inundation regime for each of the study sites using impoundment water level and hydraulic model results.
    e. Using the above data calculate quantitative limits for the windows of inundation within which each of these community types occurs. Report all relevant statistics.

3. In GIS, predict distributions of the above riparian communities across the digital elevation model as a function of impoundment water levels and discharge using the statistical relationships developed in step 2. Complete this task using an existing software tool such as HEC-EFM developed by the US Army Corps of Engineers for this purpose (USACE 2013).
4. Verify the accuracy of the model by calculating how well it predicts known community occurrences. Once this is completed, use model outputs to examine how terrace elevation influences the amount of each defined community type that is available in the project areas under realistic alternative scenarios of impoundment water levels and discharge regimes.

Level of Effort and Cost

§5.9(b)(7) – *Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.*

In their PAD, First Light identified impacts of the project operations on wetlands, riparian and littoral zone habitat as a potential issue to be addressed in relicensing, and proposed wetland vegetation mapping. However, additional analysis as described above is needed to understand the impacts of the project on these resources and habitats.

The cost of collecting the data for this study will be largely dependent on how the digital elevation models are developed. Otherwise, field sampling should require 2-3 people for 3-4 months, followed by 3-4 months of analysis by 1 person.

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Requested Study 4: Determine fish assemblage structure in project-affected areas

Projects: Wilder (FERC No. 1892-026), Bellows Falls (FERC No. 1855-045), Vernon (FERC No. 1904-073), and Turners Falls (FERC No. 1889-081) hydroelectric projects

Goals and Objectives

§5.9(b)(1) – *Describe the goals and objectives of each study proposal and the information to be obtained*.

The goal of this study is to determine the occurrence, distribution, and relative abundance of fish species present in the project-affected areas from the headwaters of Wilder reservoir to Sunderland, Massachusetts, an area which potentially includes Species of Greatest Conservation Need (SGCN) for New Hampshire, Vermont, and Massachusetts.

Specific objectives include:

1. Document fish species occurrence, distribution, and relative abundance within project-affected along spatial and temporal gradients; and
2. Compare historical records of fish species occurrence in the project-affected areas to the results of this study.

Relevant Resource Management Goals and Public Interest Considerations

§5.9(b)(2) – *If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied*

Not applicable.

§5.9(b)(3) – *If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.*

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a given project is located. In making its license decision, the Commission must equally consider the environmental, recreational, fish and wildlife, and other non-developmental values of a project, as well as power and developmental values.

The mission of The Nature Conservancy is to conserve the lands and waters on which all life depends. We have over 30,000 members in the Connecticut River Basin and have assisted in the protection of 350,000 acres in the watershed, currently managing approximately 13 preserves. Through the relicensing process, the Conservancy will seek solutions that will restore natural patterns of the Connecticut River's flow regime to support floodplain forests, riparian invertebrates, freshwater mussels, and resident and migratory fish. Understanding project effects on the communities of resident fish that inhabit project-affected areas first requires an understanding of the structure of the fish species assemblage within these areas. Therefore, determining the resource status of the resident fish species assemblage in project-affected areas is relevant to the Commission's public interest determination.

Existing Information and Need for Additional Information

§5.9(b)(4) – *Describe the existing information concerning the subject of the study proposal, and the need for additional information.*

A thorough and comprehensive assessment of the fish assemblage present in the project-affected areas is lacking. Whereas some sampling was conducted in all project-affected areas during a 2008 Connecticut River electrofishing survey (Yoder et al., 2009), this survey did not have the same goals and objectives as those outlined above. Due to the design of this study, limitations in geographic/habitat type coverage both spatially and temporally, and the use of a single gear type, the use of these data are limited and may not represent the full complement of species that occur in the project-affected areas. In addition, some fairly comprehensive fish surveys have been conducted in the Vernon pool, as referenced in the Vernon PAD. However, objectives and methodology for these fish surveys differ from those stated here, and gear types were generally limited to boat electrofishing which may not be suitable for properly assessing all species present in the project-affected areas.

The PAD for the Wilder project states "No targeted studies have been conducted to characterize the fish community in relation to the Project" (p. 3-42, Wilder PAD), and that of the Bellows Falls project similarly states "Little comprehensive information is available regarding characterization of the fish community in relation to the Project" (p. 3-50, Bellows Falls PAD). The PAD for the Turners Falls and Northfield Mountain Pump Storage projects cites resident fish surveys conducted by the State of Massachusetts in the early to mid-1970s and the 2008 sampling effort by Yoder et al. (2009). This PAD identifies a total of 22 fish species in the project area but omits northern pike, tessellated darter, burbot, and channel catfish, which are known to occur in this area (Ken Sprankle, USFWS, personal communication). It follows that since information is limited or lacking regarding the composition of the fish community and their use of habitats in the project-affected areas, project effects on the fish species assemblage are also unknown.

Project Nexus

§5.9(b)(5) – *Explain any nexus between project operations and effects (direct, indirect, or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.*

Project operations have the potential to directly impact fish species life history requirements, biological interactions, and habitat quantity and quality. For example, headpond and tailwater water level fluctuations could dewater important spawning areas, thus limiting productivity of fish species by direct impacts to their spawning success or indirectly by limiting the spawning success of forage fish species. Accordingly, a thorough understanding of the current fish assemblage structure and associated metrics are needed in order to examine any potential project-related impacts.

Proposed Methodology

§5.9(b)(6) – *Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.*

An accepted and robust field sampling design (e.g., as described in Pollock et al. 2002 or MacKenzie et al. 2006) and accepted methods for collecting fish species likely to be present in the project-affected areas (Bonar et al. 2009) should be used to conduct field surveys. Randomly sampling multiple habitat types using a multi-gear approach will be required to ensure that all fish species present are sampled. The spatial scope of the study will be from the headwaters of Wilder pool downstream to Sunderland, Massachusetts, and will omit the upper reservoir of Northfield Mountain Pump Storage project. Sampling should occur at each selected site across multiple seasons (spring, summer, and fall). Digital photographs should be taken to avoid misidentification of certain species such as Cyprinids.

The sampling design should include replicate samples for estimation of species detection probability. Sample replicates may be gathered temporally, using different methods, by independent observers, or by randomly sampled spatial replicates (MacKenzie et al. 2006). For each replicate sample, data that may be important for describing variation in species occurrence and presence/absence should be collected and recorded, such as gear type, mesohabitat type, depth, velocity, water temperature, substrate, time of day, day of year, presence of cover, proportion of vegetation cover, size of individuals collected (juveniles may select different habitat), and/or other factors as determined by a qualified biologist. Species detection, occurrence, and/or abundance and potential effects of habitat on these parameters should be estimated using methods as described by Kery et al. (2005), MacKenzie et al. (2006), Wenger and Freeman (2008), or Zipkin et al. (2010).

A report should be prepared or supplemental material provided that includes:

- the specific location (coordinates) of each site and date /time of each sample,
- the measures of habitat variables that are collected at each site and for each sample,
- the type of gear used for each sample,
- the identity and length of each individual fish collected,
- photos of representative specimens of each collected species,
- estimates of species detection probability,
- estimates of species occurrence probability,
- estimates of species abundance, and
- tables of model selection results.

Based on first year study results, and on the results of other studies, additional studies examining impacts of project operations on specific fish species may be requested. A second year of study may be required if first year data collection is limited due to environmental or other conditions, or if river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period.

Level of Effort and Cost

§5.9(b)(7) – *Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.*

The cost of the study will be moderate to high as seasonal sampling with several types of gear will be required. However, cost will also be partially dependent on the number of sites sampled, the number of sample replicates, and the extent of the covariate data that are measured, all of which should be determined during the development of the study plan in consultation with fishery agencies and other parties. Based on study results of the first year of sampling, a second year of sampling may be requested, especially if natural environmental conditions are extreme (e.g., a drought or flood occurs). Provided the collected data are of high quality, analysis and synthesis should take approximately 10-20 days. Neither TransCanada nor FirstLight has proposed any studies specifically addressing this issue.

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Requested Study 5: Effects of the Wilder and Bellows Falls Projects on the Dwarf Wedgemussel (*Alasmidonta heterodon*)

Projects: Wilder (FERC No. 1892-026) and Bellows Falls (FERC No. 1855-045) hydroelectric projects

Goals and Objectives

§5.9(b)(1) – *Describe the goals and objectives of each study proposal and the information to be obtained*.

The goal of this study is to evaluate the effects of the Wilder and Bellows Falls hydroelectric projects on populations of the federally-endangered dwarf wedgemussel (*Alasmidonta heterodon*) and to develop measures to minimize adverse impacts to the dwarf wedgemussel in the future. The specific objectives of the study are as follows:

1. Conduct an initial survey of the free flowing stretch of the Connecticut River from the Wilder Dam to the upstream end of the Bellows Falls impoundment to determine the distribution of the dwarf wedgemussel in this reach.
2. Determine the best sites for intensive quantitative sampling of mussel communities, with emphasis on the dwarf wedgemussel. Data will be collected to estimate density (mussels per unit area) and age class structure for all species.
3. Lay the groundwork for a long-term monitoring program.
4. Document instream behavior of mussels during varying flow conditions.
5. Determine how availability and persistence of dwarf wedgemussel habitat changes with water level and flow fluctuations.

Relevant Resource Management Goals and Public Interest Considerations

§5.9(b)(2) – *If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied*

Not applicable.

§5.9(b)(3) – *If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.*

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a given project is located. In making its license decision, the Commission must equally consider the environmental, recreational, fish and wildlife, and other non-developmental values of a project, as well as power and developmental values.

The mission of The Nature Conservancy is to conserve the lands and waters on which all life depends. We have over 30,000 members in the Connecticut River Basin and have assisted in the protection of 350,000 acres in the watershed, currently managing approximately 13 preserves. Through the relicensing process, the Conservancy will seek solutions that will restore natural patterns of the Connecticut River's flow regime to support floodplain forests, riparian invertebrates, freshwater mussels, and resident and migratory fish. Natural patterns of river flow are critical to the life history of all riverine-dependent organisms and to the structure and function of riverine-dependent communities. As a federally-endangered species, the dwarf wedgemussel is of particular interest to the Conservancy. By understanding project effects on this species, we will begin to understand more about the patterns of flow that are necessary to support the larger river ecosystem. Ensuring that project effects on dwarf wedgemussel are considered in a reasoned way is relevant to the Commission's public interest determination.

Existing Information and Need for Additional Information

§5.9(b)(4) – *Describe the existing information concerning the subject of the study proposal, and the need for additional information.*

In 2011, Biodrawversity, LLC conducted a freshwater mussel survey throughout the Vernon, Bellows Falls, and Wilder project areas (Biodrawversity and LBG 2012). This survey was semi-quantitative (i.e. timed searches were used) and the main goal was to assess the distribution, abundance, demographics, and habitat of the dwarf wedgemussel in the project areas. Dwarf wedgemussel were found in the Wilder impoundment (all within a 14-mile stretch of the river beginning 27 miles upstream of the Wilder Dam) and Bellows Falls impoundment (located sporadically in the upper 17 miles of the impoundment); none were found in the Vernon project-affected area. These results corroborate the results of other studies performed in the past in these areas (Nedeau 2006a, Nedeau 2006b).

The 2011 survey did not include the 17-mile free flowing stretch of the Connecticut River downstream of Wilder Dam. The dwarf wedgemussel has, in the past, been found within this river reach, although overall there has been limited survey work in the area. A better understanding of the distribution and abundance of the dwarf wedgemussel in this stretch of the river is required before an evaluation of how the dam affects this species can be made. This need is represented in Objective 1.

Since the 2011 survey was semi-quantitative, it cannot be used as a basis for determining population estimates or trends (Wicklow 2005). In fact, few if any of the past surveys performed in the project-affected areas have employed quantitative methodology. In addition, there is little quantitative information regarding the age class structure, and therefore recruitment, of the mussel communities in the area. In order to demonstrate that a dwarf wedgemussel population is viable according to the Dwarf Wedgemussel Recovery Plan (USFWS 1993), it must have a large and dense enough population to maintain genetic variability and annual recruitment must be adequate to maintain a stable population. Thus, knowledge of population size and density as well as a better understanding of age class structure is a necessary step in determining the baseline status of dwarf wedgemussel populations. The 2011 survey and other surveys can be used to determine the best sites for implementing a monitoring program. This need is represented in Objective 2.

Once this baseline is established, it will be important to monitor the sites so that biologists can estimate and track changes to dwarf wedgemussel populations and/or evaluate any project-related population impacts. Therefore, there is a need to develop long-term monitoring plots that will be surveyed at regular intervals using methodology that is repeatable and yields quantitative, statistically valid results. This need is represented in Objective 3.

Flow conditions that result from dam operations may alter the behavior of individual dwarf wedgemussels or individuals of other species. Dam operations affect streamflow, temperature, and dissolved oxygen, and changes to these variables can often be rapid. It is not known how these rapid changes affect various aspects of a mussel’s biology, including lure display, shell position (open/closed), siphoning rate, and vertical migration. This need is represented in Objective 4.

Dam operations can also affect the availability of habitat for mussels, and this availability can change quickly as water levels fluctuate under peaking operations. The persistence of habitat is a key element to the long-term success of sedentary lotic organisms such as the dwarf wedgemussel (Maloney et. al. 2012), which is unable to quickly move in response to rapid changes in its environment and can thus become stranded in areas of unsuitable habitat; however, there is currently no information concerning the relation of project operations to habitat persistence within the Wilder and Bellows project-affected areas. This need is represented in Objective 5.

Project Nexus

§5.9(b)(5) – *Explain any nexus between project operations and effects (direct, indirect, or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.*

It has been well documented that the damming of rivers can have detrimental impacts on the mussel communities that inhabit areas both upstream and downstream of dams (Watters 1999, Layzer et. al. 1993, Moog 1993). The dwarf wedgemussel is known to occur within the Wilder and Bellows Falls project areas and operations of these two dams may affect the viability of this species in the Connecticut River. This study plan will allow for a better understanding of how sub-daily flow and water level fluctuations influence dwarf wedgemussel abundance, available habitat, and behavior. This information can be used to inform the development of license requirements that can ensure the continued existence of this species within the project-affected areas.

Additionally, a long-term monitoring program of important dwarf wedgemussel sites within the project areas is necessary to evaluate any project-related population and/or behavioral impacts that may occur. This information can be used to inform decision makers in the future.

Proposed Methodology

§5.9(b)(6) – *Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.*

A survey of the 17-mile reach between the Bellows Falls impoundment and the Wilder Dam is the logical first step of the study plan, and this can be done in well less than one field season. This may be treated as an extension of the Biodrawversity and LBG (2012) survey and the same semi-quantitative methodology may be used. Once completed, this survey will help fill in the knowledge gap that exists in the distribution of the dwarf wedgemussel within this reach of the Connecticut River. This proposed methodology corresponds to Objective 1.

Next, quantitative study plots should be established at sites throughout the two project-affected areas that are known to support the dwarf wedgemussel. Plots should be set up and surveyed using methodology that will allow for the estimation of population density and size. Smith et. al. (2001) have developed such a methodology, which is also outlined in Strayer and Smith (2003).

It is based on a double-sampling design (visual inspection of the substrate surface plus excavation of a random subset of quadrats) using 0.25 m2 quadrats that are placed systematically with multiple random starts. This protocol has been used to monitor dwarf wedgemussel populations at two sites on the Ashuelot River in Keene, NH (Nedeau 2004). A number of other recent studies have also made use of this protocol for different species of mussels (Fulton et. al. 2010, Crabtree & Smith 2009, Bradburn 2009).

Data to determine age class structure should also be collected at these selected sites. This would involve measuring the length and estimating the age (through external annuli counts) of each mussel sampled within a quadrat. Based on this information, an analysis of recruitment can be made. This field work and analysis was performed on the mussel community inhabiting the lower Osage River in Missouri as part of the relicensing process of the Osage Hydroelectric Project (FERC no. 459) (ESI 2003). The work done on the Osage can be used as a template for this study. Depending on how many plots are chosen, this phase of the study could take one or two field seasons. This proposed methodology corresponds to Objective 2.

The sites surveyed to meet Objective 2 should be resurveyed using the same methodology at regular intervals in the future so that any changes over time and/or over varied flow regimes can be evaluated. In addition, a mark-recapture pilot study should be initiated to evaluate the potential for using this methodology for long-term monitoring of dwarf wedgemussel abundance and survival. Mark-recapture methods provide statistically robust estimates of population parameters that are superior to simple count estimates in cases where it is not practicable to count all individuals in a population. Methods should be similar to those in Peterson et al. (2011), Meador et al. (2011), and Villella et al. (2004), but should focus on differences among sampled sites. Sites should be selected based on those sampled to meet Objective 2, but should also include sites outside of the project area to fully evaluate project effect and to account for any natural variability that may be independent of project effect.

A long-term mussel monitoring program was devised as part of the study plan for the relicensing of the Lake Blackshear Hydroelectric Project (FERC No. 659) on the Flint River, Georgia. According to the monitoring plan (Lake Blackshear Project 2009), three surveys will be conducted five years apart, beginning five years after issuance of the FERC license. Surveys will be quantitative (there is a qualitative aspect to the Lake Blackshear mussel monitoring plan that can be ignored) and will focus on evaluating changes in recruitment and population size of the purple bankclimber (*Elliptoideus sloatianus*), a federally-listed species. A similar protocol should be used to monitor dwarf wedgemussel populations in the project-affected areas of the Connecticut River post-license, although the number of surveys and the time between surveys may require some research and discussion. This proposed methodology corresponds to Objective 3.

In order to investigate the effects that the hydropower projects have on mussel behavior, individual mussels should be observed as flow fluctuates as a result of dam operations. Researchers should measure changes in shell position (open/closed), siphoning rate, lure display, horizontal migration (movement across the substrate), and vertical migration (burrowing). Past studies have quantified changes in vertical migration due to flow fluctuations (Saha & Layzer 2008, DiMaio & Corkum 1997). This phase of the study will likely take two field seasons in order to maximize the number of behavioral observations so that any trends can be identified and evaluated. This proposed methodology corresponds to Objective 4.

At these same sites, an evaluation of flow fluctuations on dwarf wedgemussel habitat persistence should be conducted following methods similar to those of Maloney et. al. (2012). This will include the development of a two-dimensional hydrodynamic model based on modeled depth, velocity, Froude number, shear velocity, and shear stress. This model will be used to quantify suitable dwarf wedgemussel habitat and its persistence over a range of flows, including flows typically experienced under peaking operations. These methods are being employed to evaluate persistence of dwarf wedgemussel habitat on the Delaware (Maloney et. al. 2012) and Susquehanna (T. Moberg, The Nature Conservancy, personal communication) rivers. Depending on how many plots are chosen, this phase of the study could take one or two field seasons. This proposed methodology corresponds to Objective 5.

Level of Effort and Cost

§5.9(b)(7) – *Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.*

The cost for collecting the data for this study is entirely dependent on the number of study sites selected, as well as how frequently surveys will be conducted as part of the long-term monitoring plan. The expected level of effort and anticipated costs will be comparable to that of similar FERC relicensing projects of this size.

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Requested Study 6: Project Effects on Populations of Tessellated Darter, *Etheostoma olmstedi*

Projects: Wilder (FERC No. 1892-026), Bellows Falls (FERC No. 1855-045) and Vernon (FERC No. 1904-073) hydroelectric projects

Goals and Objectives

§5.9(b)(1) – *Describe the goals and objectives of each study proposal and the information to be obtained*.

The goal of this study is to evaluate the effects of project operations on populations of tessellated darter (*Etheostoma olmstedi*), a New Hampshire species of greatest conservation concern and known host species for the federally-endangered dwarf wedgemussel (*Alasmidonta heterodon*). The specific objectives of the study are to:

1. Determine the distribution and abundance of tessellated darter within project-affected areas; and

2. Determine the effects of project operations on the distribution and abundance of tessellated darter.

Relevant Resource Management Goals and Public Interest Considerations

§5.9(b)(2) – *If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied*

Not applicable.

§5.9(b)(3) – *If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.*

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a given project is located. In making its license decision, the Commission must equally consider the environmental, recreational, fish and wildlife, and other non-developmental values of a project, as well as power and developmental values.

The mission of The Nature Conservancy is to conserve the lands and waters on which all life depends. We have over 30,000 members in the Connecticut River Basin and have assisted in the protection of 350,000 acres in the watershed, currently managing approximately 13 preserves. Through the relicensing process, the Conservancy will seek solutions that will restore natural patterns of the Connecticut River's flow regime to support floodplain forests, riparian invertebrates, freshwater mussels, and resident and migratory fish. Because of its importance as a host species for the federally-endangered dwarf wedgemussel, the tessellated is of particular interest to the Conservancy. By understanding project effects on this species, we will begin to understand more about the patterns of flow that are necessary to support dwarf wedgemussel and the river ecosystem as a whole. Therefore, ensuring that project effects on tessellated darter are considered in a reasoned way is relevant to the Commission's public interest determination.

Existing Information and Need for Additional Information

§5.9(b)(4) – *Describe the existing information concerning the subject of the study proposal, and the need for additional information.*

In the Preliminary Application Documents (PADs) for the Wilder, Bellows Falls, and Vernon projects, the applicant acknowledges that tessellated darter is one of the confirmed hosts of dwarf wedgemussel. It also identifies the occurrence of tessellated darter both upstream and downstream of each project. However, studies that specifically target small-bodied benthic species are lacking in project-affected areas. It is therefore likely that results of previous investigations are biased and underestimate true population size. An effective evaluation of project effects on a population will require robust, unbiased estimates of population parameters such as abundance or occupancy and similar estimates of population parameters under known conditions of low to no effect.

Existing literature indicates that tessellated darters may be found in a variety of habitats (Scott and Crossman 1979, Van Snik Gray and Stauffer 1999, Hartel 2002, Van Snik Gray et al. 2005, Henry and Grossman 2008), but these habitats are not necessarily equal in their ability to support the population or its function as host to dwarf wedgemussel. We cannot be certain that habitat use infers preference, nor that habitat use will be consistent from basin to basin. Therefore, habitat use within project-affected areas should be evaluated, and should be evaluated in concert with population parameters. By estimating population parameters (e.g., abundance, occupancy, extinction/colonization) as functions of habitat, we may determine whether habitat contributes to any differences in populations and if so, what specific habitat is preferred for stable and persistent populations.

Project Nexus

§5.9(b)(5) – *Explain any nexus between project operations and effects (direct, indirect, or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.*

Operations at the Wilder, Bellows Falls, and Vernon projects alter natural river flow and consequently cause changes in the availability of instream habitat on which the tessellated darter and other lotic species depend. Habitat for tessellated darters is directly related to project operations in terms of flow (water depth and velocity, and their timing, duration, frequency, and rate of change) as well as the interactions of flow with other habitat variables such as substrata, vegetation, and cover. Operations both upstream (changes to the reservoir) and downstream (changes to the flow regime) may affect habitat, and may consequently lead to changes in the distribution, abundance, and behavior of tessellated darters that could in turn potentially affect the federally-endangered dwarf wedge mussel, for which the tessellated darter is a host species.

The information collected for this requested study will help determine whether project operations have a substantial effect on populations of tessellated darter, or whether population parameters are consistent with those of other populations in the region. If there is an effect of project operations on darter populations, study results will also permit identification of those habitat components related to operations that are most important for maintenance of stable and persistent populations of tessellated darter. This will in turn provide information that will assist the development of recommendations aimed to maintain populations of dwarf wedgemussel.

Proposed Methodology

§5.9(b)(6) – *Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.*

Using an accepted and robust field sampling design (e.g., as described in Pollock et al. 2002 or MacKenzie et al. 2006) and accepted methods for collecting tessellated darters and other similar small-bodied fishes, conduct a field survey for tessellated darters within all project-affected areas from the headwaters of the Wilder pool downstream to the Vernon dam, as well as in selected areas outside of the project-affected areas with known stable populations of tessellated darter and/or dwarf wedgemussel. Such a sampling design should include replicate samples for estimation of species detection probability. For each replicate sample, collect and record data that may be important for describing differences in populations of tessellated darter, such as presence or abundance of other species (e.g., dwarf wedgemussel, slimy sculpin *Cottus cognatus*), depth, velocity, water temperature, substrata, time of day, presence of cover, proportion of vegetation cover, size of individuals collected (juveniles may select different habitat; larger individuals may outcompete smaller individuals for preferred habitat), and other factors as determined by a qualified biologist. Include also as covariates any relevant flow characteristics (Zimmerman 2006) that may differ among sites.

Using methods as described by Kery et al. (2005), MacKenzie et al. (2006), or Wenger and Freeman (2008), determine whether population estimates of tessellated darter are different in project-affected areas and, if so, which measured factors or flow characteristics are most important in describing these differences.

Prepare a report or provide supplemental material that includes:
- the specific location (coordinates) of each site and date /time of each sample;
- the measures of habitat variables that are collected at each site and for each sample;
- the identity and length of each individual fish collected, including fish species that co-occur with tessellated darter;
- documentation of any mussel species that are encountered at each site and in each sample;
- photos of representative specimens of each collected species;
- description of flow characteristics included in the analysis;

- estimates of species detection probability;
- estimates of species occurrence probability;
- estimates of species abundance, and
- tables of model selection results.

Level of Effort and Cost

§5.9(b)(7) – *Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.*

The cost for collecting the data for this study is entirely dependent on the number of sites, number of sample replicates, and the extent of the covariate data that are measured, all of which should be determined during the development of the study plan in consultation with fishery agencies and other parties, and may be adjusted during the course of field sampling. In general, if a species is common and easily captured, few replicates and many sites produce the best estimates, whereas more replicates and fewer sites are preferable for rare species. In general, the more replicates added, the lower the errors in detection probability, and the more sites sampled, the lower the errors in population parameters. The number of people required in the field will be dependent on the sampling method that is selected, but should be at least two individuals. Provided the collected data are of high quality, analysis and synthesis should take at most 5-10 days.

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CONCLUSION

Thank you for this opportunity to provide comment on the Commission's Scoping Document 1 and offer study requests for the license renewal of the Wilder, Bellows Falls, Vernon, Turners Falls, and Northfield Mountain Pumped Storage hydroelectric projects.

If you have any questions regarding the comments or study requests herein, please contact Katie Kennedy at the Nature Conservancy's Connecticut River Program office (413-586-2349 or kkennedy@tnc.org).

Respectfully submitted,

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March 1, 2013

Federal Energy Regulatory Commission
Office of Energy Projects
Division of Hydropower Licensing
via eFiling

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Re relicensing of Northfield Mountain Pumped Storage Project (FERC No. P-2485-063)

Comments re Aquatic Resources:

"Effects of project operations (including fluctuations in water levels, and downstream releases) on aquatic habitat and resources in the projects' vicinity (e.g., resident and **migratory fish populations**; fish spawning, rearing, feeding, and overwintering habitats; mussels and macroinvertebrate populations and habitat)" [cumulative and project effects, emphasis added];

"Effects of project facilities and operations, (including reservoir fluctuations, and generation releases) on **fish migration** through and within project fishways, reservoirs, and the downstream riverine corridor" [**cumulative and project effects advocated**, emphasis added];

"**Effects of entrainment** on fish populations at each project" [cumulative and project effects, emphasis added].

(Scoping Document 1, December 2012, page 27)

Note: References to "projects" quoted above refer to the Turners Falls Project and to the Northfield Mountain Pumped Storage Project. These comments refer only to the Northfield Mountain Pumped Storage Project.

Note: Railway tank-car equivalencies below are based upon 7.48 gallons per cubic foot of water and the approximately 20-thousand-gallon capacity of a typical railway tank car (www.gatx.com, lessor of 57 thousand railway tank cars).

Note: American shad counts are as reported by the U.S. Fish & Wildlife Service.

The extraordinary environmental impacts upon migratory fish of daily operation of Northfield Mountain Pumped storage have been overlooked since it became a merchant power plant.

The commenter advocates a thorough scientific study of these project and cumulative environmental impacts and their mitigation.

The very greatest environmental impacts upon the Connecticut River are due to Northfield Mountain Pumped Storage, which could power the entire state of Vermont at peak summertime electric load.

Pumping water from Turners Falls reservoir 800 feet up to the summit reservoir at 15 thousand cubic feet per second is equivalent to 340 typical railway tank cars climbing Northfield Mountain every minute during many nighttime hours. Further illustrating the volume of water, such a train would be rolling at 150 miles an hour (assuming a 40-foot tank-car length per www.arleasing.com).

Cascading water from the summit reservoir back into Turners Falls reservoir at 20 thousand cubic feet per second is equivalent to 450 typical railway tank cars rolling down the mountain every minute during many daytime hours. Further illustrating the volume of water, such a train would be rolling at 200 miles an hour (assuming a 40-foot tank-car length per www.arleasing.com).

Such extraordinary volumes of water sucked from and then flooded back into Turners Falls reservoir overpower during many nighttime and daytime hours the natural current of the Connecticut River at Northfield Mountain Pumped Storage, necessarily, predominantly and cumulatively affecting migratory fish swimming upstream and downstream, because most nonmigratory fish remain upstream or downstream.

The wide variability of American shad counts at Vernon as a percentage of the counts at Turners Falls merits scientific investigation to quantify the inevitable environmental impacts upon migratory fish as they pass by Northfield Mountain Pumped Storage:

American shad counts	Holyoke	Turners Falls	Vernon	Vernon as % of Turners Falls
2000	225,042	2,590	1,536	59.3
2001	273,220	1,540	1,666	108.2
2002	374,548	2,870	336	11.7
2003	286,814	-	267	-
2004	191,555	2,092	653	31.2
2005	116,511	1,500	167	11.1
2006	154,745	1,500	133	8.9
2007	158,807	2,248	65	2.9
2008	153,110	3,982	271	6.8
2009	160,649	3,813	16	0.4
2010	164,439	16,768	290	1.7
2011	244,177	16,798	-	-
2012	490,431	*26,727	*10,715	40.1

* Turners Falls total as of 9/5/2012; Vernon total as of 9/28/2012.

Sources:
U.S. Fish & Wildlife Service, Connecticut River Coordinator's Office, Historic Fish Counts
U.S. Fish & Wildlife Service, Connecticut River Coordinator's Office, Daily Fish Counts

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CONNECTICUT RIVER WATERSHED COUNCIL
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March 1, 2013

Honorable Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

Re: Northfield Mountain Pumped Storage Project No. 2485-063
Turners Falls Project No. 1889-081
Comments on the Pre-Application Document, Scoping Document 1, and Study Requests

Dear Secretary Bose,

The Connecticut River Watershed Council, Inc. (CRWC) is a nonprofit citizen group that was established in 1952 to advocate for the protection, restoration, and sustainable use of the Connecticut River and its four-state watershed. We love to celebrate the River and its tributaries. We are proud that the Connecticut River was designated one of 13 American Heritage Rivers during the Clinton Administration and became the country's first National Blueway in 2012. The Connecticut River is a tremendous recreational resource, and as such, we have published the *Connecticut River Boating Guide*, which describes each reach of the 410-mile long river and all access and camping points. Paddlers and motor boaters alike find this book useful for planning outings and lengthy trips. We also organize an annual Source to Sea Cleanup that involves thousands of volunteers each year helping to keep our rivers free of litter and trash dumping.

The interests and goals represented by CRWC include, but are not limited to, improving water quality; enhancing habitat for fish and other aquatic biota; safeguarding and improving wildlife habitat; protecting threatened and endangered species; protecting wetlands; preserving undeveloped shore lands; enhancing public recreation and promoting recreational safety; protecting aesthetic values; protecting archeological, cultural, and historical resources; fostering sustainable economic development, energy production, and preserving the local tax base along the Connecticut River and its tributaries.

The Council's members use and are concerned about the area of the Connecticut River affected by the presence and operation of the Northfield Pumped Storage Project and the Turners Falls, owned and operated by FirstLight Hydro Generating Company. We have long been concerned about the water level fluctuations associated with the operation of the Northfield Mountain Pumped Storage and Turners Falls Projects, which impact streambank erosion, water quality, wildlife habitat including endangered species, wetlands resources, agricultural land, and recreational use. CRWC is an active member of Connecticut River Streambank Erosion Committee (CRSEC), and as a member of the committee, we have been working with the owners of the Project to address erosion in the Turners Falls pool, including development of bioengineering river bank stabilization projects that are part of the Erosion Control Plan ordered and approved by the FERC.

CRWC is committed to working with FERC and other stakeholders to implement an Integrated Licensing Process for these projects that will positively affect the Connecticut River and its resources for present and future generations. CRWC has intervened in relicensing proceedings and license amendments at the Holyoke Dam (FERC No. 2004), Canaan Dam (No. 7528), Fifteen Mile Falls (No. 2077), Vernon (No. 1904), and Northfield Mountain Pumped Storage projects on the Connecticut River.

On February 22, 2013, FirstLight filed a " Draft Study Plan- Conduct Instream Flow Habitat Assessments in the Bypass Reach and Below Cabot Station," with a request for a meeting on April 16, 2013. This was submitted prior to the March 1 deadline for study requests, and only included consultation with agencies (not other stakeholders). We also received notification that FirstLight filed a "Hydraulic Modeling Assessment of the Turners Falls Impoundment, Turners Falls Hydroelectric Project (No. 1889) and Northfield Mountain Pumped Storage Project (No. 2485)" with FERC on February 22. FirstLight will propose modifying both the width and upstream geographic extent of the Project Boundary as part of its relicensing proposal. This study was planned and completed prior to anyone filing a request for this study. The Pre-Application Document also contained a few studies, namely the ones related to erosion by Simons & Associates, that were done outside of any official process and with no knowledge of or participation from stakeholders (and in the case of Simons, the Connecticut River Streambank Erosion Committee). These filings seem to be contrary to the spirit of the Integrated Licensing Process (ILP), which was aimed at increasing public participation in pre-filing consultation. Moreover, the filings that are reports are now in the record and there is not necessarily a process for reviewing the methodology, challenging the findings, or making revisions to a final report.

We appreciate the opportunity to submit our comments on the Pre-application Document (PAD), Scoping Document 1, and we are also submitting multiple study requests. Our comments on the PAD and Scoping Document 1 are organized by the sections of each respective document. The full text of our study requests are located in an appendix to this letter.

CRWC comments on the Pre-Application Document (PAD)

1. <u>Section 3.2.1 (Page 3-8) and Section 3.3.1 (page 3-22)</u> of the PAD states that the FERC license allows for a 9-foot fluctuation "as measured at the Turners Falls Dam." During the FERC site visit on October 5, 2012 when we were touring the Turners Falls Dam near the gatehouse fish ladder , we asked if this was where these fluctuation measurements were taken, and John Howard answered that the measurements were taken upstream and he pointed in the direction of Unity Park. We would like to know the true location of the measuring device and how measurements are recorded.

2. <u>Section 3.2.1 (Page 3-8)</u> of the PAD states that the river fluctuation "decreases as one travels upstream." We request that FirstLight present data to show how the river fluctuation behaves at various points in the Pool on a subdaily basis. The limited graphing in Appendix E does not show fluctuation decrease at West Northfield Rd (near NH/VT border) compared to the Route 10 bridge.

3. <u>Section 3.2.2 (page 3-10)</u> describes the intake channel at Northfield Mountain, which directs water from the upper reservoir to the pressure conduit intake. In the Intake Channel, the velocity in front of

the trashracks when operating at full capacity of 20,000 cfs is approximately 5.1 feet/second. The clear-spacing of the trash racks is not given. This information should be provided.

4. Section 3.2.3 (pages 3-12 and 3-13) describes the upstream fish passage facilities at Turners Falls. The Cabot fishway is described as having 66 pools and the spillway fishway has 42 pools. The gatehouse fishway is a vertical slot fishway, and the PAD does not state how many pools this fishway has. Please provide this information.

5. Section 3.2.3 (page 3-13) describes the Northfield Mountain Guide Net. The PAD does not offer any details about the size of the mesh of the net. FirstLight should please provide specifications and performance data for the net, including the size fish excluded when the net is in place. If there is any entrainment data when the net is in place, please provide that.

6. Section 3.4.3, proposed modifications. The list of proposed modifications should include installing a turbine at the dam so that if more spill is required into the bypass channel, power could be generated by the spill.

7. Section 4.1, general description of the River Basin. There is no description of the river before the Turners Falls Dam was constructed, or before it was raised in the early 1970's. A description of the river and the falls under the Turners Falls Dam should be provided.

8. Figure 4.1.1-1 shows land use and land cover in the vicinity of the projects. A more detailed close-up along the river would be helpful.

9. Section 4.2. Interesting armored mud balls have been found in Turners Falls. Contact geologist Rich Little for more information.

10. Table 4.2.3-1 shows the dominant soil types in the vicinity of the project. These types add up to only 76% of the aerial coverage. In order to be useful for analysis, the soil type data for areas along and adjacent to the riverbank should be grouped according to their erosivity and susceptibility to slumping and sliding.

11. Section 4.2.4 of the PAD discusses shoreline and stream bank erosion issues. This section does not include a U.S. Army Corps of Engineers report from 1977 (CRWC has a copy of this report) entitled, "Streambank Erosion Control Evaluation and Demonstration Projects (Section 32) in New England." This report on page 16 states:

    > "Site No. 3 – Turners Falls Pool, Massachusetts – Northeast Utilities (NU) constructed a pump-storage electric facility at Northfield Mountain which uses the Turners Falls pool as the lower impoundment. Turners Falls pool was raised 5.5 feet in 1973 to accommodate the pump-storage operation. **Streambank erosion began to accelerate in 1973 and this area is one of the most actively eroding reaches of the Connecticut River today. … NU acknowledges that much of the problem is a result of the lower pool operations**…." (emphasis ours).

    It is of note that this study is missing and that the entire section 4.2.4 is written in a way that diminishes the effect of the Projects on streambank erosion.

12. Section 4.2.4.2, shoreline and streambank characterization. CRWC, along with the Connecticut River Streambank Erosion Committee, felt the methodology used in the 2008 Full River Reconnaissance Report had serious flaws, and therefore we do not regard the data provided in Table 4.2.4.2-2 as valid.

13. Section 4.2.4.3, Geomorphic Studies. CRWC supported the 2007 Field 2007 study and endorsed the conclusions. As noted in the letter submitted by the Franklin Regional Council of Governments, the summary of the Field report provided in the PAD provides a very limited view of the causes of erosion, leaving out many relevant points and analysis in the Field report that provide for a fuller and more complete assessment of erosion concerns and causes in the Turners Falls impoundment. The PAD should also note that this study was conducted in order to comply with a FERC order that the licensee develop and implement a plan for how it is going to keep apace with the present rate of erosion. CRWC also questions the inclusion of two reports completed by Simons and Associates in 2012. The PAD should include the reason for completing these studies. CRWC has reviewed both documents themselves. We find no description of the methodology used in these studies, flawed assumptions, and the very questionable conclusion that the Turners Falls impoundment is in better condition than all other reaches included in the study.

14. Annual and seasonal elevation duration curves (Figure 4.3.1.3-7 through 19) for each of the gaging stations are not useful for understanding the sub-daily fluctuations, which are significant and directly related to habitat and recreational impacts. We are requesting that FirstLight provide hourly data (water surface elevations, dam discharge, generation, and pumping data) from the Northfield tailrace, the Turners Falls dam, and Cabot station for the past 10 years. For the upstream fish migration period, data on dam gate position should also be provided for the past 10 years.

15. Section 4.3.1.4 summarizes existing water withdrawals from the Connecticut River upstream of the Turners Falls Dam and from within the canal. In addition to the Water Management Act permit for Four Star Farms, Nourse Farms, Inc. received a Water Management Act permit (#9P2-1-06-074.02) on April 21, 2011 for two agricultural withdrawals in Northfield (Wickey South #1 and Wikey North #2) and Deerfield. These additional permits should be noted in the PAD.

16. Section 4.3.1.4, does not mention or describe any program that FirstLight has to "permit" water withdrawals or non-project use of their land, such as the summer camps, Franklin County Boat Club, or the Turners Falls Rod & Gun Club. The plan for each summer camp has been submitted to FERC, but this should be mentioned in the PAD. In addition, FirstLight's protocol or program on irrigation withdrawals (or any other) is not mentioned and should be described in detail.

17. Section 4.3.1.6 describes a water level monitoring study plan, of which CRWC obtained a copy. Appendix E provides some data that was generated, but out of six recorders in the Turners Falls impoundment, only data from two are shown. Though there was some loss of recorders, the permanent ones at the dam, the tailrace, and elsewhere should have been included in this analysis. More information is needed to understand the behavior of fluctuations in the Pool. Data from 2000 to the present should be provided, not just to 2009. CRWC recommends that FirstLight continue this study, for the next three years. If automatic electronic recorders are not currently present at the sites that have handwritten log sheets, electronic recorders should be installed. Key punching log book results is not conducive to providing up-to-date information to stakeholders.

18. Table 4.3.2.6-1 shows NPDES discharges in the project vicinity. We have the following comments.

a. Montague Water Pollution Control Facility's NPDES permit (http://www.epa.gov/region1/npdes/permits/2008/finalma0100137permit.pdf) indicates there is a combined sewer overflow outfall (02) that is adjacent to the power canal.

b. Since the table includes Hinsdale NH, the table should also include Erving WWTF #1, which discharges into the Millers River a half mile upstream of the confluence with the Connecticut River,

c. Entergy Vermont Yankee shows a flow capacity of "not specified." According to their 2006 NPDES permit modification, which is online at http://www.northfieldrelicensing.com/NorthfieldRelicensing/SitePages/Contacts.aspx, the facility has two flow limits: 543 million gallons/day (MGD) daily max during open cycle cooling, and 12.1 MGD daily max during closed-cycle cooling.

19. Table 4.4.6-1 shows anadromous fish passage numbers at Turners Falls. A new table should be made available showing the American shad numbers at Holyoke compared to numbers at the Gatehouse ladder, and then a calculated percentage of passage at Turners Falls compared to Holyoke. The Connecticut River Atlantic Salmon Commission (CRASC) passage goal is that 50% of the fish that pass at Holyoke should pass Turners Falls. Also, a calculated success rate of shad that pass up Cabot and the spillway compared to the passage at Gatehouse. For example, 2010 would be 16,768/(30,232+2,735) = 50.9% of fish attempting to pass upstream of Turners actually did pass.

20. Section 4.7 of the PAD should also list the federally endangered puritan tiger beetle as potentially affected by river fluctuations of the project. Puritan tiger beetles are located at Rainbow Beach in Northampton, downstream of the Projects and within the Holyoke impoundment.

21. Section 4.7.2.4 discusses state-listed invertebrates in the project vicinity. It would be helpful for the PAD to include more information on when the process of eclosion occurs with clubtail dragonflies (page 4-179).

22. Section 4.8. The list of recreational uses on page 4-192 is incomplete and should also include waterskiing, diving, birdwatching, swimming, running, dog walking, snowshoeing, geocaching, and rockclimbing. "Canoeing" should be widened to the term "paddling" so that kayaking is also included. The PAD does not mention key rock climbing areas at Northfield Mountain.

23. Section 4.8. A list of all the Chapter 91 boat dock licenses with FirstLight listed as the landowner, together with the dock owner, should be included to give a sense of the level of recreational boating that occurs on the river in this stretch. Larger owners like Northfield Mount Hermon School and the Franklin County Boat Club should be highlighted.

24. Section 5.2.5.1, baseline botanical and wildlife inventory. The Turners Falls canal should be added to the list of study locations.

CRWC comments on the Scoping Document

<u>3.1 No action alternative</u>. The science about rivers and about the species that depend on rivers has come a long way since FERC licensed these dams in the 1970s. Hence CRWC does not support the no action alternative and puts forth information requests and study request in this document to augment our understanding of the impact of these dams and how changing their operation can mitigate the negative effects on the river.

<u>3.4.2.4 Turners Falls Project Licensees Proposals</u>

Water Resources

- The current 9-foot drawdown limit is too wide a range and has resulted in impacts to riverbank erosion and recreation. Even the voluntary 3.7-foot drawdown may be too wide a fluctuation range, especially during low-flow periods in the summer. Further study is warranted to determine a fluctuation range that will minimize erosion. Article 405 in Holyoke's license, for example, limits the fluctuation to 0.2 feet for the protection of water quality, aquatic and fisheries, and recreational resources of the Holyoke Project and the Connecticut River.

Aquatic Resources

- The upstream and voluntary downstream fish passage facilities need to be improved and updated.
- The minimum instream flow requirements in the bypass reach of the river are inadequate and should be updated based on results of further study. Study by Dr. Boyd Kynard indicate that flows of 2,500 cfs are more conducive to successful spawning by shortnose sturgeon.

Recreational Resources

- Paddlers and rowers downstream of the Turners Falls dam complain that river fluctuations prevent them from being able to use the river during the summer, particularly during dry periods such as those experienced in 2012. They reported that these fluctuations were minimal during the year that Northfield Mountain was not operating (2010), which indicates the fluctuations are more a results of Turners/Northfield operations than Deerfield River hydropower plants. CRWC recommends and investigation as to what river levels negatively impact recreational use downstream of the Project and what can be done to minimize these impacts. Holyoke's article 405 of the settlement agreement required that Holyoke modify their run-of-river operations to provide, among other things, "to the extent possible, reduce fluctuations in river flows downstream of the Project."
- The current portage at Turners Falls is something that requires making a phone call to the power company and getting driven several miles to the end of the canal. A new portage should made available that is a walkable path around the dam. If flows in the bypass channel were increased, the bypass channel apparently offers Category II/III whitewater and would be navigable by paddlers that have more experience than novice level.
- There is still a need to have a river access point downstream of the canal, such as currently available at Poplar Street. Poplar Street has very limited parking, is located in a quiet neighborhood, and the slope of the shore is very steep. Paddlers sometimes instead choose the Route 5 bridge between Deerfield and Greenfield to put boats into the Deerfield River, for trips to

the Sunderland Bridge. Alternative locations to Poplar should be evaluated, such as re-configuring the gates at Cabot St and allow parking and river access, or evaluate buying land elsewhere.

- There are three public access locations in the 22-mile stretch between Vernon dam and Turners Falls dam. With the increase in popularity of kayaking and canoeing more frequently spaced car-top boat access points would make accessible more sections of the river for paddling recreation. More information is needed about expanding river access and increasing recreational opportunities in the project area.
- Other recreational activities, such as mountain biking have also increased in popularity and trails designed specifically for mountain bikes would expand the recreational opportunities at Northfield Mountain Recreation Center.
- Several improvements to fishway viewing area should be made: better signage, make it handicap accessible, and make fish Spillway fish ladder accessible for viewing to the public.
- For many years, FirstLight and its predecessors partnered with state organizations to have a web-accessible and cable TV-access eagle nest camera at Barton Cove. This camera was incredibly popular, with the TV viewing available at the Great Falls Discovery Center and a spotting scope available at the fishway. Unfortunately, the branch and tree broke and the nesting site was abandoned. If there is a suitable alternative nest, this eagle viewing partnership should be re-established and become part of the license.

Land Use

- Permissions for non-project uses. A list of these permissions, the fees associated with them, the time-frames of the permissions, and the process for reviewing these permissions, should all be documented and viewable to the public and possibly changes should be made.

<u>3.4.2.5 Northfield Mountain Project Licensees Proposals</u>

Geology and Soil Resources

- Bank erosion is a significant concern. CRWC recommends that the Erosion Control Plan be updated. We recommend the continuation of Full River, but with improved methodology and an approved Quality Assurance Project Plan (QAPP).

Aquatic Resources

- The fixed position guide net may not be sufficient for protecting fish from entrainment. A net at other seasons should be explored, and FirstLight should evaluate whether fish are confused by the flows coming from the tailrace. See study requests.

Terrestrial Resources

- Riparian land management should be incorporated into bank erosion program, depending on study results.

Recreation Resources

- Currently, the camping season ends Labor Day, and there is need for a longer season.

- The level of effort for the environmental programs should be defined.
- River users would like to have river information made publicly available: staff gages along river, information about river stage and temperature available online from afar, drawdown information.
- Evaluate Pauchaug boat ramp – sediment movement in area and what could be done to minimize natural filling in. At what flow levels does the deposition of sediment become problematic and impact use of the facility? Should the dock be extended?

3.5 Alternatives to the Proposed Action

One alternative that deserves close consideration is converting Northfield Mountain Pumped Storage to a closed loop or partially closed loop facility. This would eliminate many concerns about erosion, entrainment, recreational impacts, and wetlands impacts. See feasibility study request.

3.6 Alternatives considered but eliminated from detailed study. Subsection 3.6.3 states that Project decommissioning has been eliminated from further consideration. CRWC believes the decommissioning alternative should be considered, with no particular facility targeted, but an overall look at the cumulative effects and all options considered. Could there be one dam removed, and other modifications made to existing hydropower facilities, to make for a win-win situation for the river and for power generation? The TNC/USACE/UMASS flow model could be employed to complete such an alternatives analysis.

4.1 Cumulative effects.

4.1.1: Resources.

- At the scoping meetings, enough people brought up the issue of multi-day paddle trips and need for more and better access points and campsites and improved portage around dams, that the presence of four dams can be considered to have cumulative impacts on recreational uses.
- Floodplain communities have mostly been lost as a result of flood control dams and hydropower dams. To the extent possible, the cumulative impact of hydropower plants on these resources should be examined.
- Sediment movement, or lack thereof, is a cumulative impact of the dams.

4.1.2 Geographic Scope. Flows at Wilder on downstream to Turners Falls are impacted by the operation of Fifteen Mile Falls. Flows from Fifteen Mile Falls down to Holyoke Dam should be considered in the geographic scope of the area that is cumulatively affected. Contributions from Vermont Yankee should be considered within the cumulative effects analysis.

4.1.3 Temporal Scope: We are presently in a period of time during which the energy generation industry is changing dramatically as we attempt to change patterns to ward off severe climate change. We have little understanding of how this will all play out in the coming decades, and there is much disagreement about how climate change will affect our civilization. We therefore recommend that the new licenses be the shortest possible length, or 30 years, as allowed by law. License conditions could also be incorporated that allow for re-evaluation of flows, habitat, and changed hydrology as a result of climate change.

Section 4.3.8 Aesthetic Resources. Bank armoring, dead and dying trees, and severe erosion along the Turners Falls impoundment is an impact to aesthetic resources. The lack of water in the bypass reach is also an aesthetic impacts from the operation of Turners Falls.

Section 4.3.9 Socioeconomic Resources. Loss of agricultural land from soil erosion and impact of the dam on recreational use of the river are two impacts on socioeconomic resources from the Projects.

Section 5.0 Proposed studies

FirstLight plans on conducting a recreational use survey. We recommend that this survey be available online. CRWC is willing to help with spreading the word about the suvey: we can send e-blasts to our members and post a link to the survey on our web page and on our FaceBook page.

We also think a recreational use survey should include possible future uses, not just current uses.

Section 6.0 Request for information and studies

Multiple study requests have been drafted by federal and state resource agencies, researchers, and nongovernment organizations for the Turners Falls and Northfield Mountain Pumped Storage projects. The number of study requests indicates the possible impacts the projects have on the Connecticut River and how little we know about these impacts now and in the future. We support these group-generated study requests, adopt them as our own with some modifications, and encourage FERC to require the applicant to undertake these studies. CRWC staff provided comments during the generation and drafting of several of these study requests.

Geology and Soil Resources

CRWC is a member of the Connecticut River Streambank Erosion Committee and we are concerned about the effects project operations has on streambank stability.

We request that the following studies be conducted to address our concerns on these issues (the full text of the study requests are found in the Appendix).

Study requests

- Study of shoreline erosion caused by Northfield Mountain Pumped Storage (NMPS) operations (see Study Request #1)
- Northfield Mountain/Turners Falls Operations Impact on Sedimentation and Sediment Transport (#2)
- Study the feasibility of converting Northfield Mountain Pump Storage (NMPS) facility to a closed-loop or partially closed-loop system (#3)
- Model flows in the Northfield Mountain Pumped Storage Project discharge tailrace and Connecticut River 1 kilometer upstream and downstream of the discharge using two-dimensional Computational Fluid Dynamics (CFD) model techniques (#4)

Water Resources

Additional information requested

- Provide a description of the river and the falls under the Turners Falls Dam prior to dam construction and dam raising in the 1970's.
- Hourly data (water surface elevations, dam discharge, generation, and pumping data) at three stations in spreadsheet format for the past 10 years.
- CRWC recommends that FirstLight continue the study outlined in "Study Plan: Installation of Connecticut River Stage Recorders" for the next three years. If automatic electronic recorders are not currently present at the sites that have handwritten log sheets, electronic recorders should be installed. Key punching log book results is not conducive to providing up-to-date information to stakeholder

Study requests

- Climate Change as it Relates to Continued Operation of the Vernon, Bellows Falls, Wilder, Northfield Mountain Pumped Storage, and Turners Falls Projects (#5)
- Water Quality Monitoring in the Turners Falls Impoundment and Downstream of the Turners Falls Project (#6)
- Study of shoreline erosion caused by Northfield Mountain Pumped Storage (NMPS) operations (#1)
- Model River Flows and Water Levels Upstream and Downstream from the Turners Falls Project Dam Generating Stations and Integration of Project Modeling with Upstream and Downstream Project Operations (#7)

<u>Aquatic Resources</u>

Additional information available

The USEPA has published a "Connecticut River Fish Tissue Contaminant Study 2000" available online at http://www.epa.gov/region1/lab/reportsdocuments/ctriverftr2000/index.html. This study shows that fish tissue in river segments affected by fluctuations from Fifteen Mile Falls on down to the Turners Falls Dam have higher mercury concentrations than downstream reaches, which are either not impounded or do not fluctuate to the degree of upstream reaches. High fluctuation of lake reservoirs have been associated with higher rates of mercury methylation, and therefore higher levels of mercury in fish tissue (see for example http://nsrcforest.org/project/understanding-how-lake-water-and-nutrient-levels-affect-mercury-levels-aquatic-organisms).

Additonal information requested

- Hourly data at the Turners Falls Dam for pool elevation at the dam, dam discharge and gate status, along with fish passage numbers at the spillway and gatehouse ladders, for the past 10 years in spreadsheet format.
- Any mortality or injury data available for the downstream passage chute at the end of Cabot station.
- Clear spacing of the trash racks at the Northfield Mountain Intake Channel.
- Provide the number of pools in the gatehouse fishway.
- Provide specifications and performance data on the Northfield Mountain guide net.

- Provide the American shad numbers at Holyoke compared to numbers at the Gatehouse ladder, and then a calculated percentage of passage at Turners Falls compared to Holyoke for the previous term of the license. The Connecticut River Atlantic Salmon Commission (CRASC) passage goal is that 50% of the fish that pass at Holyoke should pass Turners Falls. Also, provide a calculated success rate of shad that pass up Cabot and the spillway compared to the passage at Gatehouse. For example, 2010 would be 16,768/(30,232+2,735) = 50.9% of fish attempting to pass upstream of Turners actually did pass.

Study requests

- Determine the Fish Assemblage in the Turners Falls and Northfield Mountain Pumped Storage Project-Affected Areas (#8)
- Impacts of the Turners Falls and Northfield Mountain Pump Storage Projects on Fish Spawning and Spawning Habitat (#9)
- Three-dimensional Computational Fluid Dynamics (CFD) Modeling in the Vicinity of Fishway Entrances and Powerhouse Forebays (#10)
- In-stream Flow Habitat Assessment Downstream of Cabot Station (#11)
- In-stream Flow Habitat Assessment of the Turners Falls Bypassed Reach (#12)
- Shad Population Model for the Connecticut River (#13)
- Telemetry Study of Upstream and Downstream Migrating Adult American Shad to Assess Passage Routes, Effectiveness, Delays, and Survival (#14)
- Impact of Project Operations on Shad Spawning, Spawning Habitat, and Egg Deposition in the Project Areas of the Turners Falls, Northfield Mountain Pumped Storage and Vernon Project Areas and downstream from Bellows Falls Dam (#15)
- Impact of Project Operations on Downstream Migration of Juvenile American Shad (#16)
- Use of an Ultrasound Array in to Create Avoidance of the Cabot Station Tailrace By Pre-spawned Adult American shad and Facilitate Upstream Movement to the Turners Falls Dam (#17)
- Upstream American Eel Passage Assessment at Turners Falls (#18)
- Evaluation of Timing of Downstream Migratory Movements of American Eels on the Mainstem Connecticut River (#19)
- Downstream American Eel Passage Assessment at Turners Falls and Northfield Mountain (#20)
- Impacts of the Turners Falls and Northfield Mountain Pumped Storage Project Operations on Tributary and Backwater Area Access and Habitats (#21)
- Impacts of Water Level Fluctuations on Riparian and Aquatic Vegetation Including Invasive Species and their Associated Habitats in the Turners Falls Dam Project Impoundment (#22)
- Entrainment of Migratory and Riverine Fish from the Connecticut River into the Northfield Mountain Pump Storage Project (#23)
- Model flows in the Northfield Mountain Pumped Storage Project discharge tailrace and Connecticut River 1 kilometer upstream and downstream of the discharge using two-dimensional Computational Fluid Dynamics (CFD) model techniques (#4)
- Model River Flows and Water Levels Upstream and Downstream from the Turners Falls Project Dam Generating Stations and Integration of Project Modeling with Upstream and Downstream Project Operations (#7)
- Impacts of Turners Falls Canal Drawdown on Fish Migration and Aquatic Organism Populations (#24)

Terrestrial Resources

Study requests

- Study of shoreline erosion caused by Northfield Mountain Pumped Storage (NMPS) operations (#1)
- Northfield Mountain/Turners Falls Operations Impact on Sedimentation and Sediment Transport (#2)
- Study the feasibility of converting Northfield Mountain Pump Storage (NMPS) facility to a closed-loop or partially closed-loop system (#3)
- Model flows in the Northfield Mountain Pumped Storage Project discharge tailrace and Connecticut River 1 kilometer upstream and downstream of the discharge using two-dimensional Computational Fluid Dynamics (CFD) model techniques (#4)

Threatened and Endangered Species

Study requests

- Evaluate the frequency and impact of: 1) emergency water control gate discharge events and: 2) bypass flume spill events, on shortnose sturgeon spawning and rearing habitat in the tailrace and downstream from Cabot Station (#25)
- Model River Flows and Water Levels Upstream and Downstream from the Turners Falls Project Dam Generating Stations and Integration of Project Modeling with Upstream and Downstream Project Operations (#7)
- In-stream Flow Habitat Assessment Downstream of Cabot Station (#11)
- In-stream Flow Habitat Assessment of the Turners Falls Bypassed Reach (#12)

We see that the Massachusetts Natural Heritage and Endangered Species Program has submitted the following study requests, which we support but do not include.

- Integrate Modeled River Flows and Water Levels with Habitat Assessment for State-listed Riparian Invertebrate Species
- Habitat Assessment, Surveys, and Modeling of Suitable Habitat for State-listed Mussel Species in the Connecticut River
- Fish Assemblage Assessment and Glochidia Surveys in the Connecticut River
- Assessing Operational Impacts on Emergence of State-listed Odonates in the Connecticut River and Northfield Mountain Upper Reservoir[1]
- Assessing Operational Impacts on State-listed Rare Plants in the Connecticut River

[1] CRWC recommends that this study also include the Turners Falls canal so that impacts to dragonflies during annual canal draining activities can be better understood.

Recreation

Additonal information requested

- Provide information about the environmental educational and recreational programming and staffing, including the staff numbers, budget, number of programs per season, and days each facility was open for the years 1970, 1980, 1990, 2000, and 2010. Include programs that have been eliminated over the years, such as radio programming.

- Provide a list of all the Chapter 91 boat dock licenses with FirstLight listed as the landowner, together with the dock owner, should be included to give a sense of the level of recreational boating that occurs on the river in this stretch.

S*tudy requests*

- Model flows in the Northfield Mountain Pumped Storage Project discharge tailrace and Connecticut River 1 kilometer upstream and downstream of the discharge using two-dimensional Computational Fluid Dynamics (CFD) model techniques (#4)
- Model River Flows and Water Levels Upstream and Downstream from the Turners Falls Project Dam Generating Stations and Integration of Project Modeling with Upstream and Downstream Project Operations (#7)
- Feasibility of New Portage Route Around Turners Falls Dam and Improved River Access Point Downstream of Turners Falls Canal (#25)

Land Use

Additonal information requested

- Permissions for non-project uses. A list of these permissions (water withdrawals, seasonal camps, etc), the fees associated with them, the time-frames of the permissions, and the process for reviewing these permissions, should all be documented and viewable to the public and possibly changes should be made.

S*tudy requests*

- Study of shoreline erosion caused by Northfield Mountain Pumped Storage (NMPS) operations (#1)

Aesthetic Resources

S*tudy requests*

- In-stream Flow Habitat Assessment of the Turners Falls Bypassed Reach (#12)

Socioeconomic Resources

Study requests

- Climate Change as it Relates to Continued Operation of the Vernon, Bellows Falls, Wilder, Northfield Mountain Pumped Storage, and Turners Falls Projects (#5)

- Study the feasibility of converting Northfield Mountain Pump Storage (NMPS) facility to a closed-loop or partially closed-loop system (#3)

Section 7.0 EIS Preparation Schedule

CRWC believes that the magnitude of river alteration caused by these five projects and the complexity of issues involved fully warrants an Environmental Impact Statement (EIS) under NEPA, as proposed by FERC.

We appreciate the opportunity to provide comments on the PAD, Scoping Document 1, and the study requests. We look forward to our active participation in the relicensing of the Connecticut River projects.

Sincerely,

Andrea F. Donlon

Andrea Donlon
River Steward

Cc: John Howard, FirstLight
MassDEP
USFWS
NOAA
Don Pugh, Trout Unlimited
Katie Kennedy, The Nature Conservancy
Kimberly Noake MacPhee, FRCOG

Appendix

CRWC study requests

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Study Request 16. Impact of Project Operations on Downstream Migration of Juvenile American Shad

Study Request 17. Use of an Ultrasound Array in to Create Avoidance of the Cabot Station Tailrace By Pre-spawned Adult American shad and Facilitate Upstream Movement to the Turners Falls Dam

Study Request 18. Upstream American Eel Passage Assessment at Turners Falls

Study Request 19. Evaluation of Timing of Downstream Migratory Movements of American Eels on the Mainstem Connecticut River

Study Request 20. Downstream American Eel Passage Assessment at Turners Falls and Northfield Mountain

Study Request 21. Impacts of the Turners Falls and Northfield Mountain Pumped Storage Project Operations on Tributary and Backwater Area Access and Habitats

Study Request 22. Impacts of Water Level Fluctuations on Riparian and Aquatic Vegetation Including Invasive Species and their Associated Habitats in the Turners Falls Dam Project Impoundment

Study Request 23. Entrainment of Migratory and Riverine Fish from the Connecticut River into the Northfield Mountain Pump Storage Project

Study Request 24. Impacts of Turners Falls Canal Drawdown on Fish Migration and Aquatic Organism Populations

Study Request 25. Evaluate the frequency and impact of: 1) emergency water control gate discharge events and: 2) bypass flume spill events, on shortnose sturgeon spawning and rearing habitat in the tailrace and downstream from Cabot Station

Study Request 1. Study of Shoreline Erosion Caused by Northfield Mountain Pumped Storage (NMPS) Operations

Development of the current configuration of the Northfield Mountain Pumped Storage project included raising the dam height at Turners Falls by 5.9 feet in 1970 in preparation for NMPS operations. Operations began in 1972; since then the project has operated under this raised dam environment. The operation of NMPS effects the river in the following ways: 1) daily fluctuating pond levels that at times exceed six feet in some places (the license allows fluctuations up to 9 feet measured at an undisclosed location near and upstream of the Turners Falls dam), 2) altered flow and velocity profiles of river, and 3) changes to the downstream hydrograph. Elevation data of the head pond in Appendix E of the PAD indicate that stage changes of 2 to 3 feet during the summer of 2012 were not uncommon. The additional 5.9 foot elevation increase in the headpond resulted in motorized boat traffic becoming more popular and the use of larger boats possible. The presence of motorized recreational boats increases wake energy that can accelerate bank erosion rates.

Raising the level of the headpond can saturate bank soils. These same soils can quickly become dewatered when the headpond is lowered. Repeated saturation and dewatering of banks can lead to bank instability which in turn can lead to bank failure and eroded material entering the river. See Field (2007) for an extended discussion on bank erosion and failure mechanics. Elevated levels of turbidity and suspended solids in the water column can diminish rearing and migratory habitat for fish. When too much fine grain material is deposited on channel bed substrates, particularly those substrates used for spawning, spawning success of resident and migratory fish is compromised, potentially reducing recruitment and carrying capacity.

Goals and Objectives

The goals of this study request are to determine the environmental effects of the presence and operation of the licensed facilities on river bank stability, shoreline habitat, agricultural farmland, wetland resources, bed substrate, and water quality in the Turners Falls impoundment. We recognize that data from other studies will be made available and note that the data from these other studies could be used to help meet the objectives of this study request.

Objectives of the study include the following:

- Calculate the total volume of eroded material, calculate resulting nutrient loading of eroded material, and document and describe the three dimensional changes to the bank, including lateral bank recession, changes to bank slope, and the presence and subsequent inundation of pre-project beaches and shoreline since the Turners Falls Dam was raised and the Northfield Mountain Pumped Storage facility came on-line.

- Document and describe the changes to banks upstream and downstream of riverbank restoration projects, including bank recession.

- Identify the changes that have occurred to bed substrate as a result of the deposition on the channel bed of fine grain material eroded from the banks.

Relevant Resource Management Goals

Not applicable, requester is not an agency or Indian tribe.

Public Interest Consideration If Requester Is Not A Resource Agency

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. Fish and wildlife are important public resources. The public has an interest in maintaining high quality habitat for migratory diadromous fish. Shortnose sturgeon, American shad, and American eel all require suitable spawning, rearing, migratory, and foraging habitat. Eroding banks and subsequent increases in turbidity and deposition of fine grained material onto bed substrates in the Turner's Falls headpond, the bypass reach, and downstream of the Turner's Falls project reduces the quality of habitat for these species. Elevated levels of suspended sediment are associated with a diminution in water quality, which also diminishes the quality of habitat encountered by fish species.

In addition, the Connecticut River Watershed Council supports the work of the Connecticut River Workgroup and the Connecticut River Nitrogen Project, which were established by the New England Interstate Water Pollution Control Commission (NEIWPCC) in 2001 after the U.S. EPA approved New York and Connecticut's Long Island Sound (LIS) dissolved oxygen TMDL. This project is a cooperative effort involving staff from NEIWPCC, the states of Connecticut, Massachusetts, New Hampshire, and Vermont, and EPA's Region 1 and Long Island Sound (LIS) offices. All are working together to develop scientifically-defensible nitrogen load allocations, as well as an implementation strategy, for the Connecticut River Basin in Massachusetts, New Hampshire, and Vermont, which are consistent with TMDL allocations established for LIS. Since its inception, the Connecticut River Workgroup has participated in a number of projects to better understand nitrogen loading, transport, and reductions in erosion.

Existing Information and Need for Additional Information

The PAD makes reference to several studies in section 4.2.4 including the Erosion Control Plan (Simons & Associates, 1999), previous Full River Reconnaissance studies (1998, 2001 – maps but no report generated, 2004, and 2008), Field Geology Services' 2007 fluvial geomorphic investigation of the Turners Fall headpond, and 2012 investigations by Simons & Associates.

Field Geology Services' 2007 investigation provided several good recommendations for future work in section 9.3 of this report, which if implemented, could provide for: a) an improved understanding of the causes of erosion; b) more accurate monitoring of erosion; and c) more successful bank stabilization efforts. This document is a good point of reference. The Simons & Associates' (2012) documents are qualitative and based on several unstated assumptions that may not be valid. Full River Reconnaissance efforts have been undertaken using varying methodologies, making for difficult comparisons from one report to the other.

We believe that these existing studies do have data that can be useful if certain new analyses are undertaken. These analyses of existing data would help fill in our gaps of understanding of bank erosion in the Turners Fall headpond. We are also asking for the collection of additional field data. With the existing information, it should be possible to better display what changes have occurred to streambanks over time. Current Geographic Information System (GIS) software allows for various types of data to be assembled onto a map and into a database such that analysis of change over time can be conducted fairly easily. The change over time analysis is critical and needed, and has been started by Field (2007).

Photos taken at or near some erosion sites at different times exist. For example, the last three Full River Reconnaissance efforts have included continuous videotaping of the river banks with locational information. "Snapshots" of the bank at various locations could be extracted from these videos and compared over time. Field (2007) photo locations could be re-shot as well. This existing information should be presented such that it is easy to discern where the photo were taken and what changes have occurred over time. A comparison of the bank every 100 ft could be compared over the years.

Historic aerial photography for the Turners Fall headpond should be gathered and analyzed. Examples of good photographic datasets include the Field 2007 appendices and 1929 aerials. The location of the shoreline over time should be noted such that it is easy to discern where bank retreat has been most severe and where the river has been relatively stable since the earliest aerial photograph was taken.

Very little turbidity data exist for the Turner's Falls headpond, the bypass reach, or stretches of the Connecticut River downstream of the Turner's Fall project. Thus far, implementation of the *Northfield Mountain Pumped Storage Project Sediment Management Plan* (revised February 15, 2012) has yielded few results, and many technological difficulties (see *2012 Sediment Management Plan – 2012 Summary of Annual Monitoring* dated November 30, 2012). Suspended sediment monitoring equipment is installed at the Route 10 Bridge upstream of the project and inside the powerhouse, theoretically taking readings representative of pumping and discharging through the turbines. An analysis of how turbidity might change relative to rapidly changing headpond levels would be very useful information.

Nexus to Project Operations and Effects

The construction of the NMPS project was contingent upon the Turner's Falls project raising the dam crest elevation by 5.9 feet. The NMPS project operations rely on the Turner's Falls headpond as the source of water to be pumped and to be discharged into. The importance of this river reach to the NMPS operation is made clear by Firstlight's reference to this portion of the river as the "lower reservoir." Daily pumping and discharging changes the ponded elevation of the Connecticut River which in turn leads to bank material that repeatedly becomes saturated and then dewatered. Weakened bank material can then become eroded and the fine grain material from the banks can enter the water column and be transported in suspension in the river and eventually settle onto bed material. The raising of the Turner's Falls headpond also made recreational boating more popular, including the introduction of large, high-horsepower powerboats that were not previously present. Because of the fluctuating water levels, boat wakes impact the shoreline to a much greater extent than would occur if levels were more constant, thus exacerbating both the effects of the wakes and the fluctuating levels. For these reasons, erosion caused or contributed by NMPS project operation can negatively affect spawning, rearing and migratory habitat for fish species, including the endangered shortnose sturgeon. The requested study will help inform the Commission when contemplating mitigation measures and or operational modifications.

Proposed Methodology

- This study should determine the net soil loss in cubic yards between 1970 and the present; a density estimate of the eroded material should also be provided. It should also provide an analysis of where the greatest loss has occurred, location of proximity to the tailrace, soil type, riparian land use, and vegetative cover in that area; calculate nutrient loadings (nitrogen and phosphorus compounds) to the river system based on soil loss; and obtain copies of the original survey plans for the project, and complete a new survey using the same landmarks used previously. The Field (2007) report states on page 11 that the original survey plans of the river are still retained by Ainsworth and Associates, Inc. of Greenfield MA. In addition it should use pre-operation aerial photos and current aerial photos to complete a 10-foot topographic map of the section of river between Turners Falls Dam and Vernon Dam and the 200-foot buffer regulated under the Massachusetts Rivers Protection Act. The Field (2007) report on page 11 states that Eastern Topographics, Inc. determined that sufficient information is known about the 1961 aerial photos (e.g., height of airplane) to create a 10-foot topographic map of that time period, and that 1961 aerial photos could be accurately overlayed with recent aerial photos. Field (2007) states that this analysis would enable a more reliable determination of small-scale shifts in channel position and changes in bank height that may have resulted from the erosion of a low bench that previously existed along portions of the river. Among other things this study should create a single map showing areas of erosion and deposition, and also overlay the Field report's hydraulic modeling analysis of the river channel.

- With respect to the January 22, 2013 submittal from FirstLight to FERC regarding its long term monitoring transects in the Turners Fall impoundment, we ask that any data errors (as discussed in Field, 2007) and problems that have occurred over the years at each site be mentioned. We also ask that that an analysis for each cross section extending to the top of the bank and including a portion of the floodplain be provided.
- Take the information presented in Figure 4.2.3-1 "Soils in the vicinity of Turners Falls and Northfield Mountain projects" in the PAD and convert from 63 categories to just a few that are defined in a key that will allow readers to understand which soils are easily erodible, which aren't, and where there is bedrock along the banks.
- Complete detailed surficial mapping (topographic map or LIDAR) to identify the various geomorphic surfaces, height of benches/terraces above the river level, and types of sediments underlaying the surfaces. This will allow one to determine how erosion varies with geomorphic conditions. One could then normalize the amount of erosion to a specific type of bank material/geomorphic surface/terrace.
- Another information request covers the range of daily water level fluctuations. In this study request, we ask for an analysis of the degree to which boat wakes increase that fluctuation range. The task would be to observe boat wakes under a range of boat sizes and flow rates on the river. We recommend the 2007 Field report recommendation which states, "A more thorough study of boat waves is merited to better document how many boats use the Turners Falls Pool, how fast they travel, the type and size of waves they produce, and their impact on shoreline erosion."

A component of this study request is not necessarily for new data, but for existing data to be presented in a more clear, coherent and comprehensive manner. All existing photographs of banks that have been collected either by Firstlight, on behalf of Firstlight, or on behalf of the FRCOG Streambank Erosion Committee should be georeferenced so that it is easy to discern where the photograph was taken and the date readily identified as well. These photos should be presented in a manner that makes it easy to visually see how a particular section of bank has changed over time. Providing geographic context for photographic data of river banks and making these photos comparable over time should be standard practice. The 2007 Field report contains the following recommendation on page 47: "An attempt should be made to overlay the 1961 aerial photographs with a current flight and to create a topographic map from the 1961 flight. The feasibility of this effort has been confirmed by Eastern Topographics, Inc. This effort will identify the previous extent of the low bench and identify areas of the most significant bank recession the past 45 years." Given that this statement was written in 2007, we request that that the analysis is extended to current conditions.

Given the complexity of this study request and the expertise necessary to implement it, we request that the resources agencies be involved with the selection of the hired consultant.

Level of Effort and Cost

The level of effort to compile existing information and to make the data available in a map and searching for existing bed substrate material data should not take more than a few days. The level of effort for the bed sampling work will vary based upon how much historic information exists. Much of the effort of this study request is essentially office work that compiles and better presents existing data. While an estimate on the amount of field time required is difficult to make, we estimate that up to two weeks of field work could be required and some of the data collection could be done while other field studies are occurring.

Study request 2. Northfield Mountain/Turners Falls Operations Impact on Sedimentation and Sediment Transport

Goals and Objectives

Conduct hydraulic and sediment transport modeling of both the intake and discharge conditions (current and proposed) at Northfield Mountain. The results of the study should provide information sufficient to understand current and proposed effects of water level fluctuations and relate to potential increase in sedimentation to the Connecticut River. This information will identify techniques that could be used to mitigate the effects of project operations or other mitigation techniques that could be developed to reduce riverbank erosion within the impoundment. In addition, an assessment of ways to minimize the sediment load passing through the Turners Falls Canal during and after maintenance drawdowns should be conducted.

The specific objectives of this study are as follows:

- Assess hydraulic and sediment dynamics in the Connecticut River from Vernon Dam to Turners Falls Dam, the upper reservoir at Northfield Mountain, and downstream of the Turners Falls Dam.
- Identify management measures to minimize erosion and sedimentation.
- Determine areas of sediment deposition and beach formation in the Project Area and 1 km downstream of Cabot Station and describe habitat features of these areas, recreational uses and effects on invasive species, if any. Habitat areas include but are not limited to coves (e.g. Barton Cove), back channels, islands, wetland habitats, shorelines, shoals, deep water areas, and channels.
- Identify management measures to mitigate for substrate (habitat) impacts and recreational impacts in sediment-starved areas below the dam and sediment accumulation areas upstream of the dam.

Relevant Resource Management Goals

Not applicable, requester is not an agency or Indian tribe.

Public Interest Considerations If Requester Is Not A Resource Agency

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. The Connecticut River is valued public resource. The public has a strong interest in protecting the water quality of the river water to maintain its status as a Class B river, as designated by Massachusetts Department of Environmental Protection, 314 CMR 4.06(5). Class B rivers are assigned the designated uses of habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation, 314 CMR 4.05(3)(b). Class B waters must also have consistently good aesthetic value and meet minimum criteria for numerous water quality indicators to achieve compliance with the standards set forth in the regulations. The anti-degradation provisions of 314 CMR 4.04 require protection of all existing and designated uses of water bodies, and maintenance of the level of water quality needed to protect those uses. The information resulting from this study will help ensure that the operation of these projects does not degrade water quality in the Turners Falls impoundment and reaches downstream.

Existing Information and Need for Additional Information

The PAD provides a summary of the numerous studies that have been conducted to characterize streambank conditions of the Turners Falls impoundment, to understand the causes of erosion, and to identify the most appropriate approaches for bank stabilization. The *Erosion Control Plan for the Turners Falls Pool of the Connecticut River* (Simons & Associates, Inc. dated June 15, 1999) was completed in order to comply with license articles 19 and 20, and contained a list of 20 priority streambank stabilization project sites. By the end of the current license, work at all sites will have been completed, although some require further repair work. The Erosion Control Plan (ECP) will need to be updated based on current science of fluvial geomorphology, and stakeholders will need to decide the direction additional future projects may take. The next Full River Reconnaissance is scheduled in 2013. Some of the goals and objectives of that effort is contained within this study request.

FirstLight has a “Sediment Management Plan” that was revised on February 15, 2012. A summary of results for 2012 is dated November 20, 2012. Implementation of the *Northfield Mountain Pumped Storage Project Sediment Management Plan* (revised February 15, 2012) was begun in 2011 and is scheduled to end in 2014. The 2012 report describes several technical problems that prevented meaningful data from being generated.

Nexus to Project Operations and Effects

Turners Falls and the Northfield Mountain Pumped Storage Project operate in a peaking mode, with allowable headpond fluctuations of up to 9 feet, with proposals to continue as such. A proposed assessment will evaluate increasing the volume of flow from the Northfield Mountain Pumped Storage Project through increased use of the upper reservoir, which is expected to result in additional water level fluctuations. Upstream hydroelectric facilities also operate in a peaking mode of operation. Periodically, the upper reservoir at Northfield Mountain and the power canal at the Turners Falls dam need to be dewatered for maintenance purposes. Historically, both procedures have resulted in the discharge of large quantities of sediment.

Sediment from shoreline erosion and riverbank failure is one of the major contributors that negatively affect water quality and habitat by increasing the turbidity and sedimentation, smothering aquatic habitat. Repetitive water level fluctuations and flow alterations caused by hydroelectric peaking operations are known to be a major contributor to shoreline erosion.

The Proposed Massachusetts Year 2012 Integrated List of Waters shows two river segments, from the VT/NH state line to the Turners Falls dam (MA34-01 & MA34-02) impaired and considered a “Water Requiring a TMDL” due to “Other flow regime alterations,” “Alteration in stream-side or littoral vegetative covers,” and “PCB in Fish Tissue.” In addition, the segment below the Turners Falls dam to the confluence with the Deerfield River (MA34-03) is impaired by these factors as well as total suspended solids.

Proposed Methodology

This study request recommends:

<u>Assess hydraulic and sediment dynamics</u>

- FirstLight continue implementing the Northfield Mountain Pumped Storage Project Sedimentation Management Plan over the full range of river flows and pumping/generating cycles. An unfulfilled task in the Plan is to develop a correlation over the full range of flow conditions between the overall suspended sediment transport through the entire cross section of the river compared to the continuous sampling at the single fixed location. Environmental Protection Agency approval of a Quality Assurance Project Plan is required for valid data acquisition.

- Add one suspended sediment monitoring site site downstream of the tailrace. If equipment continues to be problematic, explore other options. Provide data representative of tailrace discharge conditions and river conditions for two years.

- Provide data on the daily water level fluctuation changes from the past five years from stations listed in the PAD, and estimate fluctuations within Turners Pool assuming proposed operations and hydraulic conditions.

- Identify the most appropriate techniques for bank stabilization given the existing and proposed hydraulic conditions.

<u>Determine areas of sediment deposition in the Project Area</u>

- Field (2007) conducted a bathymetric study as part of his report. Use previous bathymetric data, if available (Field 2007 recommends putting additional effort into finding a bathymetric survey from 1913 that was partially shown in Reid 1990), and current bathymetric information to look at areas of sediment accumulation. Determine areas of sediment deposition in the Project Area and 1 km downstream of Cabot Station and describe habitat features of these areas. Habitat areas include but are not limited to coves (e.g., Barton Cove), back channels, islands, wetland habitats, shorelines, shoals, deep water areas, and channels.

- Identify recreational uses and impacts in areas known to be impacted by accumulated sediment, such as Barton Cove.

- Identify invasive species (plant or animal) present in the reaches and determine if erosion and sedimentation in any way contributes to the establishment and/or proliferation of these species.

- Investigate the formation of beaches using remote sensing, LIDAR at low pool levels or some other mapping technique to understand the processes of beach deposition the distribution of beaches in the pool, the impact of beach deposition on habitat and species, and how can this be related to operation of NMPS.

- Evaluate management strategies to address the release of accumulated sediment through Northfield Mountain Project works during upper reservoir drawdown or dewatering activities. FirstLight should specifically evaluate the feasibility of the installation of a physical barrier across the bottom of the intake channel designed to prevent the migration of sediment during future drawdowns of the upper reservoir

- Evaluate management strategies to minimize flow fluctuations within Turners Pool including coordination with upstream users.

- Evaluate management strategies to minimize sediment released through spillway gates and the log sluice located near the bottom of the forebay adjacent to the Cabot Powerhouse during canal dewatering activities.

- Identify a prioritized list of locations for bank stabilization projects in the Project Area

- Develop a map of land owned by FirstLight within 200 feet of the Connecticut River with an overlay of land use and vegetation cover. Provide land use options aimed at reducing bank erosion.

<u>Management measures to change sediment flow below and above the dam.</u>

- Any historic information of existing bed substrate material in the Turner’s Falls headpond, bypass reach, or downstream of the project should be collected and assembled. To the extent possible, the location of each sample should be made available on a map. The request for new data would stem from being able to make any valid comparison to changes in bed substrate at a given location, assuming the historic data exist.
- Identify measures that could be taken to mitigate impacts to recreational use, habitat, or invasive species from sedimentation.
- Identify measures that could be taken to change or mitigate sediment starved reaches below the Turners Falls dam.

Level of Effort and Cost

Many erosion studies have already been conducted and the cost of expanding the scope of some should be reasonable. A Full River Reconnaissance under the *Erosion Control Plan for the Turners Falls Pool of the Connecticut River* (Simons & Associates, Inc. dated June 15, 1999) is scheduled for 2013 and should accomplish many of the objectives listed above.

Study Request 3. Study of feasibility for converting Northfield Mountain Pump Storage (NMPS) station to a closed-loop or partially closed-loop system

Building and operating the Northfield Mountain Pump Storage project required the Turners Falls Dam be raised 5.9 feet. The Turners Falls impoundment of the Connecticut River acts as the lower reservoir and is subject to large sub-daily fluctuations in water level. Collateral consequences of the pumping and generation cycles are not fully understood, but may have contributed to extensive erosion of streambanks, downstream sedimentation, entrainment of large numbers of resident and migratory fishes, and destruction of important spawning and nursery habitat, both within the Turners Falls Pool and downstream. Intrinsic consequences include radical fluctuations in the hydrograph at a subdaily level, which also negatively impact recreation, habitat, and likely distrupt key life history stages of resident and migratory fishes, benthic invertebrates, and macrophytes. The vast majority of proposed new pumped storage projects currently being considered by FERC are closed-loop because of a growing consensus that open-cycle pumped storage causes unacceptable environmental damage.

Resource agencies have identified restoration of a more natural hydrograph to the Connecticut River as a key management goal, and view the current relicensing process for five projects on the Connecticut River mainstem as an opportunity to achieve this. Converting to closed-loop or partial closed-loop would allow the restoration of ecological flows to the Connecticut River, and provide much greater flexibility in operational guidance for both NMPS and the other hydropower stations on the Connecticut River. It will also eliminate or partially eliminate many concerns that are outlined in many of the proposed study requests.

Goals and Objectives

The goal of this study request is to provide resource managers, stakeholders, and the licensee with an analysis of possible options for converting the plant to a close-loop or partially closed-loop system.

The objectives of this study request would be to determine

- Candidate locations for placement of a lower reservoir
- Costs and logistics of construction and modification of the current facility to convert to a closed-loop or semi-closed-loop system
- Projected savings associated with eliminating need for ongoing mitigation measures, both for stabilizing river banks as well as likely modification to operations/the facility that will be required to protect habitat and native fauna.
- Other ancillary costs or savings, such as eliminating requested studies, operational changes, or mitigation measures

Relevant Resource Management Goals

Not applicable, requester is not an agency or Indian tribe.

Public Interest Consideration If Requester Is Not A Resource Agency

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. Fish and wildlife are important public resources. The public has an interest in maintaining high quality habitat for migratory diadromous fish. Shortnose sturgeon, American shad, blueback herring, and American eel all require suitable spawning, rearing, migratory and foraging habitat. Eroding banks and subsequent increases in turbidity and deposition of fine grained material onto bed substrates in the Turner's Falls headpond, the bypass reach and downstream of the Turner's Falls project reduces the quality of habitat for these species. Elevated levels of suspended sediment are associated with a diminution in water quality, which also affects the quality of habitat encountered by fish species. Entrainment into the facility could be lethal to any of these fish. Juvenile and larval stages of resident and migratory species, including rare, threatened, and endangered species of vertebrates and invertebrates are particularly vulnerable to entrainment. This damage is aggravated by the repeated cycling of the facility—unlike standard hydro, where organisms are likely only exposed to passage events a single time and may bypass the system safely, NMPS continuously recycles river water, and therefore increases the risk of exposure to entrainment and death.

Existing Information and Need for Additional Information

Some data on environmental effects of NMPS and facilities that use fresh or salt water for generation and/or cooling are widely available and consistently point to these types of facilities as damaging to native and migratory fauna. Once plentiful populations of blueback herring have been entirely eliminated from this portion of the Connecticut River. Populations of American eel are in steep decline throughout this reach, and American shad that initially used fish passage facilities downstream of NMPS have experienced dramatic reductions above Turners Falls Dam.

Section 4.4.6 of the PAD (page 4-146) discusses entrainment at Northfield Mountain of migratory fish species. Previous studies estimated 28.6% of Atlantic salmon entrained, which was reduced to 6.7% after the installation of a guide net only during upstream passage season. LMS Engineers estimated in 1993 that the facility impacted 0 to 12.4% of adult American shad passing the water intake. No studies have looked at impacts to resident fish or other migratory fish or other times of the year, but several study request address this information gap.

Other facilities in the region (Brayton Point Power Station, a coal plant in Mt. Hope Bay) have been required by EPA to switch from open- to closed cycle at very significant cost because of the extensive damage done to fragile habitats by open-cycle pumping.

Streambank erosion has been a major concern since NMPS began operation in 1972. Section 4.2.4 of the PAD summarizes the extensive work that has been done to study and mitigate erosion along the river banks. Significant loss of agricultural land has resulted from unnatural river fluctuations and increased boat wakes from a raised impoundment, and in some cases poor mitigation efforts like helicopter removal of trees along the banks. Since 1996, the licensee has reportedly spent $750,000 - $1,000,000 annually on erosion control measures. In some cases, these projects will need to be re-done in the future. Converting the plant to closed-loop operation could provide significant cost savings over the life of the upcoming license, eliminating erosion control projects, proposed studies related to use of the Connecticut River as a lower reservoir, and any mitigation or operational changes that may be contemplated as a result of relicensing.

Nexus to Project Operations and Effects

In conjunction with other study requests, parties to the relicensing process will be reviewing data and considering operation and facility conditions that will best achieve the balance between natural resource protection, property and infrastructure protection, and power generation. Making the plant closed-loop or partially closed-loop is one important consideration to the scenario and would eliminate any operation changes that might result from concerns about fishery resources, water quality effects, and farmland losses.

Proposed Methodology

- Collate existing geological and hydrologic information of areas surrounding Northfield Mountain, including preliminary design plans for suitable facilities able to accommodate the existing and proposed discharge. These plans should include any and all possible locations, including modifications to infrastructure near the current outfall, north of Fourmile Brook, the Connecticut River, damming of the Miller's River, and any other locations that could accommodate the necessary volume of water.
- Provide an engineering analysis of structural modifications necessary to accommodate a full or partial lower reservoir in an alternate nearby location.
- Provide information on whether and how a smaller lower reservoir, with ties to the Connecticut River, would act as a buffer to river level fluctuations and change the hydrologic pattern of flow on the Connecticut River in the Turners Falls pool (fluctuations), the water quality effects, and decrease the possibility of entrainment.
- Provide an analysis on water losses from evaporation and leakage and how much make-up water would be needed during normal operations by season or month.
- Identify and make available any similar studies conducted during the planning phase of the existing facility in the 1960s or any other time.
- Provide a cost estimate of each option considered and evaluated.
- Provide an itemized cost estimate of how constructing a lower reservoir would affect other costs, such as eliminating the erosion control program, any ancillary changes to generation at Turners Falls Dam and NMPS, and fish protection measures.

These methods are consistent with accepted practice for weighing costs and benefits of environmental impacts.

Level of Effort and Cost

The level of effort to compile existing information and to make the data available in a map should be low. Development of contingency scenarios would be low. The majority of the effort of this study request is essentially office work, with some engineering and design work required to scope likely costs of various scenarios.

Requested Study 4. Model flows in the Northfield Mountain Pumped Storage Project discharge tailrace and Connecticut River 1 kilometer upstream and downstream of the discharge using two-dimensional Computational Fluid Dynamics (CFD) model techniques.

Goals and Objectives

The goal of this study is to determine the potential impacts (both project-specific and cumulative) of the Northfield Mountain Pump Storage Project operations (pumping and generating) on the zone of passage for migratory fish near the Northfield Mountain turbine discharge/pump intake, on natural flow regimes in the area of the Connecticut River immediately upstream and downstream of the project, on the potential for entrainment during pumping operations, on the potential for creating flow reversals in Connecticut River during pumping cycles that may confuse migratory fish attempting to pass the project, and on bank erosion on both sides of the river in the vicinity of the tailrace.

Specific objectives of the study include:

- Develop a 2-dimensional CFD modeling capability for the area of the Northfield Mountain discharge and tailrace, along with the full width of the Connecticut River 1km upstream and 1 km downstream of the discharge.
- Model flow characteristics upstream and downstream of the project under existing project operations (pumping and generating) and at several representative river flow levels, as well as proposed operations such as those proposed in section 3.4.4 of the PAD, and any other modifications under consideration, to assess potential impacts to fish and wildlife resources, recreational use, agricultural resources, and historical resources.
- Assess velocities at and in proximity to the Northfield Mountain intake/discharge structure, when pumping or generating and their potential to interfere with fish migration.
- Assess the potential for velocity barriers in the mainstem river resulting from pumping and generation flows at the project, alone or in combination with generation flows from the upstream Vernon Project.
- Assess potential for Northfield Mountain project operations to create undesirable attraction flows to the intake/discharge that may result in entrainment or delay of migratory fish.
- Assess the potential of a mainstem instream local flow reversal associated with pumping operations to impact migrating fish. The Connecticut River in the area of the Northfield Mountain tailrace has been said to flow upstream potentially confusing migratory fish keying in to flow as a directional aid to upstream or downstream migration, causing delay and additional "fish" energy expense and possible entrainment.
- Model and then evaluate flow characteristics under alternative project operations with potential measures to avoid, minimize, or mitigate impacts to fish and wildlife resources.
- Assess the potential for unnatural flows and eddies in the main-stem associated with pumping or generation at the Northfield Mountain Project to impact bank erosion and recreational use.

Relevant Resource Management Goals

Not applicable, requester is not an agency or Indian tribe.

Public Interest Consideration If Requester Is Not A Resource Agency

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. Fish, wildlife, plants, and their habitats are important public resources. There is a strong public interest in protecting, conserving, and enhancing these resources for public benefit, including wetlands, endangered species, and migratory species, all of which have been documented to occur in the project area. Instream flow is an important riverine habitat characteristic that can have a great impact on aquatic habitat for fish, wildlife, and plants. Flow is an important directional guidance cue for instream navigation and attraction to fishway entrances for migratory fish.

Existing Information and Need for Additional Information

No project specific information exists that will allow for a comprehensive assessment of existing project operations (pumping and generating flows) on Connecticut River flows and on fish and aquatic organisms in the project area upstream and downstream of the project in the Connecticut River. Preliminary results from an ongoing study of radio-tagged American shad by the USFWS and USGS Conte lab indicate that shad are exposed to the intakes and some individuals spend substantial amounts of time in the vicinity of the intakes. The PAD does not contain any information or tool that will allow for predictions of impacts of alternative project operations, or potential mitigation measures to protect or enhance aquatic fish and wildlife resources.

As part of Field (2007; see appendix 4), a "Connecticut River Hydraulic Analysis – Vernon Dam to Turners Falls Dam" was completed by Woodlot Alternatives in July 2007. For this analysis, a 2-dimensional flow model was developed for the entire Turners Falls impoundment. This study was geared towards looking at shear stresses from high-flow events, and did not focus in detail around the tailrace or examine how pumping and generation may affect flows in the vicinity of the tailrace under a variety of flows.

As a result of the hydraulic analysis, Field (2007) on page 20 states that "While erosion does occur where high flow velocities and shear stresses approach near the bank, significant amounts of erosion also occur where flow velocitieis near the bank are low." No specific examination was done in the report on the ±1 km area near the tailrace and existing erosion sites. Banks immediately upstream and downstream and across river have all required bank stabilization projects over the last 15 years, in some cases needing several repairs.

Nexus to Project Operations and Effects

Existing project operations have a direct impact on instream flow and aquatic habitat in the pump/discharge area of the Connecticut River. The PAD in section 3.2.2 says that the velocity at the trash racks when operating at full capacity is 20,000 cfs and maximum pumping conditions are 15,200 cfs. Annual flow duration curves shown for below the Vernon Dam submitted in the PAD section 4.3.1.2 (for years 1944-1973; recent and near project flows are not available; see p. 459) indicate that river flows are ≤ 20,000 cfs more than 85% of the time. Flows released from the project must therefore influence flow patterns and velocities in the Connecticut River, particularly at flows below some unknown threshold level.

Recreational users of the Connecticut River in the Turners Falls impoundment have anecdotally described flow reversals in the mainstem river. Discharges from the project could potentially be larger than river flows or at least act like a major tributary to the Connecticut River. Project flows may influence the availability and extent of upstream and downstream migration zones, or may confuse fish and delay migration. Project flows may also impact stream banks in ways that natural river flow (or flows affected by upstream hydropower facilities) does not, and may also impact recreational use of the river.

Proposed Methodology

CFD modeling is consistent with generally accepted practice, and has been used to assess proposed modifications to the Holyoke Dam fish passage facilities, upstream of the intakes and downstream of the dam, as well as at hydroelectric projects on the Susquehanna River to assess existing and proposed project operations, and develop mitigation measures for fish and wildlife resources.

Level of Effort and Cost

This study will require a detailed elevation map of the study area upstream and downstream of the Northfield Mountain project. Information already exists in historic construction files for the project, the hydraulic analysis included in Appendix 4 of Field (2007), and possibly in conjunction with work done after the 2010 maintenance procedures that resulted a portion of the river being dredged after a large sediment dump) that are in the possession of the applicant. Additional elevation data will likely need to be collected in the field using standard survey techniques. Elevation data will then need to be entered into a CFD modeling program. The CFD computer program will need to simulate existing project operations that include all potential variations of pumping and generating, and static operation. No project specific instream flow analysis tool has been developed for the Northfield Mountain project that will allow for assessment of existing operations and alternative operational impacts on instream flow and aquatic habitat for fish and wildlife resources. The computer model, once built, can be used to simulate flow conditions in the vicinity of the project during migratory fish passage and can be used together with behavior studies (i.e., telemetry studies and entrainment studies requested herein) to assess the impacts of varying project operations or potential mitigation operations and measures on fish migration and aquatic habitat. We know of no other tool that will provide for these types of assessments. Cost is expected to be moderate to high.

Study Request 5: Climate Change as it Relates to Continued Operation of the Vernon, Bellows Falls, Wilder, Northfield Mountain Pumped Storage, and Turners Falls Projects

Goals and Objectives

The goal of this study is to determine how climate change relates to the continued operation of the Vernon, Bellows Falls, Wilder, Northfield Mountain Pumped Storage, and Turners Falls projects.

The objectives of this study are:

- Quantify the amount of thermal loading contributed by each respective impoundment (including the NMPS upper reservoir).
- Using climate change prediction models, calculate how much warmer the project impoundments are projected to get in the next 30-50 years.
- Model the effect of various project modifications on river temperature under current conditions and climate change predictions (e.g., converting to run-of-river, deep-water releases, dam removal, large-scale riparian revegetation, etc.).
- Using climate change prediction models, determine if the projects actually provide an environmental benefit with respect to mitigating against climate change impacts (vis a vis warming of air and water temperatures) by producing low greenhouse gas emitting energy. The Northfield Mountain Pump Storage assessment must be based on net energy production (i.e., NMPS generates1,143,038 MWh annually, but consumes 1,567,506 in its pumping operations; for a net consumption of 424,468 MWh annually).
- Determine how climate change predictions will impact management of high flow events at the three projects and evaluate if changes to dam structures would mitigate adverse impacts of the existing flood management protocols.

Relevant Resource Management Goals

Not applicable, requester is not an agency or Indian tribe.

Public Interest Consideration If Requester Is Not A Resource Agency

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. The Connecticut River is a valued public resource, including the organisms (fish, wildlife, plants) that depend on river, wetland, bank and floodplain habitats for any part of their lifecycle. The public has a strong interest in protecting and enhancing these resources. Climate change poses the potential for increased water temperature in the dam impoundments and more frequent and more extreme high flow events, all of which can degrade or stress riverine and riparian habitats and resident and migratory wildlife populations dependent on the Connecticut River and its floodplain. This study will assess potential Climate Change caused effects and consider potential mitigating actions to minimize ecosystem degradation and enhance adaptation to a changing climate.

Existing Information and Need for Additional Information

The PADs contains no information relative to climate change and how climate change predictions may impact future operation of the hydroelectric plants, nor of how the projects either mitigate for or exacerbate predicted climate change impacts to freshwater ecosystems.

TransCanada's PADs provide a summary of water quality data collected in 2012. Table 1 below is a synthesis of the temperature data collected by TransCanada. It should be noted that the upper and mid-impoundment stations at each project represent the average of temperature readings taken over the entire water column, while the continuous loggers (Lower Cont. and TR) were located near the water surface. These data indicate that from the upstream end of the Wilder headpond to the Vernon tailrace, water temperature increased approximately 6°C.

Table 1. Median water temperature at monitoring stations located within the impoundments and tailraces of the three hydropower projects.

	Median Water Temperature °C			
Project	Upper Imp.	Mid-Imp.	Lower Cont.	TR
Wilder	20.86	21.83	24.08	23.59
BF	22.43	23.67	24.86	24.38
Vernon	23.81	24.49	26.73	26.35

Relative to existing flood management protocols at each station, TransCanada's PADs identify that all three dams utilize stanchion bays (two at Vernon, three at Bellows Falls, and four at Wilder). When inflows to each dam reach certain levels, the stanchion bays are removed, and cannot be replaced until inflows subside. The depth of these bays and the flows they are removed at are outlined in Table 2, below.

Table 2. Summary of pertinent stanchion bay Information for the Vernon, Bellows Falls, and Wilder projects.

Project	Stanchion Height (feet)	Flow Triggering Complete Stanchion Removal
Wilder	17	145,000 cfs
BF	13	50,000 cfs
Vernon	10	105,000 cfs

The PADs provide no information on the history of stanchion removal at any of the projects (frequency, duration, timing), nor a discussion of how predicted climate change might alter management of the stanchion bays in the future (with respect to the frequency and seasonality of occurrence). There also is no discussion of potential impacts to headpond resources that occurs as a result of stanchion bay removal. These information gaps need to be filled in order to assess the relative and cumulative impact of project operations with respect to protecting river and floodplain habitats and the organisms that depend on them.

Data provided by the National Oceanic and Atmospheric Administration, Climate Data Center, illustrates long-term increasing air temperatures in the Northeast (Figure 1). Long-term, monthly mean water temperature data for the Vernon Dam impoundment, monitored by Vermont Yankee, has shown significant differences over time (ANOVA analyses, $P < 0.05$) that when plotted and further analyzed by linear regression, show a significant increasing trend for the period 1974 – 2011 for the months of

January, September, and October (Figure 2). These analyses were performed with data from Vermont Yankee, analyzed by the Massachusetts Department of Environmental Protection.

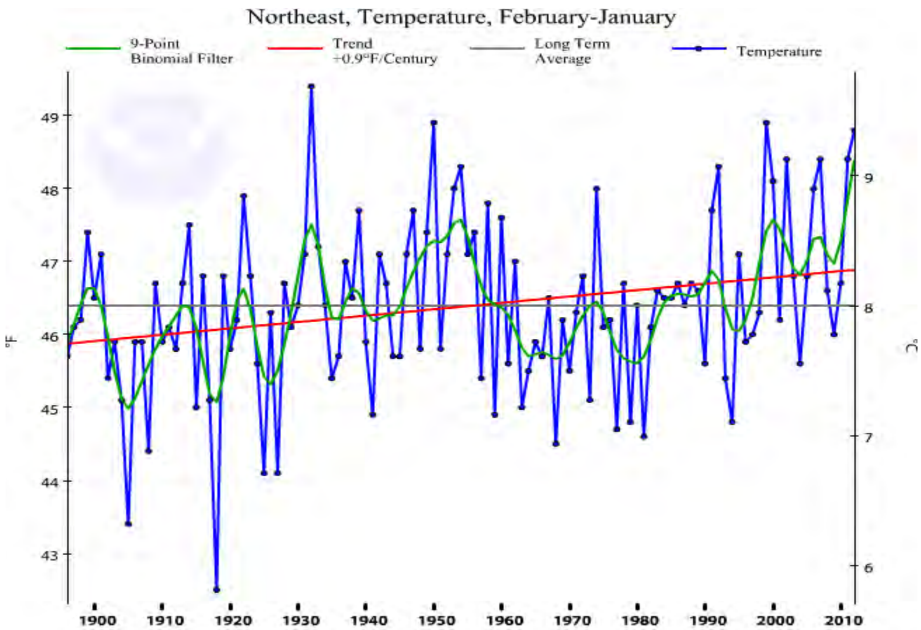

Figure 1. NOAA National Climate Data Center, Northeast 12-month average temperature for the period 1896 through 2012 (October).

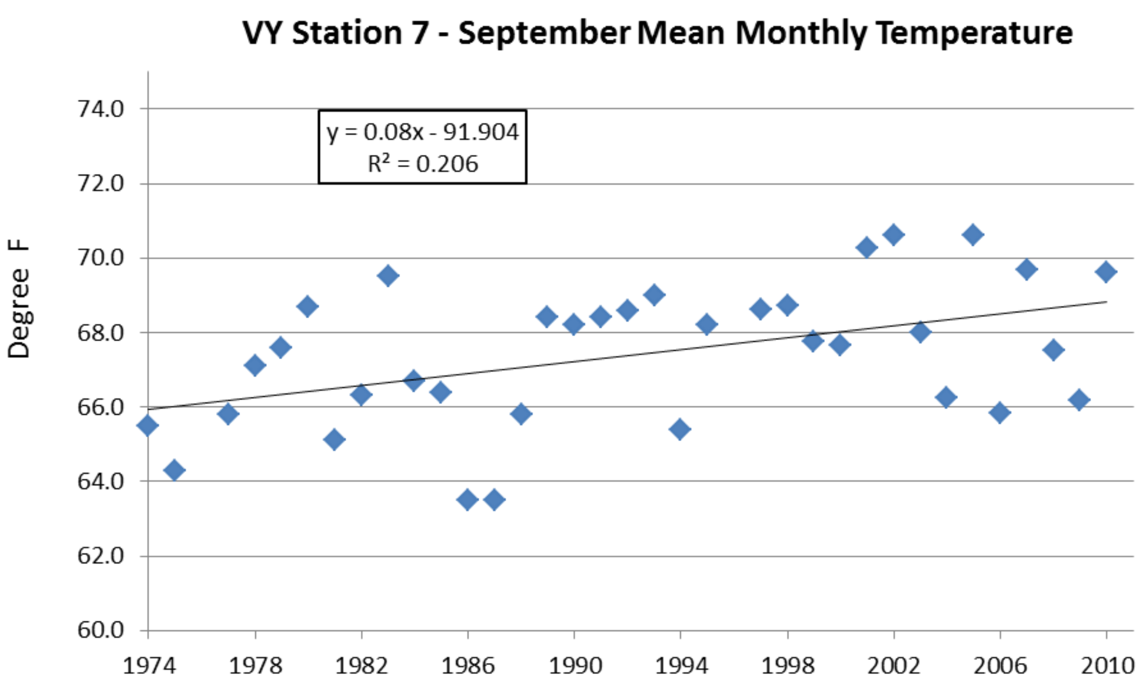

Figure 2. A plot of September's mean temperatures for Vermont Yankees' Station 7 (excludes outlier 1996 data point) for the period 1974 through 2011.

The PAD for Turners Falls and Northfield Mountain Pump Storage projects provides a summary of existing water quality data compiled by FirstLight. The PAD also notes a 1991 study by the former licensee that modeled thermal effects of pumping to the upper reservoir. That model reported a maximum temperature difference attributable to NMPS operation of 0.21°C in the Turners Falls reach of the Connecticut River in low flow (4,000 CFS) simulation.

Nexus to Project Operations and Effects

The four mainstem projects have very long impoundments capable of storing large volumes of water (Table 3, below). These impoundments effectively have converted large portions of the Connecticut River into a series of in-river "lakes." Because water velocities slow in these impounded sections of river, it allows for increased thermal loading and resultant higher water surface temperatures than in free-flowing sections of river.

Table 3. Relevant characteristics of the reservoirs behind the Wilder, Bellows Falls, Vernon, Turners Falls dams and NMPS.

Project	Headpond Length (miles)	Gross Storage Volume (acre-ft.)	Average Depth (ft.)	Surface Area (acres)	Flushing Rate (days)
Wilder	45	34,350	11	3,100	3
BF	26	26,900	10	2,804	<2
Vernon	26	40,000	16	2,550	2
Turners	20	21,500		2,110	
NMPS	n.a.	17,,050		246	n.a.

Depending on where the hydropower intakes withdraw water, these warmer surface waters may be discharged downstream, raising the temperature of those waters as well (the data in Table 1 above suggest that the projects do draw water from the upper levels of the reservoirs). This effect may be felt for miles downstream. If there are a series of impoundments (like on the Connecticut River), the cumulative impact is an overall warming of the river. Even small run-of-river dams have been shown to elevate downstream water temperature (Lessard and Hayes 2003; Saila et al. 2005). The most recent climate change prediction models specific to the northeast forecast warmer air temperatures, more frequent high precipitation events, more heat waves, and an increase in the incidence of short term droughts (Karl et al. 2009).

Resource concerns related to this project effect include the potential impacts to populations (reductions in abundance, structure, condition) or loss of species not tolerant of increases in temperature and other effects related to physiology such as energetic costs with warmer temperatures (Leggett 2004). As one example, American shad restoration target numbers for fish passage at mainstem dams into upstream historic habitat could be negatively impacted from artificially increased water temperatures. Water temperature has been identified as a factor in the timing (i.e., duration) of this species migration, as well as its role in gonad development and spawning (Glebe and Leggett 1981; Leggett 2004). These factors can be logical reasoned to potentially result in accelerated rates of energy reserve use and a reduced migration window, possibly reducing the ability of fish to reach up-river habitats and further reducing the ability to survive downstream outmigration.

With respect to project operations during high flow events, all TransCanada projects have stanchion bays that are used to manage water during high flow events. Each time these stanchion bays are removed, the headponds are lowered substantially (from 10 to 17 feet, depending on the project) and must remain lowered until inflows subside. Depending on the timing and duration of these deep drawdowns, headpond resources could be negatively impacted.

All of the dams also contain other mechanisms for managing flows, such as tainter gates, sluice gates, roller gates, skimmer gates and hydraulic flood gates. All of these gates have an advantage over stanchion bays in that they do not require flows to subside significantly before they can be closed to return impoundment levels back to normal. One climate change prediction for the northeast is that we will see more frequent high precipitation events which will result in high flow conditions on rivers. Therefore, it is likely that the stanchion bay removal protocol will have to be employed more frequently in the future.

Proposed Methodology

- In order to quantify the amount of thermal loading contributed by each respective impoundment, detailed bathymetry will need to be collected. This bathymetry, combined with storage volume, tributary hydrology, and project operations, should be used to calculate the thermal loading of each headpond. The individual and cumulative increase in surface water temperature due to the impoundments should then be used to predict future warming based on climate change models.
- Analyze different mitigation strategies to understand which have the greatest benefit in terms of building resilience against the impacts of climate change on water temperature. Potential scenarios to analyze include converting the projects to run-of-river, implementing deep-water releases, removing one or more dams, conducting large-scale riparian revegetation, etc.
- Input to climate change models the amount of GHG emissions that would be generated if fossil fuel plants were producing the equivalent amount of net energy as the five hydropower projects to determine the impact on air and surface water temperatures.
- Climate change prediction model output should be assessed to determine if the frequency and timing of high flow events is likely to change in the future. If high flow events that necessitate initiating the stanchion bay removal protocol are predicted to increase in frequency and/or shift in timing, the applicant should evaluate structural and/or operational alternatives that would mitigate adverse impacts of the existing flood management protocols.

Level of Effort and Cost

The level of cost and effort for the thermal loading analysis would be low to moderate. Collecting bathymetry in the three TransCanada headponds would take two staff less than one week to collect (it took the Kansas Biological Survey two days to collect bathymetry at a 3,500 acre lake; Jakubauskas et al. 2011). Bathymetry for the Turners Falls pool and NMPS upper reservoir already exist. The remaining work would be desk-based; loading relevant information into an appropriate thermal loading model to compute the estimated thermal loading of each headpond and then comparing this information to surface water data from climate change prediction models.

The high flow flood protocol study is a desktop analysis that should require low cost and effort. Climate change models already exist and that output would be downloaded and analyzed. The remaining analysis requires a review of alternative means of managing flows without the use of stanchion bays.

The applicants did not propose any studies to meet this need in the PAD.

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Study Request 6. Water Quality Monitoring

Goals and Objectives

Determine the current water quality of the Connecticut River within the Project area. The results of the study should provide information sufficient to understand water quality conditions at the project. The study plan should be developed in consultation with the U.S. Fish and Wildlife Service (FWS) and the Massachusetts Department of Environmental Protection (MassDEP), the U.S. Environmental Protection Agency, and other stakeholders such as the Connecticut River Watershed Council and the Franklin Regional Council of Governments.

The specific objectives of this study are as follows:

- Characterize water quality in the Turners Falls impoundment, bypass reach, canal and below the confluence of the bypass reach and canal discharge.
- Evaluate the potential effects of project operation on water quality parameters such as temperature and dissolved oxygen in conjunction with various other water uses.
- Determine the level of contamination in sediment impeded by the Turners Falls dam.
- Collect dissolved oxygen and temperature data during the spring through fall period and under various hydropower operating conditions at the Northfield Mountain Project.

Relevant Resource Management Goals

Not applicable, requester is not an agency or Indian tribe.

Public Interest Consideration If Requester Is Not A Resource Agency

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. The Connecticut River is valued public resource. The public has a strong interest in protecting the water quality of the river water and to maintaining the river's status as a Class B river, as designated by Massachusetts Department of Environmental Protection, 314 CMR 4.06(5). Class B rivers are assigned the designated uses of habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation, 314 CMR 4.05(3)(b). Class B waters must also have consistently good aesthetic value and meet minimum criteria for numerous water quality indicators to achieve compliance with the standards set forth in the regulations. The anti-degradation provisions of 314 CMR 4.04 require protection of all existing and designated uses of water bodies, and maintenance of the level of water quality needed to protect those uses. The results from this study will provide information necessary to understand water quality conditions at the project.

Existing Information and Need for Additional Information

The PAD provides a summary of existing water quality data. While a number of monitoring efforts have taken place and include sample sites within the project boundary, none of those studies were designed to comprehensively investigate whether all relevant project areas currently meet Class B standards: The Massachusetts DEP's Connecticut River watershed assessment monitoring occurred in 2003, only had two stations located within the project area (both upstream of the Turners Falls dam) and only collected five to six samples from late April to early October; the Connecticut River Watershed Council's volunteer monitoring program only had one sample site within the project area (at Barton's Cove in the Turners

Falls headpond) and while those data are more recent, only three samples were collected in 2007 and only six samples in 2008 (over the course of three to four months each year); and the U.S. Geological Survey's long-term water quality monitoring station located downstream of the Cabot Station tailrace only collects information roughly once per month (and no dissolved oxygen data are provided).

The 2012 Massachusetts Integrated List of Waters considers the entire length of the river within the projects' boundary as impaired, having the following impairments.

- Segment MA34-01 (3.5 miles) for "other flow regime alternations" and "alteration in stream-side or littoral vegetative covers"
- Segment MA34-02 (10.9 miles) for "alteration in stream-side or littoral vegetative covers"
- Segment MA34-03 (3 miles) for total suspended solids, "low flow alterations" and "other flow regime alternations"
- Segment 34-04 (34.4 miles) for E.coli bacteria
- Barton Cove is listed as impaired for non-native aquatic plants (Eurasian water milfoil).

No directed, site-specific surveys have been conducted to determine whether waters within the Project area meet State standards. This information gap needs to be filled so that resource agencies can evaluate properly the potential impact of project operations on water quality.

Nexus to Project Operations and Effects

The project creates a 20-mile-long impoundment where there would naturally be a free-flowing river. It currently operates in a peaking mode, with allowable headpond fluctuations of up to 9 feet, with proposals to continue as such. Portions of the headpond are nearly 100 feet-deep. There is a 2.7 mile-long reach of river bypassed by the Turners Falls power canal with only a nominal seasonal release required (equal to 0.05 cfsm). The below-project flow requirement is equal to 0.20 cfm (1,433 cfs). Water quality can be affected by the operating mode of a hydropower project. Impoundments can stratify, resulting in a near-hypoxic hympolimnion. If the project intake draws off of these deep waters then it could cause low dissolved oxygen levels downstream from the project discharge.

This study requests that the applicant conduct a water quality survey of the impoundment, bypass reach and tailrace reach in order to determine whether state water quality standards are being met under all currently-licensed operating conditions (i.e., during periods of generation and non-generation). Results of the survey would be used, in conjunction with other studies requested herein, to determine an appropriate below-Project flow prescription, bypass reach flow(s), and to recommend an appropriate water level management protocol for the headpond (e.g., limiting impoundment fluctuations to protect water quality).

Operation of upstream hydroelectric projects as well as the Turners Falls Project and Northfield Mountain Project may impact water quality through the use of water for hydropower generation.

Proposed Methodology

<u>Turners Falls</u>: Water temperature and DO measurements should be collected from a minimum of six locations: upstream in the impoundment (Route 10 bridge), at a deep location within the impoundment, in the forebay near the intake, in the bypass reach, in the canal near Cabot Station and downstream of the confluence of the Cabot Station discharge and the bypass reach but upstream of the confluence with the Deerfield River.

In order to ensure that data are collected during a time of important biological thresholds and anticipated "worst case" conditions for dissolved oxygen (low flow, high temperature, antecedent of any significant rainfall event), we recommend deploying continuous data loggers at all six locations, with biweekly vertical profiles taken at the deep impoundment location from April 1 through November 15. Results should include date, time of sampling, sunrise time, GPS location, generation status (estimated flow through canal and bypass reach), precipitation data, water temperature, DO concentration and percent saturation. In addition, impoundment sediment adjacent to the Turners Falls dam should be analyzed for metals and polychlorinated biphenyls.

A proposed water quality sampling plan would need to be submitted to MassDEP for approval prior to sampling. A section on quality assurance and quality control must be included.

If river flow and temperature conditions are representative of an "average" or "low" water year, then one year of data collection should be sufficient to perform the study. If conditions are not representative (i.e., a "wet" or cool year) then a second year of data collection may be necessary.

<u>Northfield Mountain:</u> The water quality study will include two components: a) continuous dissolved oxygen and temperature monitoring at specific locations in the Northfield Mountain Project area and b) monthly *in-situ* dissolved oxygen and temperature profiles within the Northfield Mountain Upper Reservoir. It is anticipated that the study will be conducted from approximately June 1 through September 30.

Level of Effort and Cost

Cost would depend on the specific methodology chosen. If continuous data loggers are installed at all six locations and biweekly vertical profiles taken at the deep impoundment location from April 1 through November 15 then the estimated cost of the water quality study is moderate. It is expected to take two technicians approximately one day to deploy the loggers, twelve days to collect the vertical profiles, one day to remove the loggers, one day to download the data, and five days to write the report.

In the PAD, the applicant proposes to assess the effects of the Turners Falls and NFMPS project operations on dissolved oxygen and temperature by continuously monitoring DO and temperature at locations within the project areas and gathering vertical profiles within the TF impoundment and NFMPS upper reservoir.

Requested Study 7. Model River Flows and Water Levels Upstream and Downstream from the Turners Falls Project Dam Generating Stations and Integration of Project Modeling with Upstream and Downstream Project Operations

Develop a river flow model(s) that are designed to evaluate the hydrologic changes to the river caused by the physical presence and operation of the Turners Falls Hydroelectric Project and the interrelationships between the operation of all five hydroelectric projects up for relicensing (i.e., P-1889 Turners Falls Hydroelectric Project, P-2485 Northfield Mountain Pumped Storage, P-1904 Vernon Hydroelectric Project, P-1855 Bellows Hydroelectric Project, P-1892 Wilder Hydroelectric Project) and river inflows. The flow studies should assess the following topics:

- Conduct quantitative hydrologic modeling of the hydrologic influences and interactions that exist between the water surface elevations of the Turners Falls Project impoundment and discharges from the Turners Falls Dam and generating facilities and the upstream and downstream hydroelectric projects. Data inputs to and outputs from the model(s) should include:
    - Withdrawals from the Turners Falls impoundment by the Northfield Mountain Pumped Storage Project, FERC No. 2485,
    - Discharges to the Turners Falls impoundment by the Northfield Mountain Pumped Storage Project,
    - Discharges into the Turners Falls impoundment from the Vernon Project, FERC No. 1904 and other sources.
    - Existing and potential discharges from the Turners Falls Project generating facilities and spill flows.
    - Existing and potential water level fluctuation restrictions (maximum and minimum pond levels) of the Turners Falls impoundment and downstream flows from the project
    - Existing and potential required minimum flows and/or other operation requirements at each of the four upstream projects.
    - Minimum discharge flows ranging between 2,500 and 6,300 cfs in the bypass reach from April 15th through June 22nd to support spawning, rearing, and outmigration of shortnose sturgeon at Rock Dam.
- Document how the existing and potential outflow characteristics from the four upstream projects affect the operation of the Turners Falls Project including downstream flow releases and Turners Falls impoundment levels.
- Assess how recreational use of the Connecticut River between the Route 16 bridge and the Turners Falls Dam is impacted by downstream flows under a range of river flow conditions.
- Assess how the operation of the existing Turners Falls Project and upstream projects affect Holyoke Project (P-2004) operations including:
    - How Turners Falls Project flow fluctuations affect Holyoke impoundment water levels, with emphasis on the influence on the water levels on listed Puritan tiger beetle habitat at Rainbow Beach in Northampton, MA. and assess what changes would be needed in Turners Falls operations to stabilize water levels at Rainbow Beach.

- How Turners Falls Project operations affect Holyoke Project discharges and what changes in Turners Falls operations would be needed to reduce fluctuations in the discharges from the Holyoke Project.
- To the extent predictable and practical, incorporate the potential effects of climate change on project operations over the course of the license.

Goals and Objectives

Determine the extent of alteration of river hydrology caused by operation of the project and the interactions between upstream project operations, Turners Falls operations and downstream operations at the Holyoke Project. The models will provide necessary information on what changes can be made to each of the five project's flow releases and/or water levels restrictions, and how those changes affect downstream resources.

Specifically, for the Turners Falls Project continuous minimum discharge flows in the Turners Falls bypass reach need to be no less than 2,500 cfs during shortnose sturgeon spawning, rearing, and outmigration (April 15th – June 22nd). Incorporating these parameters into the model will inform what changes, if any, need to be made to operations of upstream projects to accommodate such flows.

As other specific modifications of the operations of each of the projects are identified based on results of other requested studies, these desired conditions will need to be input into the models to assess how each change affects that project and other project operations and the implications of those changes on other resources and/or the ability to achieve desired operational changes at other projects.

Relevant Resource Management Goals

Not applicable, requester is not an agency or Indian tribe.

Public Interest Consideration If Requester Is Not A Resource Agency

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. Fish, wildlife, plants, and their habitats are important public resources. There is a strong public interest in protecting, conserving, and enhancing these resources for public benefit, including wetlands, endangered species, and migratory species. This study will provide important information about how project operations effect river flows, which has a significant impact on the Connecticut River ecosystems and the plants and animals that depend on them.

Existing Information and Need for Additional Information

Available information in the PAD does not indicate how project operations have altered downstream hydrology, which may affect resident and migratory fish, macroinvertebrates, rare, threatened, and endangered species, aquatic plants and other biota and natural processes in the Connecticut River from below the Vernon Dam downstream to the Holyoke Dam.

Information in the PAD also does not reflect data analyzed in Kynard et al. 2012, which identifies minimum discharge thresholds for shortnose sturgeon spawning and rearing at the Rock Dam spawning site. Spawning success was observed at Rock Dam when discharge was between 2,500 cfs and 22,000 cfs during the spawning period (April 27–May 22nd) (Kynard et al. 2012, chapter 3). In 1995 at the Cabot spawning area, the greatest level of spawning and spawning success occurred (i.e., 21 late stage females present, 342 ELS captured, spawning period was 17 days) even though no spawning was detected at Rock

Dam (Kynard et al. 2012, chapter 3). Discharges in 1995 at Rock Dam had dropped below 2,500 cfs by March 26th (Kynard et al. 2012, chapter 3), showing that even though 1995 saw the largest number of pre-spawning adults, none spawned at Rock Dam. This may indicate the need to have adequate flow well in advanced of spawning. Discharge reductions at the Rock Dam site that occurred during spawning caused females to leave the spawning cite and not return even if flow increased to acceptable levels later during the spawning period. Researchers observed that substrate did not change during fluctuating flows and thus cessation of spawning is likely due to velocities falling below the range preferred by females. Given the current flow dynamics at Rock Dam, spawning does not occur most years (Kynard et al. 2012, chapter 3). These data represent the best available scientific information and indicates that the current minimum flow thresholds at the project are not adequate for the protection of endangered shortnose sturgeon. All modeling efforts described above must incorporate the identified minimum flow and temporal parameters.

River users complain that project operations negatively affect use of the river downstream of the Turners Falls Dam. No information in the PAD is provided to understand the flows at which recreational use is affected.

Nexus to Project Operations and Effects

The Turners Falls Project is currently operated with a seasonally-varying minimum bypass flow (400 cfs from 5/1 through 7/15, then 120 cfs through the winter until river temperature rises to ≥ 7°C) and year-round minimum flow below the projects of 1,433 cfs. The project operates as a daily peaking project, often with large, rapid, daily flow fluctuations between the minimum and project capacity (15,928 cfs) and fluctuations in headpond elevation (175’ to 186’ MSL). These changes affect biotic habitat and biota upstream and downstream of the project. Project operations and potential changes to operations to mitigate impacts are influenced by inflows and operations of upstream peaking projects and the Northfield Mountain Pumped Storage Project operations and potential changes in operations of each project could affect the ability to achieve desired operational changes at other projects. Results of river flow analyses will be used to develop flow-related license requirements and/or other mitigation measures.

Proposed Methodology

River hydrology statistics and modeling are commonly employed at hydroelectric projects to assess implications of project operations on the river environment.

Level of Effort and Cost

Level of effort and cost of model development are expected to be moderate but to be valuable in developing license conditions, the model(s) will need to be run under various scenarios throughout the relicensing process to assess the implications of changes to the operations of each project on other projects and other resources. Therefore, ongoing consultation and re-running of the model(s) are likely to be needed throughout the relicensing process. The modeling exercise will also require coordination and cooperation between First Light and the upstream licensee to assure that the model inputs and outputs can be accurately related.

We would anticipate that the expected level of effort and anticipated costs will be comparable to that experienced on similar FERC relicensing projects of this size (e.g., Conowingo, FERC No. 405).

Requested Study 8. Determine the Fish Assemblage in the Turners Falls and Northfield Mountain Pumped Storage Project-Affected Areas

Goals and Objectives

The goal of this request is to determine the occurrence, distribution, and relative abundance of fish species present in the Project affected areas of the Turners Falls and Northfield Mountain Project Areas, which potentially includes Species of Greatest Conservation Need (SGCN) for Massachusetts, New Hampshire, and Vermont.

Specific objectives include:

- Document fish species occurrence, distribution, and abundance within the project affected area along spatial and temporal gradients.
- Compare historical records of fish species occurrence in the project affected area to results of this study.

Relevant Resource Management Goals

Not applicable, requester is not an agency or Indian tribe.

Public Interest Consideration If Requester Is Not A Resource Agency

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. Fish and their habitats are important public resources. There is a strong public interest in protecting and conserving fish and their habitats. This study will provide important information about fish species occurrence, distribution, and abundance and will better clarify what species occur in the project area both spatially and temporally, relative to habitats which may be affected by project operations of the Turners Falls or Northfield Mountain Pump Storage projects. This information will better inform other results from other study requests that will be examining project operation effects on various aquatic habitats, water quality and other related concerns such as entrainment concerns at NFMPS. This information will be used to make recommendations and provide full consideration for all species, including those that might not otherwise be known to occur in the project-affected area and impacts that may affect their population status through direct or indirect effects of the projects.

Existing Information and Need for Additional Information

A thorough and comprehensive assessment of the fish assemblage present in the project-affected areas of the Turners Falls and NFMPS projects is lacking. The PAD for these projects sites notes resident fish surveys conducted by the State of Massachusetts in the early to mid 1970s and a limited 2008 sampling effort by Midwest Biodiversity Inst. (contracted by EPA). The PAD identifies a total of 22 fish species in the project area which omits, as an example of its limited information basis, northern pike, tessellated darter, burbot, eastern silvery minnow, and channel catfish (Ken Sprankle, USFWS, and Jessie Leddick, MADFW, personal communication). It is unknown how many other species may inhabit or utilize aquatic habitats in the projects area, potentially including species of greatest conservation need.

The most relevant recent fish survey study related to the project affected areas is a Connecticut River electrofishing survey conducted in 2008 (Yoder et al., 2009). While some sampling was conducted in both project areas during the 2008 survey, this survey did not have the same goals and objectives as those outlined above. Due to the design of the study limitations in geographic/habitat type coverage both spatially and temporally, and the use of a single gear type, limits the use of these data and that synthesized data may not be a full representation of species occurrence in the project affected areas. It follows that since information is limited regarding the composition of the fish community and their use of habitats in the project-affected area, project impacts on fish species are also unknown.

Nexus to Project Operations and Effects

Project operations have the potential to directly impact fish species life history requirements, biological interactions, and habitat quantity and quality. For example, headpond and tailwater water level fluctuations could dewater important spawning areas, or affect habitat availability, thus limiting productivity of fish species by direct impacts to their spawning success or indirectly by limiting the spawning success of forage fish species. Accordingly, a thorough understanding of the current fish assemblage structure and associated metrics are needed in order to examine any potential project-related impacts. A Study Request to examine project effects on aquatic habitats, as well as impacts to spawning habitats (e.g., sea lamprey and black bass) has been submitted and will compliment this request.

Proposed Methodology

An accepted and robust field sampling design (e.g., as described in Pollock et al. 2002 or MacKenzie et al. 2006) and accepted methods for collecting fish species likely to be present in the project-affected areas (Bonar et al. 2009) should be used to conduct field surveys. Randomly sampling multiple habitat types using a multi-gear approach will be required to ensure that all fish species present are sampled. The spatial scope of the study will be from the headwaters of the Turners Falls pool downstream to Sunderland, Massachusetts, and will omit the upper reservoir of Northfield Mountain Pump Storage Project. Sampling should occur at each selected site across multiple seasons (spring, summer, and fall). Digital photographs should be taken to avoid misidentification of certain species such as Cyprinids.

The sampling design should include replicate samples for estimation of species detection probability. Sample replicates may be gathered temporally, using different methods, by independent observers, or by randomly sampled spatial replicates (MacKenzie et al. 2006). For each replicate sample, data that may be important for describing variation in species occurrence and presence/absence should be collected and recorded, such as gear type, mesohabitat type, depth, velocity, flow, water temperature, substrate, time of day, day of year, presence of cover, proportion of vegetation cover, size of individuals collected (juveniles may select different habitat), and/or other factors as determined by a qualified biologist. Species detection, occurrence, and/or abundance and related habitat measures on these parameters should be estimated using methods as described by Kery et al. (2005), MacKenzie et al. (2006), Wenger and Freeman (2008), or Zipkin et al. (2010).

This will be a one year study provided river discharge conditions fall within 25th to 75th percentile for weekly averages. Based upon this study's results, and the additional information obtained on requests to survey aquatic habitats and littoral zone fish spawning, an additional study may be required if evidence of project operation affects on population status or habitat for identified species.

Level of Effort and Cost

The cost of the study will be moderate to high as seasonal sampling with several types of gear will be required. However, cost will also be partially dependent on the number of sites sampled, the number of sample replicates, and the extent of the covariate data that are measured, all which may be flexible. Based on first year study results, a second year of sampling or specific studies examining impacts of project operations on specific fish species may be needed and requested. Provided the collected data are of high quality, analysis and synthesis should take approximately 10-20 days. FirstLight did not propose any studies specifically addressing this issue.

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Requested Study 9. Impacts of the Turners Falls and Northfield Mountain Pump Storage Projects Fish Spawning and Spawning Habitat.

Goals and Objectives

The goal of this study is to determine if project operations and water level fluctuations in the Turners Falls Project impoundment negatively impact anadromous and resident fish species including but not limited, to sea lamprey, white sucker, fall fish, smallmouth bass, yellow perch, spottail shiners, bluegill, black crappie, chain pickerel, northern pike, common sunfish, and walleye, and if impacts are found to occur, to develop appropriate mitigation measures. This study complements a separate study requests specific to American shad spawning and also on habitats affected by water level manipulations. An additional instream flow study request will address fish habitat effects for species of concern downstream of the Turners Falls Dam.

Specific objectives include:

- Conduct field studies in the main stem, tributaries and backwaters of project affected areas to assess timing and location of fish spawning.
- Conduct field studies in the main stem, tributaries and backwaters of project affected areas to evaluate potential impacts of impoundment fluctuation on nest abandonment, spawning fish displacement and egg dewatering. The study should also evaluate if changes in impoundment fluctuation range would mitigate for identified impacts and if other mitigative measures would lessen these impacts.

A second year of study may be required should river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period (end of March through mid July). Similarly, water temperatures should be closely considered, to ensure representative conditions occurred to reduce bias in observations.

Relevant Resource Management Goals

Not applicable, requester is not an agency or Indian tribe.

Public Interest Consideration If Requester Is Not A Resource Agency

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. Fish and their habitats are important public resources. There is a strong public interest in protecting and conserving fish and their habitats. This study will provide key information about resident fish species, which are an important component of the river's ecology and in some cases are the basis for a sport fishery. This requested study will help protect and conserve resident fish species by ensuring Project operations do not negatively impact their spawning success and spawning habitats.

Existing Information and Need for Additional Information

To our knowledge, no information exists related to this requested study. The Massachusetts Integrated List of Waters shows the Project Area from the VT/NH state line to the Turners Falls Dam impaired due to "other flow regime alterations."

Nexus to Project Operations and Effects

Project operations have the potential to impact fish species by influencing spawning success and spawning habitat quality and quantity. For example, water level changes due to Project operations could create conditions where fish eggs are exposed to air, where spawning habitat is dewatered, and/or where fish abandon nests containing eggs.

Proposed Methodology

Common tools to evaluate fish spawning would be used including visual observations of habitats and sampled fish (i.e., in spawning condition, coloration, gonads mature, and other external features that become developed with spawning) collected by gears such as electrofishing, seining and other net gears during defined environmental and or time windows for spawning activity. Project operation impacted areas, should be quantified to identify and define areas subject to dewatering and mapped relative to observations of fish nests, spawning fish, egg deposits. During identified spawning periods for these species, suitable spawning habitats subjected to daily project operational fluctuations will be surveyed to document the type and extent of project effects on nests or spawning habitat (fall fish nests, lamprey nests, bass and sunfish nests, white sucker eggs/larvae) and observable eggs or larvae, relative to water level and other environmental condition, including water temperature and water velocity in noted areas.

Level of Effort and Cost

FirstLight Power does not propose any studies to meet this need. Estimated cost for the study is moderate.

Requested Study 10: Three-dimensional Computational Fluid Dynamics (CFD) Modeling in the Vicinity of Fishway Entrances and Powerhouse Forebays

Goals and Objectives

The goal of this study is to determine the flow field conditions that exist in and around the fishway entrances, and upstream of both Turners Falls powerhouses (Station 1 and Cabot). The information from this request is meant to be coupled with data from the telemetry study such that a comprehensive understanding of fish behavior is developed.

The objective of this study is to develop a series of maps that show color contour maps of velocity magnitude at discharges that have been agreed upon by the resource agencies and the licensee. With respect to upstream passage, the results will show approach velocities and orientation within the approach zone of the fish that may create a response in fish. This information can be coupled with telemetry data (from the requested shad telemetry study) and passage counts to understand which conditions are optimal for guiding migrating fish to the fishway entrances and for stimulating fishway entry. With respect to downstream migration, the results will show velocities and orientations in front of each powerhouse. At Cabot Station, the results will indicate to what degree, if any, flow directs downstream migrating fish towards the surface bypass weir. At Station 1, we will have an improved understanding of the magnitude of velocity in front of the turbine intakes.

Relevant Resource Management Goals

Not applicable, requester is not an agency or Indian tribe.

Public Interest Consideration If Requester Is Not A Resource Agency

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. Fish and their habitats are important public resources. There is a strong public interest in protecting and conserving fish and their habitats. The goals of this study request are to obtain information that will help assist in designing effective upstream fishways for upstream migrating fish species and to reduce impingement, entrainment and delay for downstream migrating fish. CFD models are a relatively cost effective way to analyze existing and future conditions. As such, changes in the amount of attraction water, changes in which turbines are operating and which spillway gates are releasing water can all be examined. As stated, the results from this study are meant to be used along with the data generated from the telemetry study. The combined analysis from these two data sources can help assess which flow conditions are most advantageous for migrating fish species to enter the fishway under current and proposed conditions.

As for downstream migration of adult and juvenile shad, and adult eel, the results from the models will reveal flow magnitude and direction in front of each powerhouse. Given the limited information that currently exist on survival through Cabot and Station 1, our goal is to direct as many downstream migrating fish as possible towards the uniform acceleration weir and downstream bypass. With respect to upstream passage, we want to maximize the number of fish that find and enter the fishway entrances.

Existing Information and Need for Additional Information

To date, no CFD modeled data exist in front of either fish ladder, nor do they exist in front of either powerhouse. Some preliminary modeling has been done downstream of the Gatehouse, but changes to the gatehouse entrances would require updated modeling. It is our understanding that the licensee has worked with the firm Alden to develop a CFD model of the upper power canal and that elevation survey data from the power canal also are available. Detailed 2-dimensional movement data on shad are available from observations made between 2003 to 2005 and 2010 to 2012. By coupling and analyzing these two data sets, flow and fish movement, we believe this will have substantial benefits to our management efforts.

When designing upstream passage structures, a site assessment is critical. The development of these models gives resource agencies valuable information into the hydraulic cues which may elicit a response from upstream migrants. For downstream passage, the U.S. Fish and Wildlife Service has approach velocity guidelines; the output from these models would inform the resource agencies under what conditions appropriate approach velocities are being met and when they are being exceeded.

Nexus to Project Operations and Effects

The Turners Fall Project has direct impacts to upstream and downstream migrating shad and eel.

With respect to upstream migration, the auxiliary water system (AWS) plays a critical role in determining whether or not fish are attracted to the entrance. The results from this study would allow us to assess how well the AWS is performing and under what conditions it attracts the most fish.

With respect to downstream migration, as a general rule, fish tend to follow the flow. If flow fields are directing fish towards the turbine intakes, the results from this study will indicate that. The development of a CFD model under existing conditions also informs the design of future modifications. The development of a CFD model could be used to improve the survivability of downstream migrating shad and eel.

Proposed Methodology

A 3-dimensional CFD model has become and increasing common standard of analysis at hydro-electric projects around the nation. Within the Northeast region, we have seen these types of models developed at the Holyoke (P-2004), Brunswick (P-2284), Shawmut (P-2322), Milford (P-2534) and Orono (P-2710). We would expect to engage with the licensee in terms of determining the appropriate area and flows to be modeled. We expect that the spatial extent of the model at each study site will vary. Given the large number of ways that output from these models can be presented and the near infinite number of flows that could potentially be modeled, we would expect to consult with the licensee to reach agreed upon modeling efforts and scenarios to be examined.

Level of Effort and Cost

The cost of developing, running and testing a CFD model can vary tremendously; one large variable is determining the cost is based on the amount of existing bathymetric data the applicant currently has access to. We roughly estimate the cost of each CFD model could run as high as $50,000 assuming no bathymetric data currently exists. Proactive communication with resource agencies will reduce the cost and iterative effort. Given the above mentioned projects where this level of effort has occurred for other projects that have proposed to amend their license for various reasons, we see the level of effort as commensurate with the other projects given that the applicant is requesting a renewal of its existing license.

Requested Study 11. In-stream Flow Habitat Assessment Downstream of Cabot Station

Conduct an instream flow habitat study to assess the impacts of the range of the proposed project discharges on the wetted area and optimal habitat for key species. The study should include non-steady flow approaches to assess effects of within-day flow fluctuations due to peaking power operations on target fish species and benthic invertebrate communities. Target fish species include: federally endangered shortnose sturgeon, American shad, fallfish, and white sucker.

Goals and Objectives

The goal of this study is to determine an appropriate flow regime that will protect and enhance the aquatic resources from the Cabot tailrace of the Turners Falls Project downstream to the Rt. 116 bridge in Sunderland, MA. Specifically, the objective of the study is to conduct an instream flow habitat study to assess the impacts of a range if flows on the wetted area and optimal habitat for key species, including the impacts of hydropeaking flow fluctuations on the quantity and location of aquatic habitat.

The study should include non-steady flow approaches to assess effects of within-day flow fluctuations due to peaking power operations on target fish species and benthic invertebrate communities. Target fish species include: federally endangered shortnose sturgeon, American shad, fallfish, white sucker and walleye.

For shortnose sturgeon, the flow study will need to evaluate bottom velocities in shortnose sturgeon spawning and rearing areas during discharge conditions normally observed from April 15th to June 22nd. Protection of shortnose sturgeon spawning will necessitate establishment of discharges that create bottom velocities suitable for shortnose sturgeon spawning and rearing over a sustained period of time and avoid dramatically fluctuating flows. To protect shortnose sturgeon rearing, adequate discharge without dramatic flow fluctuations are needed to ensure the rearing shoals are wetted and velocities are sufficiently protective for early life stage (ELS) rearing.

Field verification will be necessary to confirm the flow modeling results that identify the flows needed to provide sustained bottom velocities for spawning also maintain flows, depths, and water release regime adequate for spawning and rearing. Velocity and depth data should be collected under each potential operation scenarios such that actual velocity, depth, and flow conditions occurring across the entire spawning and rearing areas including wetted shoals.

Relevant Resource Management Goals

Not applicable, requester is not an agency or Indian tribe.

Public Interest Consideration If Requester Is Not A Resource Agency

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. Fish and their habitats are important public resources. There is a strong public interest in protecting and conserving fish and their habitats. This study will conduct an instream flow habitat study to assess the impacts of a range if flows on the wetted area and optimal habitat for key species, including the impacts of hydropeaking flow fluctuations on the quantity and location of aquatic habitat. Key fish species include, federally endangered shortnose sturgeon, American shad, fallfish, white sucker and walleye.

Existing Information and Need for Additional Information

Presently FirstLight is required to release 1,433 cfs below the Project. Information included in the PAD does not provide a detailed description of how this minimum flow was established and we are not aware of any previously conducted studies that evaluated the adequacy of this minimum flow in protecting aquatic resources in the 10+ miles of riverine habitat below the Cabot Station. Therefore, in order to fill this important information gap, an empirical study is needed to provide information on the relationship between flow and habitat in the Connecticut River downstream of the Cabot tailrace. Results will be used to determine an appropriate flow recommendation.

Kynard et al. (2012, chapter 3) examined the effects of water manipulation at the Turners Falls project on shortnose sturgeon spawning over the course of 17 years. This body of data represents the best available scientific information which does not support 1,433 cfs as an adequate minimum flow to support successful shortnose sturgeon spawning at Cabot Station. Peaking operations at Cabot Station cause discharge fluctuations to rapidly change bottom velocities from 0.4 m/s to 1/3 m/s over 30 minutes (Kynard et al. 2012, chapter 3). Shortnose sturgeon have not evolved to adapt to such artificial rapid changes in velocities and therefore continue to spawn during fluctuations even though conditions may be unsuitable and likely result in high egg mortality. During the 10 years when spawning succeeded at Cabot Station, discharge flow decreased to less than 35, 460 cfs by April 29th. The lowest discharge level observed while females remained on the spawning site was 4,700 cfs. Spawning behavior was not monitored during Cabot Station discharges at or below 3,500 cfs, so it is unclear what the minimum flow threshold is for spawning at Cabot Station. When peaking generation discharges cease during naturally low flow years, the tailrace shoals, likely used by shortnose ELS for rearing, were exposed (observed during years ’95, ’98-99, ’04) and may have resulted in larvae mortality due to stranding and exposure (Kynard et al 2012, chapter 3). Researchers observed that shoal exposure began when river flow below Cabot Station dropped below 7,062 cfs (Kynard and Kieffer 2007). Thus, total flow at Cabot, which may include flow from the Turners Falls Dam or Station 1, must be at least 7,062 cfs to both support adequate bottom velocities and prevent shoal exposure.

Furthermore, the emergency water control gates at Cabot Station that are used to sluice trash from the canal and balance canal flows spill large amounts of water. These large spill events create a plume of turbid turbulent flow, which caused some females to leave the area. These spill events scour bottom sediments which are then carried downstream over the spawning and rearing shoals where an entire year class of early life stages may be destroyed (Kynard et al. 2012, chapter 3). Information included in the PAD does not address adequate flows for shortnose sturgeon spawning and rearing. Results of the requested modeling will be used by the Services to determine an appropriate flow recommendation.

Researchers have also looked at suitable depth and velocity habitat for spawning (Kieffer and Kynard 1996, Kynard et al. 2012, chapter 3). Spawning sites are characterized by moderate river flows with average bottom velocities between 0.4 and 0.8 m/s (Hall et al. 1991, Kieffer and Kynard 1996, NMFS 1998). Water depth at the spawning site appears to be a less important habitat feature than substrate type and flow. A recent study by Kynard et al. (2012, chapter 6) demonstrated that females in an artificial stream will readily accept a shallow water depth of 0.6 m, with a rubble bottom, and 0.3–1.2 m/s bottom velocity. In addition, although eggs and embryos can likely tolerate very low depths, researchers measuring water depths between Turners Falls Dam and Cabot Station in order to recommend minimum flows suitable for an escape route for shortnose sturgeon trapped in the Turners Falls Dam Plunge Pool used a minimum depth of 1.5 x adult body depth. Because adults spawning in an artificial spawning channel frequently positioned themselves on top of one another (Kynard et al. 2012 Chapter 6), a minimum depth to facilitate spawning within the known Cabot Station spawning area is 3.0 body depths, or 19.2 inches.

Nexus to Project Operations and Effects

The Project is currently operated with a minimum flow release that was not based on biological criteria or field study. Further, the project generates power in a peaking mode resulting in significant with-in day flow fluctuations between the minimum and project capacity on hourly or daily basis. The large and rapid changes in flow releases from hydropower dams are known to cause adverse effects on habitat and biota downstream of the project (Cushman 1985, Blinn 1995, Freeman et al. 2001). There are more than ten miles of lotic habitat below the project's discharge that are impacted by peaking operations at Cabot Station. This section of the Connecticut River contains habitat that supports native riverine species, including important spawning and rearing habitat for migratory fish such as American shad and federally endangered shortnose sturgeon. Shortnose sturgeon larval migrants initially become bottom dwellers and transition from living off of yolk sacs to orally feeding, which is a critical stage in their life history. While the existing license does require a continuous flow of 1,433 cfs below the project (0.20 cubic feet per second flow per square mile of drainage area - cfsm), that is equal to only 40% of the Aquatic Base Flow[1]. This flow does not sufficiently protect the aquatic resources, including endangered species, in this substantial reach of river, especially in the context of the magnitude, frequency, and duration of changes in habitat that likely occur between minimum and generation flows.

Results of the flow study will be used to determine an appropriate flow recommendation that will protect and/or enhance the aquatic resources below the Project.

Proposed Methodology

In-stream flow habitat assessments are commonly employed in developing plant operational regimes that will reduce impacts or enhance habitat conditions downstream of hydroelectric projects.

This study requests a flow study be conducted at the Project. Given the length of the river reach (10+ miles) impacted by project operations, we believe a study methodology that utilizes an IFIM approach is appropriate for this site. This same protocol was used during the relicensing of the Housatonic River Project (FERC No. 2576),[2]and has been accepted by the Commission in other licensing proceedings[3].

At a minimum, the study design should involve collecting wetted perimeter, depth, velocity, and substrate data along transects located in the reach of river below Cabot Station. The measurements should be taken over a range of test flows. This information then should be synthesized to quantify habitat suitability (using mutually agreed upon HSI curves) of each test flow for target species identified by the fisheries agencies. Habitat modeling using standard PHABSIM 1 dimensional modeling is acceptable for the river channel downstream from the railroad bridge below the mouth of the Deerfield River. The area from the Cabot Station discharge to the railroad bridge should be modeled using 2 dimensional 2D modeling to better characterize flows and velocities in this complex channel area.

The types of data collected with this study should be sufficient to perform a dual-flow analysis and habitat time series or similar approaches that will permit assessment of how quality and location of habitat for target species changes over a range of flows between existing minimum flow and maximum project generation flows.

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[1] The Aquatic Base Flow equates to the August Median Flow as determined using unregulated hydrography or on drainage area at the project site (0.5 cfs per square mile of drainage area) if unregulated hydrography is unavailable.
[2] Housatonic River Project License Application, Volume 4, Appendix F. Connecticut Light and Power Company, August 1999.
[3] Glendale Project (FERC No. 2801) Final Bypass Reach Aquatic Habitat and Instream Flow Study in Glendale Hydroelectric Project Application for Subsequent License (FERC No. 2801), Volume 2, Appendix B, pages 7-8, October 2007.

Level of Effort and Cost

Field work for instream flow studies can be reasonably extensive but will depend on consultation with the applicant on study methodology and on-site decisions on locations for data collection and the number of collection locations. Post-fieldwork data analysis would be a moderate cost and effort. We anticipate that the level of effort and costs will be comparable to that experienced on similar FERC relicensing projects of this size (e.g., the Conowingo Project, FERC No. 405).

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Requested Study 12. In-stream Flow Habitat Assessment of the Turners Falls Bypassed Reach

Goals and Objectives

The goal of this study is to determine an appropriate flow regime that will protect and enhance the aquatic resources in the bypassed reach between Turners Falls Dam and the Cabot Station discharge. Specifically, the objective of the study is to conduct an instream flow habitat study to assess the impacts of the range of the proposed project discharges on the wetted area and optimal habitat for key species.

Target fish species include: federally endangered shortnose sturgeon, American shad, fallfish, white sucker, freshwater mussels and benthic macroinvertebrates.

Relevant Resource Management Goals

Not applicable, requester is not an agency or Indian tribe.

Public Interest Consideration If Requester Is Not A Resource Agency

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. Fish and their habitats are important public resources. There is a strong public interest in protecting and conserving fish and their habitats. This study will determine an appropriate flow regime that will protect and enhance the aquatic resources in the bypassed reach between Turners Falls Dam and the Cabot Station discharge. Specifically, the objective of the study is to conduct an instream flow habitat study to assess the impacts of the range of the proposed project discharges on the wetted area and optimal habitat for key species. Key fish species include, federally endangered shortnose sturgeon, American shad, fallfish, white sucker and walleye.

Existing Information and Need for Additional Information

The Turners Falls Project bypasses a 2.7 mile-long section of the Connecticut River. Presently the only required spill releases from the Turners Falls dam to the bypassed reach are 400 cfs from May 1 through July 15 and 120 cfs from July 16 until the river temperature reaches 7°C.

In addition to these flows provided at the Turners Falls Dam, the bypassed reach receives flow from one small tributary (the Fall River, drainage area of 34.2 square miles), which enters the mainstem approximately 0.16 miles below the dam. The bypassed reach also receives the discharge from Station 1, when it is generating (typically when there is flow in excess of Cabot Station's needs). This discharge enters the bypassed reach approximately 0.9 miles below the dam.

Available information in the PAD does not indicate how project operations have altered downstream hydrology, habitat quantity and quality, and water quality, which may affect resident and migratory fish, macroinvertebrates, listed species, aquatic plants and other biota and natural processes in the Connecticut River from below the Turners Falls Dam downstream to the Cabot Station discharge. The PAD also provides no detailed description of the physical or biological characteristics of the bypassed reach.

Limited information exists on the adequacy of the existing bypass flow regime to protect water quality and aquatic life. However, there is existing information (not included in the PAD) relative to minimum flows necessary for shortnose sturgeon spawning and rearing at the Rock Dam spawning site (Kynard et al. 2012). Spawning success was observed at Rock Dam when discharge was between 2,500 cfs and

22,000 cfs during the spawning period of April 27th through May 22 (Kynard et al. 2012, chapter 3). In 1995 at the Cabot spawning area, the greatest level of spawning and spawning success occurred (i.e., 21 late stage females present, 342 ELS captured, and the longest spawning period of 17 days) even though no spawning was detected at Rock Dam (Kynard et al. 2012, chapter 3). Discharges in 1995 at Rock dam had dropped below 2,500 cfs by March 26th (Kynard et al. 2012, chapter 3), which may indicate the need to have mitigated flow well in advance of spawning. Flow reductions at the Rock Dam site that occurred during spawning caused females to leave the spawning site and not return even if flow later increased to acceptable levels. Researchers observed that the rubble substrates remained dominant during fluctuating flows and cessation of spawning is likely due to velocities falling outside the range preferred by females. Given the current flow dynamics at Rock Dam, spawning does not occur most years (Kynard et al. 2012, chapter 3). These data represent the best available scientific information and does not support current minimum flow thresholds at the project.

An empirical study is needed to provide information on the relationship between flow and habitat in the bypassed reach for determining a flow recommendation.

Nexus to Project Operations and Effects

The Project includes a 2.7 mile-long bypassed reach. The Turners Falls Project is currently operated with a seasonally-varying minimum bypass flow (200 cfs starting on May 1, increasing to 400 cfs when fish passage starts through to July 15, then reduced down to 120 cfs until river temperature drops below 7°C). The 400 cfs release is primarily to facilitate upstream movement of anadromous migrants to the spillway fish ladder at Turners Falls Dam and the 120 cfs was intended to provide protection to shortnose sturgeon by maintaining a wetted habitat 1.5 times the maximum adult body depth through connections between pools within the bypassed reach. Neither of the currently required flows were based on quantitative, rigorous scientific studies.

This section of the Connecticut River contains habitat that supports native riverine species, including important spawning and rearing habitat for the federally endangered shortnose sturgeon. While the existing license does require seasonally-varying flow releases from the Turners Falls dam, we do not believe these flows sufficiently protect the aquatic resources, including endangered species, inhabiting the bypassed reach.

Results of the flow study will be used to determine an appropriate flow recommendation that will protect and/or enhance the aquatic resources in the bypassed reach for the duration of any new license issued by the Commission.

Proposed Methodology

This study proposes a bypass flow study be conducted at the Project. Bypass flow habitat assessments are commonly employed in developing flow release protocols that will reduce impacts or enhance habitat conditions in reaches of river bypassed by hydroelectric projects.

Given the size of the bypassed reach (2.7 miles long) and the important resources known to inhabit the reach (i.e., federally endangered shortnose sturgeon and diadromous fishes), we believe a study methodology that utilizes an IFIM approach is appropriate for this site. This same protocol was used during the relicensing of the Housatonic River Project (FERC No. 2576),[4]and has been accepted by the Commission in other licensing proceedings[5].

At a minimum, the study design should involve collecting wetted perimeter, depth, velocity, and substrate data within a range of discharge levels along transects located in the reach of river between the dam and the Cabot Station discharge. The measurements should be taken over a range of test flows up to 6,300 cfs or over a sufficient range of flows to model flows up to 6,300 cfs. This information then should be synthesized to quantify habitat suitability (using mutually agreed upon HSI curves) of each test flow for target species/life stages identified by the fisheries agencies. Habitat modeling using standard PHABSIM 1 dimensional modeling is acceptable for the bypassed reach from the area downstream of the spillway where the river channel constricts to Rawsons Island upstream from the Rock Dam. The area from Rawson Island to the Cabot station discharge should be modeled using 2 dimensional 2D modeling to better characterize flows and velocities in this complex channel area. Likewise, we recommend 2D modeling in the spillway area and mouth of the Falls River to the point where the channel constricts given this complex area with numerous potential flow discharge locations.

The flow study should incorporate the identified minimum flow and temporal parameters for shortnose sturgeon discussed in the Background and Existing Information section of this request.

Level of Effort and Cost

Field work for flow studies can be reasonably extensive but will depend on consultation with the applicant on study methodology and on-site decisions on locations for data collection and the number of collection locations. Post-fieldwork data analysis would be a moderate cost and effort. Field work associated with this study could be done in conjunction with the below-project instream flow study request. We anticipate that the level of effort and costs will be comparable to that experienced on similar FERC relicensing projects (e.g., the Glendale Project, FERC No. 2801).

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[4] Housatonic River Project License Application, Volume 4, Appendix F. Connecticut Light and Power Company, August 1999.

[5] Glendale Project (FERC No. 2801) Final Bypass Reach Aquatic Habitat and Instream Flow Study in Glendale Hydroelectric Project Application for Subsequent License (FERC No. 2801), Volume 2, Appendix B, pages 7-8, October 2007.

Study Request 13. Shad Population Model for the Connecticut River

Develop an American shad annual step, mathematical simulation population model for the Connecticut River to quantify how project operations and potential restoration/mitigation measures impact the population of shad in the Connecticut River.

Goals and Objectives

The goal of the model is to assess impacts of both upstream and downstream passage at each of the Connecticut River projects and potential management options for increasing returns to the river.

Specific objectives include:

- Annual projections of returns to the Connecticut River;
- A deterministic and stochastic option for model runs
- Life history inputs of Connecticut River shad
- Understanding the effect of upstream and downstream passage delay at projects
- Calibration of the model with existing data
- Analysis of the sensitivity of model inputs
- Analysis of sensitivity to different levels of up- and downstream passage efficiencies at all projects
- Multiple output formats including a spreadsheet with yearly outputs for each input and output parameter

Relevant Resource Management Goals

Not applicable, requester is not an agency or Indian tribe.

Public Interest Consideration If Requester Is Not A Resource Agency

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. Fish and their habitats are important public resources. There is a strong public interest in protecting and conserving fish and their habitats. This study will quantify how project operations and potential restoration/mitigation measures impact the population of shad in the Connecticut River.

Existing Information and Need for Additional Information

Since the construction of the first fish lift facility at Holyoke Dam in 1967, American shad have had access to spawning and rearing habitat upstream from Holyoke Dam. A number of improvements to the Holyoke fishway have occurred since that time, but while the numbers of shad lifted at Holyoke have reached as much as 721,764 and the overall shad population to the river exceeded 1.6 million shad in 1992 (CRASC 1992), total shad populations, and numbers of shad passing Holyoke, Turners Falls and Vernon Dam have not met CRASC management goals.

Population and passage numbers past Holyoke have declined substantially from those totals in recent years, with average Holyoke passage numbers since 2000 of 229,876. Whole river population estimates have shown that approximately half of the returning population of shad pass upstream of Holyoke. Recent returns to Holyoke are far below management goals. Average passage efficiency of shad at Turners Falls (Gatehouse counts) and Vernon since 2000 has been 3.1 and 20.4 % respectively. These too are well below the CRASC management goals.

Safe, timely and effective up- and downstream passage along with successful spawning and juvenile production are necessary to help achieve shad management goals for the Connecticut River.

Nexus to Project Operations and Effects

Existing project operations and fish ladder efficiencies have a direct effect on shad populations in the Connecticut River. Poor upstream passage efficiencies and delays restrict river access to returning shad. Fish unable to reach upriver spawning grounds may not spawn or have reduced fitness or survival of young. Poor downstream passage survival and downstream passage delays affect outmigration and consequently repeat spawning, an important ecological aspect of the iteroparous Connecticut River shad population (Limberg et al. 2003).

Poor passage efficiencies and delays at projects may be limiting access to upstream reaches of the river, altering spawning behavior, decreasing outmigration survival and contributing to the failure of the Connecticut River shad population to meet management targets (Castro-Santos and Letcher 2010).

Development of a population model will allow an assessment of individual project impacts on the population as well as the cumulative impacts of multiple projects. The model will allow managers to direct their efforts in the most efficient manner toward remedying the conditions that most impact the shad population.

Proposed Methodology

Population models are commonly used to assess anthropomorphic and natural impacts and are consistent with accepted practice. A model similar to this request was constructed for the Susquehanna River by Exelon (FERC #405, RSP 3.4). The model is constructed in Microsoft Access

Specific parameters that would be included in the model:

- Upstream passage efficiency at Holyoke, Turners Falls (Cabot, Gatehouse and Spillway Ladders), Vernon fishways, and any impacts associated with Northfield Mountain.
- Distribution of shad approaching the Turners Falls project between the Cabot Ladder and the spillway at the dam
- Downstream passage efficiencies at Vernon, Northfield Mountain, Turners Falls, and Holyoke projects for juveniles and adults
- Entrainment at Mount Tom and Vermont Yankee
- Sex ratio of returning adults
- The proportion of virgin female adults returning at 4, 5, 6, and 7 years
- The proportion of repeat spawning females at 5, 6 and 7 years
- Spawning success of females in each reach
- Fecundity
- Percent egg deposition

- Fertilization success
- Larval and juvenile in-river survival
- Calibration factor to account for unknown parameters such as at sea survival
- Options for fry stocking and trucking as enhancement measures
- Start year and model run years
- Start population
- Rates of movement to and between barriers
- Temperature, river discharge, and other variable of influence to migration and other life history events

The model should be adaptable to allow the input of new data and other inputs.

Level of Effort and Cost

Neither First Light nor TransCanada have proposed any study to meet this need. Estimated cost for the study is expected to be low to moderate. As the model describes the impacts of multiple projects and two owners, both project owners would share the cost of model development.

Literature cited:

CRASC (Connecticut River Atlantic Salmon Commission). 1992. A management plan for American shad in the Connecticut River basin. Sunderland, MA

Castro-Santos, T and B. H. Letcher. 2010. Modeling migratory bioenergetics of Connecticut River American shad (*Alosa sapidissima*): implications for the conservation of an iteroparous anadromous fish. Can.J.Fish.Aquat.Sci. 67: 806-830

Limberg, K. E., K. A. Hattala, and A. Kahne. 2003. American shad in its native range. Pages 125-140 in K. E. Limberg and J. R. Waldman, editors. Biodiveristy, status and conservation of the world’s shads. American Fisheries Society, Symposium 35, Bethesda, Maryland

Requested Study 14. Telemetry Study of Upstream and Downstream Migrating Adult American Shad to Assess Passage Routes, Effectiveness, Delays, and Survival

Goals and Objectives

Assess behavior, approach routes, passage success, survival, and delay by adult American shad as they encounter the projects during both upstream and downstream migrations, under permitted project operations conditions, proposed operational conditions, and study treatment operational conditions at First Light Power's Turners Falls and Northfield Mountain Pumped Storage projects and TransCanada's Vernon Project. There are multiple fishways and issues related to both upstream and downstream passage success at the projects. Some of these issues at the Turners Falls Project are similar to and/or pertain directly to the Northfield Mountain and Vernon projects. Therefore, it is reasonable to address passage issues at all projects in a similar manner.

Telemetry Study - This requested study requires use of radio telemetry using both radio and Passive Integrated Transponder (PIT) tag types to provide information to address multiple upstream and downstream fish passage issues. The following objectives shall be addressed in these studies:

- Assessment of any migration delays resulting from the presence of the dam and peaking flow operations of the Turners Falls Project;
- Determine route selection and behavior of upstream migrating shad at the Turners Falls Project under various spill flow levels (e.g., movement to the dam, attraction to Cabot Station, attraction to Station 1 discharge, movement between locations, delay, timing, etc.). A plan and schedule for dam spill flow releases will need to be developed that provides sufficient periods of spill flow conditions, and various generating levels from Turners #1 Station coupled with Cabot Station generation flows (e.g., treatments will require multiple days of consistent discharge). Evaluated spill flows should include flows between 2,500 – 6,300 cfs, which relate to bypass flows identified as providing spawning opportunities for shortnose sturgeon in the lower bypass reach at the Rock Dam. (Kieffer and Kynard 2012). Sturgeon spawning and upstream shad passage occur concurrently;
- Assess near field, attraction to and entrance efficiency of the Spillway Ladder by shad reaching the dam spillway, under a range of spill conditions;
- Evaluate the internal efficiency of the Turners Falls Spillway Ladder;
- Continue data collection of Cabot Station Ladder and Gatehouse Ladder efficiency, to include rates of approach to fishway entrances, entry into fishways, and passage through them, under different operational conditions that occur in these areas;
- Evaluate modifications to the Cabot and/or Spillway fishways recommended by the US Fish and Wildlife Service if they are implemented;
- Assess upstream migration from Turners Falls to the Vernon Dam in relation to Northfield Mountain's pumping and generating operations and Vernon Project peaking generation operations. Typical existing and proposed project operation alterations should be evaluated;
- Assess near field, attraction to and entrance efficiency of the Vernon Dam Ladder;
- Assess internal efficiency of the Vernon Dam Ladder;

- Assess upstream passage past Vermont Yankee's thermal discharge (also located on the west bank of the river 0.45 mile upstream of fish ladder exit)
- Assess upstream migration from Vernon Dam in relation to the peaking generation operations of the Bellows Falls Project. Typical existing and proposed project operation alterations should be evaluated;
- Determine post-spawn downstream migration route selection, passage efficiency, delays and survival related to the Vernon Project, including evaluation of the impact of the Vermont Yankee heated water discharge plume on downstream passage route, migrant delay/timing, efficiency and survival;
- Assess impacts of Northfield Mountain operations on up- and downstream adult shad migration, including delays, entrainment, and behavioral changes and migration direction shifts under existing and proposed project operations;
- Determine downstream passage route selection, timing/delay, and survival under varied project operational flows into the power canal and spill flows at Turners Falls Dam;
- Determine downstream passage route selection, timing/delay in the canal, Cabot Station fish bypass facility effectiveness, and survival of Cabot-bypassed adult shad that enter the Turners Falls Canal system;
- Compare rates and or measures of delay, movement and survival etc., among project areas or routes utilized (e.g., spill at dam vs. power canal) under the range of permitted and proposed conditions; and
- Utilize available data sets and further analyze raw data (e.g., 2003- 2012 Conte Lab Studies) where possible to address these questions and inform power analyses and experimental design.

Information to address all of these questions would rely on the tagging of upstream migrating adult shad at Holyoke Dam and releasing them to migrate naturally from Holyoke through the Turners Falls and Vernon projects and back downstream after spawning. Additional tagged individuals would likely need to be released farther upstream (Turners Falls Canal, upstream of Turners Falls Dam, and upstream of Vernon Dam), to ensure that enough tagged individuals encounter project dams on both upstream and downstream migrations, that these individuals are exposed to a sufficient range of turbine and operational conditions to test for project effects, and to provide adequate samples sizes for statistically valid data analyses to address the many objectives listed. This study will require two years of field data collection to attempt to account for inter-annual variability in river discharge and water temperatures.

<u>Evaluation of Past Study Data</u>- In addition to collection and analysis of new telemetry data, substantial data has already been collected at Turners Falls from multiple years of passage assessments conducted for First Light by U.S. Geological Survey's Conte Anadromous Fish Research Center (Conte Lab) researchers and there are also data from the 2011 and 2012 full river study conducted by the Conte Lab that address Turners Falls, Northfield Mountain and Vernon project migration and passage questions that have not yet been analyzed. These data include several million records each year from more than 30 radio telemetry receivers deployed between Middletown, CT and Vernon Dam. This data will provide substantial information free from the field data collection costs and therefore should be analyzed as part of this study. This data analysis should be completed in 2013 to help inform the design of subsequent field studies.

<u>Evaluation of Methods to Get Shad Past Cabot Station for Spillway Passage at the Turners Falls Dam</u> – The poor passage efficiency of the Cabot Ladder, the first and most used fishway encountered by shad arriving at the Turners Falls Project, and at the entrance to the Gatehouse Ladder, which all Cabot fishway-passed fish must use, has resulted in very poor overall shad passage efficiency at the project. An

alternative to passing fish at the Cabot Station is to install a fish lift at the dam that would put fish directly into the Turners Falls pool, thereby eliminating problems with the Cabot Fishways, and the Gatehouse Fishway entrance and the variable passage efficiency of the Gatehouse Fishways. For this to be effective, attraction of shad to the Cabot Station discharge and associated delays would need to be overcome. It is possible that spillway flow releases coupled with behavioral measures at Cabot Station that dissuade shad from that tailrace could achieve this end. In order to assess the possibilities, we recommend the following study:

- A literature search and desk-top assessment of the possible behavioral measures that could be effective in getting shad to pass Cabot Station tailrace and continue upstream to the dam.
- Based on results of the desk-top assessment, possible evaluation of behavioral measures that are likely to be effective.
- Field evaluation of the effect of different levels of spill at the dam that would induce fish to move past the Cabot Station into the bypass reach and up to the dam (as noted in objectives).

Besides passage success and delays at passage facilities, these studies would assess the impacts of project operations on migration passage delay, route, timing, injury, mortality, and passage structure attraction, retention, and success. Of particular interest will be fish behavior during periods when flow releases from the project increase from the required minimum flows to peak generation flows and when flows subside from peak generation flows to minimum flows and the operation of NMPS in pumping and generation modes.

Relevant Resource Management Goals

Not applicable, requester is not an agency or Indian tribe.

Public Interest Consideration If Requester Is Not A Resource Agency

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. Fish and their habitats are important public resources. There is a strong public interest in protecting and conserving fish and their habitats. This study will assess behavior, approach routes, passage success, survival, and delay by adult American shad as they encounter the projects during both upstream and downstream migrations, under permitted project operations conditions, proposed operational conditions, and study treatment operational conditions at First Light Power's Turners Falls and Northfield Mountain Pumped Storage projects and TransCanada's Vernon Project.

Existing Information and Need for Additional Information

Passage of adult shad at the Turners Falls fishway complex has been the subject of intense study by the Conte Lab since before 1999. These studies have clearly demonstrated that passage through the existing fishways at Cabot and Spillway is poor (<10% in many years). Passage through the Gatehouse fishway is better, but still rarely exceeds 80%, despite the short length of this ladder. In addition to poor passage for fish entering the ladders, shad that ascend the Cabot Fishway experience extensive delays before entry into the Gatehouse Fishway. Shad that ascend Spillway frequently fall back into the canal and are also subject to these upstream delays. A new entrance to the Gatehouse Fishway installed in 2007 led to dramatic improvements in passage out of the canal (from 5% to over 50% in 2011), but passage still falls well short of management goals. In addition, shad spend considerable time (up to several weeks) attempting to pass. These delays likely influence spawning success and survival. Adult shad, unable to pass Gatehouse, experience similar delays in downstream passage, even after they have stopped trying to pass Gatehouse. Without spill, all outmigrating shad that have passed Gatehouse must enter the canal at the Gatehouse and may be subject to delays exiting the canal.

During the course of these studies a very large dataset has been compiled that could yield useful information for further improving passage of shad out of the canal in both the upstream and downstream directions. A unique feature of these data is a 2-dimensional array covering the canal just downstream of Gatehouse, documenting fine scale movements and occupancy of this zone. These data should be combined with computational fluid dynamics (CFD) and real-time hydraulic data to determine how canal hydraulics influence the ability of shad to locate and enter the fishway, and to identify modifications that are likely to lead to improvements in approach and entry rates. A separate CFD modeling study is requested that includes modeling of the Gatehouse Fishway entrance are at the head of the power canal.

In addition, whole-river shad telemetry studies performed in 2011 and 2012 will likely provide useful information and should be analyzed. These data should allow quantification of delay below Turners Falls, and could help guide studies requested above. Preliminary analyses of data through 2011 have been made available to FirstLight and the resource agencies (Castro-Santos and Haro 2005; Castro-Santos and Haro 2010).

The whole-river studies have also shown that, at least in 2011, most shad that pass Turners Falls rapidly progress upstream to Vernon Dam where extensive delays also occur. Data from the 2012 study were not available at this time, but Dr. Castro-Santos stated similar patterns were noted in the data between the years on the topic of upstream delay (personal communication, Dr. Theodore Castro-Santos). Similarly, concerns relative to the downstream passage of spent shad also remain relative to delays, with existing unpublished USGS telemetry data sets suggesting this is an issue within the Turners Falls canal.

Since the first year of operation of the Turners Falls upstream fishways (1980), the percent passage of American shad annually passed upstream of Turners Falls Dam compared to the number passed at the Holyoke Fish Lift has averaged 3.6% (1980-2012 data). The highest values for this metric has not exceed 11% and are well below the noted CRASC Management Plan target range for this objective noted earlier as 40-60% on a five year running average.

Since the first year of operation of the Vernon Dam upstream fish ladder (1981), the percent passage of American shad annually passed at Vernon compared to the number passed upstream of Turners Falls Dam (Gatehouse counts) has averaged 39.4%, ranging from 0.42% to 116.4% (> 100% due to counting error at one or both facilities, unknown).

Nexus to Project Operations and Effects

Existing project operations (peaking power generation) and limited bypass flows have a direct impact on instream flow and zones of passage (migration corridors). Project flow releases affect passage route selection, entry into fishways, and create delays to upstream migration. Inefficient downstream bypasses can result in migration delays and increased turbine passage. Mortality of adult shad passing through these turbines is expected to be high (Bell and Kynard 1985), additional stresses associated with passage and delay may cause mortality as shad are unable to return to salt water in a timely manner.   The project's upstream and downstream passage facilities need to be designed and operated to provide timely and effective upstream and downstream fish passage to meet restoration goals of passage to upstream habitat and maximize post-spawn survival. These factors are all critically important to the success of restoration efforts.

Proposed Methodology

Use of radio including passive-integrated transponder (PIT) telemetry is widely accepted as the best method to assess fish migratory behavior and passage success and has been used extensively to assess migration and passage issues at Turners Falls as well as other Connecticut River projects. These studies include one conducted in 2011 and 2012 by the US Fish and Wildlife Service and U.S. Geological Survey's Conte Anadromous Fish Research Center, which has provided substantial information related to some of the issues identified here. The requested study will build and expand on the information collected over the past two years.

The study design must specify sample sizes, tag configurations and receiver configurations, to ensure that rates of entry and exit to the tailraces, fishways, downstream bypasses, and the bypassed reach can be calculated with sufficient precision to determine effectiveness of flow and ensonification treatments (separate Study Request). For project assessments at Turners Falls (e.g., Cabot, Spillway and Gatehouse ladder attraction and entry, route selection, operational effects), double tagged (radio and PIT) shad will be required for release from Holyoke Dam. Additional shad must be released directly into the Turners Falls Canal to support assessment of the various operational and structural conditions in effect, to be modified in this period, and proposed conditions within the Turners Falls power canal relative to entrances to the Gatehouse fishway. A related request on CFD modeling in the Cabot Station tailrace, the upper power canal near Gatehouse, and in the area around the entrance of the Spillway Ladder will address related project operational effects that will also address identified objectives in this telemetry request. Shad captured at Holyoke and tagged and release upstream of Turners Falls Dam, or tagged out of Gatehouse Ladder, would help to ensure an adequate sample size for evaluations in the vicinity of NMPS and to the Vernon Dam and the ability to address identified study objectives in those project areas. Additional tagged shad are expected to be required for release upstream of the Vernon Dam, which should ensure adequate sample for a separate study request, where shad spawn upstream of Vernon Dam as well as ensuring there is an adequate number of outmigrating spent adults to address related study objectives for adult outmigrants. The required number of tagged fish to address study objectives may be adjusted accordingly from area to area depending on target numbers (i.e., best information on resultant viable tagged fish and power analyses to detect effects) to account for typical passage rates, survival rates, and handling effects as examples.

Existing information on captured, handled, tagged fish performance (e.g., percent that drop back, unsuitable for tracking) and factors such as timing of tagging and potentially transport, must all be carefully considered to ensure an adequate sample size of healthy (e.g., viable to characterize behavior, survival, etc.) tagged fish is available to address the many questions identified in this request (as supported by a statistical power analysis). Additionally, ensuring adequate downstream adult fish sample sizes (to address project effect questions above) requires close consideration as expected losses of healthy tagged fish during upstream passage, natural mortality rates, and tagging related effects, are expected to reduce sample sizes on downstream passage objectives/questions as the season progresses. The use of single PIT tagged fish can help improve sample sizes, but will be of limited use to answer some of the passage questions we have identified.

Due to environmental variability, two years of study work will be necessary. A large array of stationary monitoring stations (radio and PIT) will be needed to address the issues identified among the project areas. A sufficient level of radio receiver and PIT reader coverage will be required, to provide an appropriate level of resolution, for data analyses, to answer these questions on project operational effects. The study will provide information on a variety of structural and operational aspects of fish migration, relative to route selection, timing, survival, and up and downstream passage attraction, retention, delay, efficiency, survival as some examples at three projects (Turners Falls, NMPS, and Vernon). The use of video monitoring may also be utilized for specific study areas such as the Spillway Ladder, to provide additional information on shad entrance activity, with the understanding of some data limitations associated with this approach (fish identification, water visibility). This study will be coordinated with the proposed study request to evaluate ensonification as a shad behavioral deterrent at the Cabot Station tailrace which will be an additional treatment of the telemetry study.

In addition to the tagging studies, use of video monitoring of the Spillway Fishway would provide additional overall data on Spillway Fishway efficiency as all shad attempting to pass could be monitored versus just those shad that have been tagged.

Level of Effort and Cost

The requested study is extensive and will require a substantial effort and cost to capture, PIT tag, and radio tag a sufficient number of shad at Holyoke to release at upstream locations. We are not aware of any other study technique that would provide project specific fish behavior and migration information to adequately assess existing project operations and provide insight in possible alternative operations and measures needed to address observed negative impacts to fish migration success. Cost for the entire multi-project tagging, tracking and data analysis are expected to range from $400,000 to $500,000 based on past Turners Falls' studies and the 2011 and 2012 shad telemetry studies. Video monitoring of the Spillway fishway would add a modest cost to this study.

Due to the fact tagged shad will move throughout the larger five project area, to varying degrees, there will be expected cost savings (e.g., radio tags) to both owner/operators, provided cooperation in study planning and implementation occurs.

Literature Cited

Atlantic States Marine Fisheries Commission. 2010. Amendment #3 to the interstate fishery management plan for shad and river herring (American shad management). Washington, D.C.

Bell, C. E. and B. Kynard. 1985. Mortality of adult American shad passing through a 17-megawatt Kaplan turbine at a low-head hydro-electric dam. North American Journal of Fisheries Management, 5:33-38.

Castro-Santos, T. 2011. Analysis of American shad passage at Vernon Dam 2011. USGS Conte Lab Internal Report

Castro-Santos, T. and A. Haro. 2005. Turners Falls fish passage studies 2005: results from PIT and radio telemetry studies. CAFRC Internal Report # 2005—04.

Castro-Santos, T. and A. Haro. 2010. Gatehouse fishway telemetry studies: progress report, 2008-2010. USGS CAFRC Internal Report.

Kieffer, M. and B. Kynard. 2012. Spawning and non-spawning migrations, spawning, and effects of river regulation on spawning success of Connecticut River shortnose sturgeon. In Life history and behavior of Connecticut Rver shortnose sturgeon and other sturgeons. B. Kynard, P. Bronzi, and H. Rosenthal Editors. World Sturgeon Conservation Society: Special Publication #4. Norderstedt, Germany.

Requested Study 15. Impact of Project Operations on Shad Spawning, Spawning Habitat, and Egg Deposition in the Project Areas of the Turners Falls, Northfield Mountain Pumped Storage and Vernon Project Areas and downstream from Bellow Falls Dam .

Conduct a field study of spawning by American shad in the Connecticut River mainstem downstream of Turners Falls Dam, in the Turners Falls Dam impoundment, in the Vernon Dam Project area, and downstream of Bellows Falls Dam to determine if project operations (including operations of the Northfield Mountain Pump Storage) negatively impact shad spawning behavior, spawning habitat use, areal extent and quality of those spawning areas, and spawning activity in terms of egg deposition in those areas.

Goals and Objectives

Determine if project operations (under the permitted and proposed operational ranges) affect American shad spawning site use and availability, spawning habitat quantity and quality, and spawning activity in the river reaches downstream from Cabot Station and in the project bypass reach of Turners Falls Dam, in the Turners Falls Dam impoundment and in relation to Northfield Mountain Pump Storage operations, downstream and upstream of the Vernon Dam, and in the project area downstream of Bellows Falls Dam. The following objectives will address this request:

- Determine areas utilized by American shad for spawning by conducting night-time visual observation of spawning activity, identify and define areas geospatially, and obtain data on physical habitat conditions effected by project operations (e.g., water depth, velocity, discharge, substrate, exposure and inundation of habitats);
- Determine project operation effects on observed spawning activity, under a range of permitted or proposed project operation conditions;
- Quantify effects (e.g., water velocity, depths, inundation, exposure of habitats) of project operation on identified spawning areas for a range of conditions, over the complete period of spawning activity;
- Quantify spawning activity as measured by night-time spawning/splash surveys and egg collection in areas of spawning activity, and downstream of these areas, to further determine project operation effects (location extent of exposure from changing water levels and flows and on associated habitats from project operations).

If it is determined that the Project operations are adversely affecting the spawning activity of American shad and impacting spawning area habitat, identify operational regimes that will reduce and minimize impacts spawning habitat and spawning success, within the project area. This study will require two years of field data to capture inter-annual variability to river discharge and water temperatures and to allow for evaluation of alternative flow regimes if year one studies determine that the present peaking regime negatively affects spawning.

Relevant Resource Management Goals

Not applicable, requester is not an agency or Indian tribe.

Public Interest Consideration If Requester Is Not A Resource Agency

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. Fish and their habitats are important public resources. There is a strong public interest in protecting and conserving fish and their habitats. This study will assess spawning by American shad in the Connecticut River mainstem downstream of Turners Falls Dam, in the Turners Falls Dam impoundment, in the Vernon Dam Project area, and downstream of Bellows Falls Dam to determine if project operations (including operations of the Northfield Mountain Pump Storage) negatively impact shad spawning behavior, spawning habitat use, areal extent and quality of those spawning areas, and spawning activity in terms of egg deposition in those areas.

Existing Information and Need for Additional Information

Since the construction of the first fish lift facility at Holyoke Dam in 1967, American shad have had access to spawning and rearing habitat upstream from Holyoke Dam. A number of improvements to the Holyoke fishway have occurred since that time, but while the numbers of shad lifted at Holyoke have reached as much as 721,764 and the overall shad population to the river exceeded 1.6 million shad in 1992 (CRASC 1992), total shad population, and numbers of shad passing Turners Falls and Vernon Dam have not met CRASC management plan objectives. Population number and passage numbers past Holyoke have declined substantially from those totals in recent years, with average Holyoke passage numbers over the last 10 years of 211,850. Since historically approximately half of the returning population of shad to the river passed upstream of Holyoke, recent returns are far below management goals. Effective upstream and downstream passage and successful in-river spawning and juvenile production are necessary to help achieve shad management goals for the Connecticut River.

American shad broadcast spawn in congregations over shallow flats and rocky or sandy substrates (Davis et al, 1970, Mansuetti and Kolb 1953), at depths less than 10 feet and often far shallower with spawning fish swimming vigorously near the surface in a closely packed circle (Marcy 1972, Mackenzie et al 1985). Fertilized eggs drift downstream until hatching (Mackenzie et al 1985).

American shad are known to spawn downstream from the Turners Falls Project. Layzer (1974) identified 6 spawning sites from an area below the mouth of the Deerfield River (river mile 191.9) to river mile 161.7 below the Mill River in Hatfield, MA. Kuzmeskus (1977) verified 16 different spawning sites ranging from downstream of the Cabot tailrace to just upstream of the Holyoke dam (river mile 87.1). The only parameter that all spawning sites had in common was current (Kuzmeskus 1977). We are not aware of any more recent studies that document whether these 16 sites are still viable spawning locations for shad. We are not aware of any studies that have determined American shad spawning habitat or spawning sites upstream of Vernon Dam to Bellows Fall Dam (historic extent of upstream range).

First Light Power conducted studies in the late spring and summer of 2012, examined habitat conditions downstream of the Turners Falls Dam. The study documented that in low flow conditions, Cabot Station project operations produced fluctuations in water level elevations that can range over 4 feet in magnitude (daily operation) at the USGS Montague Gage Station, to lower values of 2 to 3 feet at the Route 116 Bridge, Sunderland, MA (PAD). Similar short-term, limited monitoring in the upper Turners Falls Dam impoundment identified water level changes due to project operations that d cyclically varied several feet on a sub-daily frequency.

Nexus to Project Operations and Effects

American shad are known to spawn at five locations downstream from the Turners Falls Project from an area below the mouth of the Deerfield River (river mile 191.9) and ten other locations downstream to river mile 161.7 below the Mill River in Hatfield (Layzer 1974, Kuzmeskus 1977).

Shad spawning is likely influenced by river flow, which fluctuates greatly due to the project's peaking mode of operation. These fluctuations may impact shad spawning activity by altering current velocities and water depth at the spawning sites. Effects on spawning behavior could include suspension of spawning activity, poor fertilization, flushing of eggs into unsuitable habitat due to higher peaking discharges, eggs dropping out into unsuitable substrate and being covered by sediment deposition and/or eggs becoming stranded on dewatered shoal areas as peak flows subside.

While a number of shad spawning and egg deposition studies were conducted in the 1970s, that research was aimed at assessing the potential impact of developing a nuclear power station in the Montague Plains section of the Connecticut River. We are not aware of any studies being conducted specifically designed to determine if a relationship between spawning behavior, habitat use, and egg deposition and project operations effects of the Turners Falls, Northfield Mountain Pump Storage and Vernon projects and downstream of Bellows Falls Dam.

Peaking operations may be altering spawning behavior and contributing to the failure of the Connecticut River shad population to meet management targets.

Proposed Methodology

The first year of study should examine known spawning areas downstream of the Turners Falls Dam project, to determine operation effects on shad spawning behavior, activity, and success. In areas upstream of Turners Falls Dam to the Bellow Falls Dam tailrace, the study should identify areas utilized for spawning by American shad. In the second year, should results from year one determine project operations affected spawning activity, access to habitat, or success, downstream of Turners Falls Dam, then an identical more detailed assessment (identified objectives) should be conducted in spawning areas upstream of Turners Falls Dam to the Bellows Falls Dam tailwater. Measures to reduce or eliminate any documented project operation impacts should be explored and evaluated in year two, downstream of Turners Falls Dam.

The impacts to spawning behavior would best be studied by night-time observations of actual in-river spawning behavior (Ross et al. 1993). Project discharge increases or decreases during actual observed spawning activity will provide empirical evidence of change in behaviors. The observational methodology should follow the protocol specified in Layzer (1974) and/or as described in Ross et al. (1993). The analysis should utilize the observational field data in conjunction with operational data from the projects (station generation and spill on a sub-hourly basis). To assess the impacts of changes in generation flows, the study should include scheduled changes in project operation to ensure that routine generation changes that occur during the nighttime spawning period affect downstream spawning habitats selected for study while shad are spawning. Stier and Crance (1985) provide optimal water velocities during spawning to range between 1 to 3 ft/sec.

In areas used for spawning, the characteristics of those areas (e.g., location, depth, flow, substrate) should be recorded. The effect of project operations (discharge, water velocity, inundation and exposure) should be assessed. Drift nets will be used to collect eggs to quantify egg production before and after flow changes at the spawning site.

In the reaches above the Turners Falls dam, night time observations of splashing associated with shad spawning should be done in each reach as sufficient numbers of shad are passed above each dam. Observations should be done regularly until the end of the spawning season. The use of radio-tagged adult shad from a separate Study Request will aid in this effort. An estimate of the total area used for spawning and an index of spawning activity should be recorded for each site.

Level of Effort and Cost

Neither First Light or TransCanada propose any studies to meet this need. Estimated cost for the study is expected to be moderate (up to $40,000) for each owner, with the majority of costs associated with fieldwork labor.

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Requested Study 16. Impact of Project Operations on Downstream Migration of Juvenile American Shad

Conduct a field study of juvenile American shad outmigration in the Turners Falls impoundment and the power canal and at Turners Falls Dam,t, Station #1, and Cabot Station to determine if project operations negatively impact juvenile American shad survival and production.

Goals and Objectives

- Determine if project operations affect juvenile American shad outmigration survival, recruitment, and production. The following objectives will address this request:
- Assess project operations effects of NMPS and Turners Falls Dam on the timing, orientation, routes, migration rates, and survival of juvenile shad;
- Determine the proportion of juvenile shad that select the Gatehouse into the power canal versus the dam spill gates as a downstream passage route, under varied operational conditions, including a range of spill conditions up to full spill;
- Determine if there are any delays with downstream movement related to either spill via dam gates or through the Gatehouse and within the impoundment due to operations (i.e., NMPS pumping and generation);
- Determine survival rates for juvenile spilled over/through dam gates, under varied operation conditions, including up to full spill during the annual fall power canal outage period;
- Determine the juvenile downstream passage timing and route selection in the power canal to: Station 1; Cabot Station; and the Cabot Station log sluice bypass, and assess delays associated with each of these locations and with project operations (e.g., stockpiling in the canal);
- Based upon year 1 study results on route selection, determine the survival rate for juvenile shad entrained into Station 1; and
- Determine the survival rates for juvenile shad entrained into Cabot Station units;

If it is determined that the Project operations are adversely affecting juvenile shad survival, migration timing, or other deleterious population effects, identify operational solutions or other passage measures that will reduce and minimize these impacts within the project area. This study will require two years of field data to capture inter-annual variability of river discharge, water temperatures, and variability in the timing and abundance of juvenile production and their outmigration timing, which may relate to spring, summer, and fall conditions. This study will compliment the NMPS Fish Entrainment Study Request which includes assessment of impacts to juvenile shad.

Relevant Resource Management Goals

Not applicable, requester is not an agency or Indian tribe.

Public Interest Consideration If Requester Is Not A Resource Agency

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. Fish and their habitats are important public resources. There is a strong public interest in protecting and conserving fish and their habitats. This study will assess juvenile American shad outmigration in the Turners Falls impoundment and the power canal and at Turners Falls

Dam,t, Station #1, and Cabot Station to determine if project operations negatively impact juvenile American shad survival and production.

Existing Information and Need for Additional Information

Since the construction of the Turners Falls Dam upstream fishways in 1980, American shad have had access to spawning and rearing habitat upstream of Turners Dam. A number of modifications to the Turners Falls fishways have occurred since that time, with the numbers of adult shad passed at Gatehouse Ladder (into Turners Falls Dam impoundment) reaching as much 60,089 in 1992 when a record 721,764 shad passed upstream of Holyoke Dam. However, since 1980 an average of only 3.6 % of the adult shad passed upstream of Holyoke Dam subsequently have passed upstream of Turners Falls Dam, and this value has never exceeded 11%. This value is well below the CRASC 1992 Shad Plan objective of 40-60% passage from the previous dam. In addition, population number and passage numbers past Holyoke have declined substantially, with the average Holyoke passage number over the last 10 years being 211,850. Because historic data suggests that approximately half the returning adult shad to the Connecticut River pass the Holyoke Dam, recent adult returns are far below management goals. Effective upstream and downstream passage and successful in-river spawning and juvenile production are necessary to help achieve shad management restoration goals for the Connecticut River, which extends to the Bellows Falls Dam. In 1990, FirstLight's predecessor, Northeast Utilities, CRASC and its member agencies, signed an MOA on downstream fish passage to address both juvenile and adults at the Turners Falls Project and Northfield Mountain Pumped Storage Project.

American shad broadcast spawn with the highest spawning activity occurring in runs and lowest activity in pools and riffle/pools (Ross et al. 1993). Field research by Ross et al. (1993) in the Delaware River further noted that a combination of physical characteristics that seems to be avoided by spawning adults is slow current and greater depth. American shad year-class strength has been shown to depend on parent stock size and environmental conditions during the larval life stages (Creeco and Savoy 1984). Delays in juvenile American shad outmigration may affect survival rates in the transition to the marine environment (Zydlewski et al. 2003). One published study on the Connecticut River, identified that juvenile shad outmigration began when declining autumn temperatures reached 19C and peaked at 16C (O'Leary and Kynard 1986).

Juvenile American shad production has been monitored upstream of the Vernon Dam and immediately downstream of that dam by Vermont Yankee Nuclear as part of an annual monitoring program using both boat electrofishing (since 1991) and beach seining (since 2000). Sampling of juvenile shad was also conducted by a contractor hired by Northeast Utilities in the Turners Falls impoundment in 1992. O'Donnell and Letcher (2008) examined juvenile shad early life history and migration upstream and downstream of Turners Falls Dam. Their study results led to the decision by the agencies to require earlier operation of downstream fishways to protect early season juvenile shad out-migrants (1 September prior to 2010, 15 August in 2010, and since 2011, 1 August).

Downstream juvenile clupeid passage studies at Turners Falls were conducted in the fall of 1991 which included the objectives of determining the percentage of juvenile shad and herring that pass via the bypass log sluice or that were entrained in the Cabot Station turbines and related data (e.g., catch rates) were compared. The 1991 Downstream Clupeid Study did not assess survival rates for juveniles for either of these passage routes. The 1991 study report documented a higher rate entrainment into the project turbines (23.0 fish per minute) versus through the bypass sluice (11.6 fish per minute). It was concluded that only an estimated 54% (average bypass rate, weighted by estimated number bypassed) of the juvenile American shad approaching Cabot Station were bypassed via the log sluice. The range of the percent bypassed varied widely by date, between nearly 0 and 83%, with 'no clear explanation as to why." The report did not identify the percentage entrained into the turbines but it can be reasoned to be substantial based on the data presented in the report or assumed as the remaining balance (46%), as there were no spill events reported during this study, and therefore nowhere else for them to pass. It was further noted that entrainment rates for juveniles were consistently greatest for units 1 and 6 (ends), not uniform across all units. Although no concurrent bypass sampling occurred during the first entrainment sampling events, it was noted that "entrainment rates were relatively high during the end of September." Additional modifications have occurred over time without quantitative evaluation to improve downstream passage attraction and use to the bypass sluice, including lighting systems.

The 1994 Downstream Juvenile Shad Study report assessed juvenile shad survival from passage via the log sluice, reported to be 98%, based on tagged and recaptured fish (held for up to 48 hours). Scale loss (<20%) (22 of treatment fish) compared with scale loss of >20% (5 of treatment fish) was examined and determined to occur in an overall total of 10% of study fish (adjusted by control fish data).

Nexus to Project Operations and Effects

Adult American shad passed upstream of Turners Falls Dam utilize upstream spawning habitat. Juvenile American shad production occurs in these habitats upstream of Turners Falls Dam on an annual basis. Juvenile American shad require safe and timely downstream passage measures to have the opportunity to contribute to the fishery agencies' target restoration population size.

We are not aware of any studies being conducted specifically designed to determine:

- When spill gates are open at the Turners Falls Dam?
- What proportion of juvenile outmigrant shad take that route of passage?
- What is the rate of survival under a range of spill and gate configurations?
- What is the timing, duration, and magnitude of juvenile shad outmigrants in summer and fall to the Turners Falls Dam and Gatehouse?
- Are there delays in migration/movement at the dam, Gatehouse, Cabot Station, or Station 1?
- For juveniles that enter the power canal, what proportion subsequently enter the Station 1 power canal?
- As there is no downstream passage facilities at Station #1, and trash rack spacing is 2.6 inches, what is the survival rate of juvenile shad entrained at Station #1?
- What is the rate of movement through the Turners Power Canal, relative to r delay to outmigrant juvenile shad and the potential accumulation of juveniles (e.g., prior to the canal drawdown in September)?
- What proportion of juvenile shad use the downstream sluice bypass versus the Cabot Station turbines under varied operational conditions given that project operations may change (PAD notes possible increase in turbine capacity at Cabot)?

Based upon earlier facility studies (1991 Downstream Clupeid) a large proportion and number of juvenile shad are entrained into Cabot Station turbines. What are the associated impacts in terms of short-term and longer term survival and injury (i.e., scale loss)?

Project operations may impact juvenile shad outmigration survival and be contributing to the failure of the Connecticut River shad population to meet management targets. In the PAD, proposed modification include; Station 1 may be upgraded with new turbines, Station 1 may be closed, and/or the turbine capacity at Cabot may be increased. It is unclear how these scenarios will affect the questions identified in this request.

Proposed Methodology

The impact to juvenile shad outmigrants by project operations would be best studied by a combination of approaches including hydroacoustic, radio telemetry, and turbine balloon tags. Project discharge over a full range of existing and, to the extent possible, potential future operational conditions at Station 1 and Cabot, at the dam (likely increased bypass reach flows in new license) and in relation to the Gatehouse, should be examined relative to timing, duration, and magnitude of juvenile shad migration to and through these areas, with hydroacoustic equipment for natural/wild fish evaluation. In addition, study fish should be collected and tagged (PIT, radio, other mark, balloon) to also empirically determine rates of survival for fish passed over or through the dam's gates, under varied operations, including up to full spill condition that occurs annually in fall with canal outage period. The understanding of the timing, magnitude, duration of the wild fish outmigration will help inform the design, data/results, and assessment of tagged study fish. The release of tagged or marked fish (radio, PIT) upstream of the Gatehouse induction into the power canal, will provide data on concerns of delay and route selection to Station 1, Cabot Station downstream bypass, Cabot Station spill gates, and Cabot Station turbines. Additional hydroacoustic assessment at Cabot Station forebay will provide information on wild/natural juvenile fish timing, magnitude, and duration to and through this area. Based upon Year 1 study findings relative to the frequency, magnitude, timing of juvenile American shad that end up in the forebay of Station 1, the determination of whether an entrainment survival study at that site is necessary will be made. Release sites for tagged fish will be determined based upon further consultation among the parties.

Radio tagged juvenile shad will be released in areas upstream of the NMPS facility at multiple release locations, to determine operation effects on migration rates, route, orientation, entrainment, and survival, over a full range of permitted and operational conditions.

Level of Effort and Cost

First Light does not propose any studies to meet this need. Estimated cost for the study is expected to be high, between $200,000 and $300,000, with the majority of costs associated with equipment (hydroacoustic gear, radio tags, radio receivers, and PIT readers) and related fieldwork labor.

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Requested Study 17. Use of an Ultrasound Array in to Create Avoidance of the Cabot Station Tailrace By Pre-spawned Adult American shad and Facilitate Upstream Movement to the Turners Falls Dam

Goals and Objectives

The goal of this study is to determine if use of ultrasound is an effective behavioral mechanism to create avoidance of the Cabot tailrace area by upstream migrating adult shad. If not attracted to the Cabot Station discharge, shad may proceed upstream and pass the Turners Falls Dam via the fishway at the dam.

The objective of the study would be to establish a high frequency sound (ultrasound) array across the entire Cabot Station tailrace and determine the effect of the ensonified field on upstream and downstream migrating radio-tagged shad moving past Cabot Station. This would be accomplished by monitoring the movements and passage of shad and the time shad spend in the tailrace area. If effective, this technology also may be applicable to the Turners Falls #1 Station discharge.

Relevant Resource Management Goals

Not applicable, requester is not an agency or Indian tribe.

Public Interest Consideration If Requester Is Not A Resource Agency

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. Fish and their habitats are important public resources. There is a strong public interest in protecting and conserving fish and their habitats. This study aims to determine if use of ultrasound is an effective behavioral mechanism to create avoidance of the Cabot tailrace area by upstream migrating adult shad. If not attracted to the Cabot Station discharge, shad may proceed upstream and pass the Turners Falls Dam via the fishway at the dam.

Existing Information and Need for Additional Information

The Turners Falls Project has two fish ladders that anadromous migrants must use to pass the project; one at the Cabot Station tailrace and one at the spillway. Both ladders have documented passage problems. Further, fish that are able to successfully swim up the Cabot Station ladder exit into the Cabot Station power canal and must successfully enter and ascend another fish ladder (Gatehouse Fishway) before entering the Turners Falls impoundment and continuing up the Connecticut River. Spillway Ladder fish must also pass the Gatehouse ladder to reach the impoundment. The Gatehouse Fishway also has well documented passage issues.

Many years of study and design changes at the Gatehouse Fishway have improved passage effectiveness of that facility, but overall passage through the Cabot and Gatehouse fishways remains less effective than necessary to achieve management goals. A potential alternative to the current configuration of fishways at the project would be to cease using the Cabot ladder (thereby eliminating problems with that ladder and the need to pass the Gatehouse ladder), and instead operate a single fish lift facility at the spillway. However, for this to be a viable option, one major issue would need to be resolved: false attraction to the Cabot Station tailrace discharge. Therefore, this study would attempt to determine if use of ultrasound technology would be an effective method to minimize false attraction to the tailrace discharge while facilitating movement past the Cabot discharge and up to the spillway area without delay.

Much information exists about adult shad avoidance of ultrasound and the adaptive significance seems related to avoidance of echolocation signals of predator bottlenose dolphins (Mann et al., 1997; 1998). These authors suggest shad can detect the echolocation clicks of dolphins up to 187 meters away. Further, in field trials in the early 1980s to develop a guidance system for downstream-migrants in the First Level Canal of the Holyoke Canal System, adult shad avoided but were not well guided by an ultrasonic array. However, upstream migrants were guided well and even stopped entirely by the ensonified field (Kynard and Taylor 1984). Creating an ensonified field caused adult shad to leave their preferred location in the river upstream of trashracks at Holyoke Dam as long as the sound system was on.

Blueback herring also avoided the ultrasound field and behaved similar to shad in the Holyoke Canal studies (Kynard and Taylor 1984). Acoustic barriers have been used for blueback herring on the Savannah River (Richard B. Russell Dam) and Santee River (St. Stephen fish lift) in South Carolina and on the Mohawk River in New York (Crescent Project, FERC No. 4678; Vischer Ferry, FERC No. 4679). Evidence from many studies that attempted to produce behavioral avoidance by adult shad strongly suggests that ultrasound is the most effective stimuli (Carlson and Popper, 1997). Thus, the available evidence suggests that shad (and blueback herring) may be dissuaded from delaying at the tailrace of Cabot Station by installing and operating an ultrasound field.

In addition, one year of study on juvenile shad and blueback herring movements in the Holyoke Canal (Buckley and Kynard 1985) and two years of study in an experimental flume (Kynard et al. 2003) found that juveniles did not exhibit an avoidance response to the same high frequency (162 kHz) that was avoided by adult shad and bluebacks at Holyoke.

Nexus to Project Operations and Effects

Given the poor performance of the upstream passage facilities at Turners Falls, studies to assess potential passage solutions are appropriate areas during relicensing proceedings. This study, coupled with the adult shad radio-telemetry study, can provide the information needed to select the best approach to resolve upstream shad passage at the project.

Proposed Methodology

Acoustic barriers have been used for blueback herring on the Savannah River (Richard B. Russell Dam) and Santee River (St. Stephen fish lift) in South Carolina and on the Mohawk River in New York (Crescent Project, FERC No. 4678; Vischer Ferry, FERC No. 4679). This study would establish a high frequency sound (ultrasound) array across the entire Cabot Station tailrace and determine the effect of the ensonified field on upstream and downstream migrating shad moving through Cabot Station by monitoring shad behavior and the time that detected shad spend in the tailrace.

Shad tagged as part of the large-scale shad movement/migration telemetry study would be used to track shad movements through the Cabot Station area with the ultrasound system on versus off. Data would be analyzed to determine if ensonification is a successful deterrent mechanism (e.g., if shad spend less time in the tailrace when the area is ensonified relative to when it is not ensonified and whether shad move past Cabot Station to the spillway with limited delay)

Several businesses sell and operate ultrasound systems for fish avoidance. The use of these systems is world-wide at power production and water control facilities.

Level of Effort and Cost

The level of effort/cost for the test will be low to moderate. Costs will be related to rental, installation, and operation of the ultrasound system, analysis of data, and production of a final report. The study could utilize the same test fish and monitoring equipment as the adult shad radiotelemetry study (although a few additional tracking stations may have to be installed in the Cabot Station tailrace).

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Study Request 18. Upstream American Eel Passage Assessment at Turners Falls

Goals and Objectives

This study has two objectives:

- Conduct systematic surveys of eel presence/abundance at Cabot Station discharge, Station #1 discharge, canal discharges, and Turners Falls Dam to identify areas of concentration of eels staging in pools or attempting to ascend wetted structures that would potentially establish the most effective locations to place upstream eel passage facilities.
- Collect eels with temporary trap/pass devices from areas identified from surveys as potential locations of eel concentration to assess whether eels can be collected/passed in substantial numbers, and whether locations are viable sites for permanent eel trap/pass structures.

Relevant Resource Management Goals

Not applicable, requester is not an agency or Indian tribe.

Public Interest Consideration If Requester Is Not A Resource Agency

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. Fish and their habitats are important public resources. There is a strong public interest in protecting and conserving fish and their habitats. This study will conduct systematic surveys of eel presence/abundance at Cabot Station discharge, Station #1 discharge, canal discharges, and Turners Falls Dam to identify areas of concentration of eels staging in pools or attempting to ascend wetted structures that would potentially establish the most effective locations to place upstream eel passage facilities. It will also assess whether eels can be collected/passed in substantial numbers, and whether potential locations of eel concentration are viable sites for permanent eel trap/pass structures.

Existing Information and Need for Additional Information

The PAD contains no information relative to areas where eels seeking to move upstream concentrate downstream of the dam, or annual numbers of eels attempting to ascend past Turners Falls Dam. While eels have been known to ascend the Cabot Station ladder (A. Haro, U.S. Geological Survey, pers. comm.), its efficiency is unknown, and it is only operated during the American shad passage season (from April 1 through July 15). Eels are currently able to pass the Turners Falls Dam complex (as evidenced by documented presence of eels upstream), but the total number of eels attempting to pass Turners Falls and the proportion successfully passing the project is unknown (but suspected to be low). The downstream Holyoke Project has operated upstream eel passage facilities since 2004. Last year these facilities passed over 40,000 juvenile eels. While there is rearing habitat in between the Holyoke and Turners Falls dams, some eels will attempt to continue upstream, and passage needs to be provided so these fish can access historical habitat.

These information gaps need to be filled to determine the best locations to site upstream eel passage facilities and assess whether operating the existing anadromous ladders would be an effective mechanism to move juvenile eels upstream past the project.

We note that within the past seven years, the US Fish and Wildlife Service has received two petitions to list the American eel under the Endangered Species Act. The first petition was received on November 18, 2004. On July 6, 2005 the Service issued a substantial 90-day finding on the petition and initiated a 12-month status review that concluded on February 2, 2007 with a finding that listing was not warranted. The second petition was filed on April 30, 2010 by the Council for Endangered Species Act Reliability (CESAR). On September 29, 2011 the Service issued a substantial 90-day finding and initiated a 12-month status review. The Service is still accepting new American eel information for the ongoing status review. The Service also is currently in settlement negotiations with CESAR on their legal complaint that the Service failed to complete the 12-month finding within the statutory timeframe. Although the date for completion of the Service's 12-month finding on the latest petition is uncertain, it is likely that it will be made before any new licenses are issued for the projects.

Nexus to Project Operations and Effects

The project generates hydropower on the head created by the Turners Falls dam. This dam creates a barrier to upstream migrating eels. While some eels are able to pass dams, some are not, and the passability of a given dam depends on factors such as its height, hydraulics, presence of climbable surfaces, presence of predators, risk of exposure to heat or drying while climbing a dam, etc. The Turners Falls dam is high (35 feet above bedrock), and the majority of the dam face is dry during most of the upstream eel passage season. Design of the dam is not currently amenable to passage of eels by climbing. While flow is released to the bypass reach via a bascule gate (typically the one closest to the gatehouse), this would not facilitate eel passage, as bascule gates open outward and downward (i.e., requiring the eels to essentially swim nearly upside down to get over the gate). As mentioned earlier, the existing anadromous passage facilities are not designed to pass eels, and even if some eels are able to ascend the ladders, they may incur delays (in attraction or passage rates), be size-selective (e.g. velocity barrier for small eels presented by ~8 ft/sec flow through weirs and orifices), present a potential predation risk (predators in or near the fishways), and are not operated throughout the upstream eel passage season.

Proposed Methodology

Objective 1: Systematic Surveys

- Surveys of eel presence and relative abundance should be conducted at regular intervals throughout the eel upstream migratory season (~1 May to ~15 October, or when river temperatures exceed 10 C). Surveys should consist of visual inspection and trapping in likely areas where eels may concentrate as they attempt to climb structures wetted by significant spill or leakage flow in the Turners Falls dam complex area. These locations include: Cabot Station downstream bypass outfall, Cabot Station spillway (including attraction water stilling basin), Cabot Fishway (dewatered state), USGS Conte Lab flume outfall, Number One Station outfall, various small turbine and process water outfalls from the Cabot Canal, Spillway Fishway attraction water stilling basin, and leakage points along the downstream face of Turners Falls Dam (bascule and taintor gates). Methods should include visual surveys (on foot, from a boat, or snorkeling) and trapping using small mesh (< 1/8” clear opening) baited eel pots. Visual surveys should be performed once per week, at night, preferentially during precipitation events. Trap sets should be performed once per week, with an overnight soak time. Recorded data should include location, observation of eels (presence, absence, relative numbers, relative sizes, behaviors, time/date of observation), and survey method.

Objective 2: Trap/Pass Collections

- Areas identified from Systematic Surveys as having significant number of eels present should be targeted as potential areas for permanent eel trap/passes, and should be initially assessed using temporary/portable trap passes. At a minimum (regardless of survey results), temporary trap passes should be installed at the following locations: Cabot Fishway attraction flow stilling basin (during dewatered fishway period), Number One Station outfall, and Spillway Fishway attraction flow stilling basin (during watered and dewatered fishway period), as these locations may be supplemented with additional attraction flow and have high potential for being concentration points for upstream migrant eels. Temporary trap/passes should be purpose-designed and built for each location, and operated throughout the eel upstream migratory season (~1May to 15 October, or when river temperatures exceed 10 C). Ramp-type traps with supplementary attraction flow are preferred temporary trap/pass designs. Traps should operate daily, with catches quantified every 2-3 days. Recorded data should include location, trapping interval, absolute numbers of eels trapped, relative eel sizes, and hydraulic and environmental conditions during the trapping period.

All collected eels from surveys should be released at their point of capture; those eels collected from trap/pass collections should be transported to and released above the dam in the Turners Falls Pool.

These methodologies are consistent with accepted practice.

Level of Effort and Cost

The level of cost and effort for the survey component of the study would be low; a minimal number of personnel may be able to conduct the weekly surveys. The trap/pass component would require low to moderate cost (estimated at $40,000) and effort.

In the PAD, the applicant has identified the need to assess issues related to upstream passage for American eels at the project, but indicates that it intends to rely on information from previously conducted studies and ongoing studies. We are not aware of any previously conducted or ongoing studies related to upstream eel passage.

Study Request 19. Evaluation of Timing of Downstream Migratory Movements of American Eels on the Mainstem Connecticut River

Goals and Objectives

The goal of this study is to better understand migration timing of adult, silver-phase American eels as it relates to environmental factors and operations of mainstem hydropower projects on the Connecticut River.

The objectives of this study are:

- Quantify and characterize the general migratory timing and presence of adult, silver-phase American eels in the Connecticut River relative to environmental factors and operations of mainstem river hydroelectric projects.

Relevant Resource Management Goals

Not applicable, requester is not an agency or Indian tribe.

Public Interest Consideration If Requester Is Not A Resource Agency

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. Fish and their habitats are important public resources. There is a strong public interest in protecting and conserving fish and their habitats. This study will improve our understanding of migration timing of adult, silver-phase American eels as it relates to environmental factors and operations of mainstem hydropower projects on the Connecticut River.

Existing Information and Need for Additional Information

Data on timing of downstream migratory movements and rates of American eels in the mainstem Connecticut River are sparse and relatively incomplete. Preliminary data on presence of "eel-sized" acoustic targets have been collected (Haro et al. 1998) within the Turners Falls Project's Cabot Station forebay that were somewhat confirmed by video monitoring at the Cabot Station downstream fish bypass; however, these were short-term studies, with acoustic monitoring only performed from 17 September to 5 October and video monitoring only conducted between 18 September to 22 October.

Some daily monitoring of the downstream bypass at the Holyoke Dam (canal louver array) was performed in 2004 and 2005 (Kleinschmidt, Inc. 2005, 2006, Normandeau Associates 2007); these studies also were of relatively short duration (spanning from October 5 to November 10 in 2004 and September 9 to November 11 in 2005) and the sampler was only operated at night.

To date, no other directed studies of eel migratory movements have been conducted at any location on the Connecticut River mainstem. This information gap needs to be filled, as it relates directly to when downstream passage and protection measures need to be operated.

We also note that within the past seven years, the US Fish and Wildlife Service has received two petitions to list the American eel under the Endangered Species Act. The first petition was received on November 18, 2004. On July 6, 2005 the Service issued a substantial 90-day finding on the petition and initiated a 12-month status review that concluded on February 2, 2007 with a finding that listing was not warranted. The second petition was filed on April 30, 2010 by the Council for Endangered Species Act Reliability.

On September 29, 2011 the Service issued a substantial 90-day finding and initiated a 12-month status review. The Service is still accepting new American eel information for the ongoing status review. The Service also is currently in settlement negotiations with CESAR on their legal complaint that the Service failed to complete the 12-month finding within the statutory timeframe. Although the date for completion of the Service's 12-month finding on the latest petition is uncertain, it is likely that it will be made before any new licenses are issued for the projects.

Nexus to Project Operations and Effects

The timing of downstream migration of adult eels is poorly defined for the Connecticut River; therefore the general effects of hydroelectric project operations on eel survival to the ocean are unknown. Although separate study requests have been submitted to address project-specific downstream passage route selection, delays, and mortality of eels, general characteristics of river flow and environmental conditions may have significant relationships with project operation and eel migratory success and survival. For example, eels may tend to move immediately before or during periods of significant precipitation (or consequently river flow); times at which projects may be generating at maximum capacity or spilling, which may (or may not) present a higher passage risk to eels. Conversely, periods of low flow may be associated with a significant proportion of total river flow passing through turbine units, which present additional (or different) passage risk to eels. If discrete conditions which promote eel downstream migration are known, it may be possible to take actions with respect to project operations which reduce or minimize passage risk; i.e., operation of a bypass, reduction of intake approach velocities, directed spillage through a “safe” route, etc. These studies should provide baseline information on river-specific downstream migration to predict when silver-phase eels are expected to be migrating in the mainstem Connecticut River, from which project operations could be modified to minimize passage risks.

The studies are proposed for a single or multiple sites; the results will be relevant to all sites on the Connecticut River mainstem.

Proposed Methodology

Quantification of downstream movements of American eels in river systems requires systematic sampling of migrants throughout the migratory season. This can be accomplished with traditional active trapping methods; i.e., fyke or stow net sampling, weirs, or eel racks, but these methods are technically challenging on larger mainstem rivers, due to the scale of flows that need to be sampled, difficulties in operation throughout all flow conditions, and high debris loading during fall flows. Passive monitoring of migrant eels using hydroacoustic methods offers an alternative to active trapping. However, passive monitoring requires verification of potential acoustic targets with some level of active (collection) or visual (traditional optical or acoustic video) sampling.

Two potential locations offer opportunities to conduct simultaneous passive and active sampling: the Cabot Station (Turners Falls project) canal/forebay and the Holyoke Dam forebay and canal louver/bypass system. Each location possesses a route of downstream passage which conducts a significant proportion of river flow (Cabot canal and Holyoke forebay or canal), and each has a proximal bypass equipped with a sampler so that fish can be concentrated/collected from the passage route and identified to species. Project operations do influence the relative proportion of flow (and thus numbers of downstream migrant eels) in each passage route, so numbers of eels sampled in each route represent only a proportion of the total number of eels migrating downstream within the entire river. Because the absolute proportion of eels using a specific route at any one time is unknown, numbers of eels quantified within a route must serve as a relative index of the degree of migratory movement.

This study shall quantify eel movements in either one, or preferably both, locations for two consecutive years (since environmental conditions strongly influence migratory timing of eels, which can vary significantly from year to year; Haro 2003). Eels will be quantified using methods similar to Haro et al. (1999), by continuously monitoring a fixed location at the projects with hydroacoustics. Because eels tend to concentrate in areas of dominant flow (Brown et al. 2009, EPRI 2001), the zone to be monitored should pass a dominant proportion of project flow throughout most periods of operation (i.e., forebay intake area). Hydroacoustic monitoring shall encompass the entire potential migratory season, beginning in mid-August and ending in mid-December, and shall operate 24 hours per day. Data will be recorded for later processing and archiving.

Systematic active quantification of eels at downstream bypass samplers shall be performed simultaneously with passive hydroacoustic monitoring, to verify presence of eels and relative abundance of eel-sized hydroacoustic targets from the hydroacoustic data. Although daily operation of the bypass sampler could be performed, a more comprehensive technique is to monitor eels entering the bypass with an acoustic camera (i.e. DIDSON, BlueView, etc.). The acoustic camera will afford positive visual identification of eels as they enter the bypass, which is a concentration point for migrating eels. Acoustic camera monitoring will also allow monitoring to be performed 24 hours a day, and will be relatively unaffected by water turbidity (which influences effectiveness of traditional optical video monitoring). The acoustic camera system will be operated during the same time period as acoustic monitoring, and images will be recorded for later processing and archiving.

Data analyses of hydroacoustic, acoustic camera, bypass sampling, and environmental/operational data will follow standard methodology.

Project operation (flows, levels, gate openings, number of units operating and operation level) and environmental conditions (river flow, temperature, turbidity, air temperature, precipitation) will be monitored regularly (hourly measurements if possible) throughout the duration of the studies.

These methodologies are consistent with accepted practice.

Level of Effort and Cost

The level of cost and effort for the downstream migrant eel migratory timing study would be moderate, given the level of cost for instrumentation, deployment, and data review/analysis. Cost is estimated at $50,000 per year for the study.

The applicant did not propose any studies to meet this need in the PAD.

References:

Brown, L.S. 2005. Characterizing the downstream passage behavior of silver phase American eels at a small hydroelectric facility. M.Sc. Thesis, Department of Natural Resource Conservation, University of Massachusetts, Amherst, Massachusetts. 110 pp.

Brown, L., A. Haro, and T. Castro-Santos. 2009. Three-dimensional movement of silver-phase American eels in the forebay of a small hydroelectric facility. Pages 277-291in: J. Casselman et al. editors. Eels at the Edge: Science, Status, and Conservation Concerns. American Fisheries Society, Bethesda, MD.

EPRI (Electric Power Research Institute). 2001. Review and documentation of research and technologies on passage and protection of downstream migrating catadromous eels at hydroelectric facilities. EPRI Technical Report No. 1000730, Palo Alto, California 270 pp.

Haro, A. 2003. Downstream migration of silver-phase anguillid eels. Pages 215-222 in: Aida, K., K. Tsukamoto, and K. Yamauchi, eds. Eel Biology. Springer, Tokyo.

Haro, A., D. Degan, J. Horne, B. Kulik, and J. Boubée. 1999. An investigation of the feasibility of employing hydroacoustic monitoring as a means to detect the presence and movement of large, adult eels (Genus *Anguilla*). S. O. Conte Anadromous Fish Research Center Internal Report No. 99-01. Turners Falls, Massachusetts. 36 pp.

Kleinschmidt, Inc. 2005. Factors influencing the timing of emigration of silver-phase American Eels, *Anguilla rostrata*, in the Connecticut River at Holyoke MA. Submitted to the City of Holyoke Holyoke Gas and Electric Department. 27 pp.

Kleinschmidt, Inc. 2006. Holyoke Project (FERC No. 2004) silver-phased American eel flow priority plan. Submitted to the City of Holyoke Holyoke Gas and Electric Department. 51 pp.

Normandeau Associates, Inc. 2007. American eel emigration approach and downstream passage routes at the Holyoke Project, 2006. Submitted to the City of Holyoke Holyoke Gas and Electric Department. Final report. Normandeau Associates, Inc., Westmoreland, New Hampshire. 81 pp.

Study Request 20. Downstream American Eel Passage Assessment at Turners Falls and Northfield Mountain

Goals and Objectives

The goal of this study is to determine the impact of two hydroelectric projects on the outmigration of silver eels in the Connecticut River. Entrainment of eels at the Northfield Mountain Pumped Storage Station (NFMPS) removes eels from the river, effectively extirpating them from the population. Entrainment at the conventional turbines at Station 1 and Cabot Station of the Turners Falls Project can result in mortality or injury. It is important to understand the passage routes at each project and the potential for mortality to assess alternative management options to increase survival.

The objectives of this study are:

- Quantify the movement rates (including delays) and relative proportion of eels passing via various routes at the projects; i.e. for NFMPS, the proportion entrained into the intake; for Turners Falls Dam, the proportion entrained into the power canal and spilled via bascule and taintor gates; for the Cabot Canal, proportion of fish passing via spillways, turbines, and the downstream bypass.
- Evaluate instantaneous and latent mortality and injury of eels passed via the Turners Falls Dam routes, including bascule and taintor gates, spillways, turbines, and the downstream bypass.

Relevant Resource Management Goals

Not applicable, requester is not an agency or Indian tribe.

Public Interest Consideration If Requester Is Not A Resource Agency

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. Fish and their habitats are important public resources. There is a strong public interest in protecting and conserving fish and their habitats. This study will determine the impact of two hydroelectric projects on the outmigration of silver eels in the Connecticut River. Entrainment of eels at the Northfield Mountain Pumped Storage Station (NFMPS) removes eels from the river, effectively extirpating them from the population. Entrainment at the conventional turbines at Station 1 and Cabot Station of the Turners Falls Project can result in mortality or injury. It is important to understand the passage routes at each project and the potential for mortality to assess alternative management options to increase survival.

Existing Information and Need for Additional Information

The PAD contains information on the biology, life history, and regulatory status of American eel. It also discusses 2-D and 3-D telemetry studies that were conducted at Cabot Station in 1996, 1997, 2002 and 2003. Results of those studies indicate that a significant proportion of eels entering the Cabot forebay become entrained (90% in 2002, 100% in 2003; Brown 2005, Brown et al. 2009). The PAD notes that the study done in 2003 determined that 15 of the 29 test eels were detected at the Hadley Falls Station. However, that study was not designed to assess turbine mortality.

To date, no directed studies of eel mortality at Cabot Station or eel entrainment or mortality at either Station 1 or the NFMPS facility have been conducted. These information gaps need to be filled to assess the relative and cumulative impact of project operations on outmigrating eels and develop adequate passage and protection measures to meet management goals and objectives.

We also note that within the past seven years, the US Fish and Wildlife Service has received two petitions to list the American eel under the Endangered Species Act. The first petition was received on November 18, 2004. On July 6, 2005 the Service issued a substantial 90-day finding on the petition and initiated a 12-month status review that concluded on February 2, 2007 with a finding that listing was not warranted. The second petition was filed on April 30, 2010 by the Council for Endangered Species Act Reliability (CESAR). On September 29, 2011 the Service issued a substantial 90-day finding and initiated a 12-month status review. The Service is still accepting new American eel information for the ongoing status review. The Service also is currently in settlement negotiations with CESAR on their legal complaint that the Service failed to complete the 12-month finding within the statutory timeframe. Although the date for completion of the Service's 12-month finding on the latest petition is uncertain, it is likely that it will be made prior to any new licenses are issued for the projects.

Nexus to Project Operations and Effects

The Turners Falls Project operates as a peaking facility, except during periods when inflow exceeds the hydraulic capacity of Cabot Station and Station 1. Silver eels outmigrate during the mid- summer through late fall, a time of year when flows are generally near the maximum operating capacity of the stations. Therefore, the project would be expected to spill infrequently during the silver eel outmigration beyond the nominal amount required in the bypass reach.

Racks at Cabot Station, Station 1, and NFMPS facility are not designed to protect eels from entrainment. At Cabot, the racks have one-inch clear spacing on the top 11-feet, with five-inch clear spacing on the bottom 20 feet of racks. The approach velocity at the racks is approximately 2.0 feet per second at maximum hydraulic capacity. At Station 1, the racks have 2.6-inch clear spacing and an approach velocity of 1.2 feet per second. Eels can readily pass through a 2.6-inch clear space. NFMPS has 48-foot-deep trashracks with six-inch clear spacing over the intake and an approach velocity of 3.5 feet per second at full pumping capacity (15,000 cfs).

As mentioned above, previous studies conducted at Cabot Station documented eel entrainment. Cabot Station has existing downstream passage facilities designed for anadromous species, but studies have documented few eels utilizing the surface bypass (likely because Cabot has a relatively deep, wide intake area). Station 1 has no passage and protection facilities. NFMPS has a seasonally-deployed barrier net to minimize entrainment of Atlantic salmon smolts, but it is only operated from April through June 15 annually. While no studies have been conducted at Station 1 or NFMPS facility, the rack spacing is wide enough to allow for entrainment.

Proposed Methodology

In order to understand the movements of outmigrating silver eels as they relate to operations at the Northfield Mountain Pump Storage Facility, Station 1, and Cabot Station, radio telemetry technology should be utilized. Radio telemetry is an accepted technology that has been used for a number of studies associated with hydropower projects, including at the Muddy Run Project (FERC No. 2355).

Studies should be designed to investigate route selection (i.e., entrainment vs. spill) independently from estimation of mortality/injury, because these metrics require different telemetric methodologies. Studies also will likely benefit from data from several seasons (especially route selection studies, which may be more significantly affected by environmental conditions during a given season that mortality/injury studies). It is also envisioned that results from route selection studies can guide design of turbine mortality studies. Therefore, it is proposed, at a minimum, that route selection studies be conducted in multiple years, but mortality/injury studies may be conducted after the first year of route selection studies have been completed.

Objective 1: Route Selection

This study will involve systematic releases of radio-tagged silver phase eels at strategic points above areas of interest, to assess general routes of passage (i.e., via spill, bypass, or turbines). Active downstream migrants should be collected within-basin if possible (i.e., Cabot or Holyoke bypass samplers), but fish sourced from out of basin may be acceptable to meet sample size demands. Experimental fish must meet morphometric (e.g. eye diameter relative to body size) criteria to ensure they are migrant silver phase. Collections should be made within the migratory season (late Aug to mid Oct), and eels should be tagged and released within 7 days of collection.

NFMPS Route Selection Study:

A minimum number of 50 telemetered eels (e.g., 5 separate groups of approximately 10 eels each) will be required to maximize the data return. Eels will be released at least 5 km upstream of the NFMPS project; releases should be timed so that there is a significant probability that migrating eels will encounter NFMPS during the pumping stage. Radio telemetry antennas will be strategically placed to determine times eels are present within the river reach in the vicinity of the NFMPS intakes, within the intakes themselves, and whether they are entrained into the upper reservoir.

Turners Falls Dam Route Selection Study:

A minimum number of 50 telemetered eels (e.g., 5 separate groups of approximately 10 eels each) will be required to maximize the data return. Groups of eels should be released during spill and non-spill periods if possible. Tagged eels will be released at least 3 km upstream of the Turners Falls dam but several km below the intake to NFMPS. Telemetry receivers and antennas will be located above and below the dam to assess passage via the following potential routes: entrainment into power canal; passage via spill over the bascule gates; passage via spill through the taintor gates.

Eels from the NFMPS route study not entrained into the NFMPS intake and migrating to the Turners Falls Dam may be used to supplement (but not serve in lieu of) these release groups.

Turners Falls Project – Canal Route Selection Study:

A minimum number of 50 telemetered eels (e.g., 5 separate groups of approximately 10 eels each) will be required to maximize the data return. Groups of eels should be released during periods of low, moderate, and high generation conditions if possible. Eels will be released in the upper canal (ideally just downstream of the Gatehouse), and allowed to volitionally descend through the canal. Telemetry receivers and antennas will be located within the canal, bypass, channel, and mainstem below Cabot Station to assess passage via the following potential routes: Spillway Fishway attraction water intake (if operational); Station 1 turbines; Cabot Station spillway; Cabot Station bypass; Cabot Station turbines

Eels from the NFMPS and Turners Falls Dam Route Studies not entrained into the NFMPS intake and migrating into the Turners Falls Canal may be used to supplement (but not serve in lieu of) these release groups.

Mobile tracking (i.e., via boat) in river reaches between release sites and several km downstream of Cabot Station will be performed at regular intervals during and after releases to confirm routes and fates of passed fish, or fish lost to follow-up.

Movement rates (time between release and passage) of eels passing the projects by various routes will also be quantified.

The route selection portion of this study should occur in both study years.

Objective 2: Spill, Bypass, and Turbine Mortality/Injury Studies

Spill, bypass, and turbine mortality will be assessed using a radio-telemetric balloon tag method. A minimum number of 50 tagged eels (e.g., 5 separate groups of approximately 10 eels each) will be required at each location (dam bascule gate, dam taintor gate, Cabot Station spillway, Cabot Station bypass, Station 1 and Cabot Station) to maximize the data return. Turbine mortality studies are not required at NFMPS because it is assumed that all entrained fish (including eels) are lost to the Connecticut River system.

For spill mortality sites (dam bascule gate, dam taintor gate, Cabot spillway, Cabot Station bypass), tagged eels will be injected or released into spill flow at points where water velocity exceeds 10 ft/sec, to minimize the possibility of eels swimming upstream into the headpond or canal. Passed balloon-tagged eels will be recovered below areas of spill and held for 48 hours in isolated tanks for observation of injury and latent mortality; unrecovered balloon-tagged eels will be censored from the data.

For turbine mortality sites (Station 1 and Cabot Station), tagged eels will be injected into intakes of units operating at or near full generation at points where intake water velocity exceeds 10 ft/sec, to minimize the possibility of eels swimming back upstream through the intakes. Passed balloon-tagged eels will be recovered in the tailrace and held for 48 hours in isolated tanks for observation of injury and latent mortality; unrecovered balloon-tagged eels will be censored from the data.

Mobile tracking (i.e., via boat) in river reaches between release sites and several km downstream of Cabot Station will be performed at regular intervals after releases to confirm routes and fates of passed fish, or fish lost to follow-up.

The turbine mortality component of the study should occur in Study Year 2.

Data analyses of route selection and turbine mortality (instantaneous and latent) will follow standard methodology.

Project operation (flows, levels, gate openings, number of units operating and operation level) and environmental conditions (river flow, temperature, turbidity, air temperature, precipitation) will be monitored regularly (hourly measurements if possible) throughout the duration of the studies.

These methodologies are consistent with accepted practice.

Level of Effort and Cost

The level of cost and effort for the downstream eel passage study would be moderate to high; silver eels would need to be collected, tagged, and released in several locations over the course of the migration season. Antennas and receivers would need to be installed at the intakes to all stations as well as at the Turners Falls dam spillway and Cabot Station bypass, and monitored regularly. Data would need to be retrieved periodically, then analyzed. A multi-site route selection study conducted by the USGS Conte Lab on the Shetucket River in Connecticut cost approximately $75,000 for the first year of study. Cost are estimated at $100,000 per year for the Route Selection studies and $75,000 per year for the Spill, Bypass, and Turbine Mortality/Injury Studies.

In the PAD, the applicant has identified the need to assess issues related to downstream passage for American eels at the project, but indicates that it intends to rely on information from previously conducted studies and ongoing studies. We are not aware of any previously conducted or ongoing studies related to downstream eel passage.

References:

Brown, L.S. 2005. Characterizing the downstream passage behavior of silver phase American eels at a small hydroelectric facility. M.Sc. Thesis, Department of Natural Resource Conservation, University of Massachusetts, Amherst, Massachusetts. 110 pp.

Brown, L., A. Haro, and T. Castro-Santos. 2009. Three-dimensional movement of silver-phase American eels in the forebay of a small hydroelectric facility. Pages 277-291in: J. Casselman et al. editors. Eels at the Edge: Science, Status, and Conservation Concerns. American Fisheries Society, Bethesda, MD.

EPRI (Electric Power Research Institute). 2001. Review and documentation of research and technologies on passage and protection of downstream migrating catadromous eels at hydroelectric facilities. EPRI Technical Report No. 1000730, Palo Alto, California 270 pp.

Requested Study 21. Impacts of the Turners Falls and Northfield Mountain Pumped Storage Project Operations on Tributary and Backwater Area Access and Habitats

Goals and Objectives

One goal of this study is to determine if water level fluctuations from the Turners Falls and Northfield Mountain Pumped Storage projects result in a barrier(s) to fish movement in and out of tributaries and backwaters to the impoundments and riverine reaches below dams.

A second goal is to determine if water level fluctuations in the Turners Falls and Northfield Mountain Pumped Storage project impoundments impact water levels, available fish habitat and water quality in tributaries and backwaters to the impoundments and riverine reaches below dams, and if impacts are found, to ascertain how spatially far reaching they are and develop mitigation measures.

Results of this study may also be used to help determine the adequacy of existing downstream minimum flow requirements.

Specific objectives include:

- Conduct a field study of tributaries and backwaters, including water velocity and habitat data where appropriate, to evaluate potential impacts of impoundment fluctuation on fish access to tributaries and backwater areas. The study should also evaluate if changes in impoundment fluctuation range would mitigate for any identified impacts and if other mitigative measures would improve access.
- Conduct a field study to examine potential impacts of impoundment fluctuations on water levels, available habitat and water quality in tributaries and backwaters. The evaluation should also evaluate if changes in impoundment fluctuation range would mitigate for identified impacts and if other mitigative measures would lessen these impacts.

Relevant Resource Management Goals

Not applicable, requester is not an agency or Indian tribe.

Public Interest Consideration If Requester Is Not A Resource Agency

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. Fish, wildlife, plants, and their habitats are important public resources. There is a strong public interest in protecting, conserving, and enhancing these resources for public benefit, including wetlands, endangered species, and migratory species. This study will help promote tributary and backwater access and protect valuable fish habitat and maintain appropriate water quality conditions for diadromous and riverine fish species in project-affected areas. Maintaining connectivity between the mainstem of the Connecticut River and tributaries and backwaters is vital to the fish populations in these systems, as many fish species utilize these areas for spawning, rearing, refuge, and feeding.

Existing Information and Need for Additional Information

To our knowledge, limited information exists related to this requested study.

Nexus to Project Operations and Effects

Project operations have the potential to impact fish species life history requirements, biological interactions, and habitat quantity and quality. For example, water level changes due to project operations could create conditions that could impede free movement of fish between tributaries/backwaters and the mainstem of the Connecticut River, thus limiting access to spawning habitat and/or growth opportunities. Additionally, water level changes could also alter tributary and backwater fish habitat quality, quantity, and also water quality, thus decreasing productivity and available habitat.

Proposed Methodology

Common tools to evaluate water level impacts would be used including: bathymetric mapping, substrate, depth and velocity measurements, and water quality information (dissolved oxygen, temperature, turbidity, and pH). Studies should be conducted throughout the year.

The study area for tributary and backwater fish sampling should cover all tributaries and backwaters within the project-affected areas of the Turners Falls and Northfield Mountain Pumped Storage projects. A second year of study may be required if first year data collection is limited due to environmental or other conditions, or if river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period.

Level of Effort and Cost

First Light does not propose any studies to meet this need. Estimated cost for the study is moderate.

Requested Study 22. Impacts of Water Level Fluctuations on Riparian and Aquatic Vegetation Including Invasive Species and their Associated Habitats in the Turners Falls Dam Project Impoundment

Conduct a study to quantify impacts of reservoir fluctuation on riparian, wetland, Emergent Aquatic Vegetation (EAV), Submerged Aquatic Vegetation (SAV), littoral zone and shallow water aquatic habitats in the Turners Falls Dam impoundment.

Goals and Objectives

The goal of this study is to obtain baseline information on riparian, wetland, emergent and submerged aquatic vegetation, and associated shallow water aquatic habitats (subject to operational inundation and exposure to near exposure) known to occur in the project area. Information would be used to determine whether riparian, wetland, EAV and SAV, littoral, and shallow water (e.g., mid river bars and shoals) habitats are impacted by current water level fluctuations permitted under the Turners Falls and Northfield projects' licenses and whether these vegetation types and shallow water habitats can be protected and restored by modifications to project operations or other mitigation measures. This analysis needs to take into account existing and potential future limits on pond level fluctuations intended to limit recreation impacts, and the interactions of any changes in pond level fluctuation range or frequency and discharge changes under a new licenses of the Turners Falls and upstream projects. This information is needed to determine whether the projects operation affects plants, habitat, and wildlife in the project area, whether aquatic vegetation and its habitats can be enhanced by modifications to project operations or other mitigative measures, and whether there is any unique or important shoreline or aquatic habitats that should be protected.

The specific objectives of the field study, at a minimum, include:

- Quantitatively describe and map wetland types within 200 feet of the shoreline, and describe associated wildlife;
- Delineate, quantitatively describe, and map all wetland types including invasive species and wildlife observed (e.g., bald eagle nesting, water fowl nesting) within 200 feet of the shoreline, and the extent of this habitat if it extends beyond 200 feet; and
- Quantitatively describe (e.g., substrate composition, vegetation type and abundance) and map shallow water aquatic habitat types subject to project operation inundation and exposure, noting and describing additional areas where water depths at lowest operational range are wetted to a depth less than one foot (flats, near shore areas, gravel bars, with very slight bathymetric change);

A second year of study may be required should river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period.

The field study should produce a habitat inventory report that includes:

- The results of the field study in the form of maps and descriptions;
- An assessment of project effects on wetland, riparian, littoral zone vegetation and shallow water habitats, invasive plant species, and wildlife habitat at the project; and
- Recommendations for any necessary plant, habitat type, or wildlife, protection and/or invasive species control measures.

Relevant Resource Management Goals

Not applicable, requester is not an agency or Indian tribe.

Public Interest Consideration If Requester Is Not A Resource Agency

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. Fish, wildlife, plants, and their habitats are important public resources. There is a strong public interest in protecting, conserving, and enhancing these resources for public benefit, including wetlands, endangered species, and migratory species. This study will gather baseline information on riparian, wetland, emergent and submerged aquatic vegetation, and associated shallow water aquatic habitats (subject to operational inundation and exposure to near exposure) known to occur in the project area. Information would be used to determine whether riparian, wetland, emergent and submerged aquatic vegetation, littoral, and shallow water (e.g., mid river bars and shoals) habitats are impacted by current water level fluctuations permitted under the Turners Falls and Northfield projects' licenses and whether these vegetation types and shallow water habitats can be protected and restored by modifications to project operations or other mitigation measures.

Existing Information and Need for Additional Information

Existing information in the PAD does not quantify EAV and SAV in this area, or other shallow aquatic habitat types and physical features (e.g., depths, substrates, wood structure) that are the environment for aquatic biota in the project area. The PAD does provide some limited monitoring data for 2012 (2 locations) on water surface elevations that show daily fluctuations, in the upper third of this impoundment, that varied over 4 feet on a daily cycling frequency, with fluctuations generally in the 2 foot range in low flow months for the data provided in the PAD. The current license does permit a greater pool elevation operational fluctuation, up to a 9 foot change in elevation, based on the Turners Falls Dam water elevation. In the PAD it is noted these operational fluctuations under most circumstances at the Turners Falls Dam are within 3.5 feet.

In the PAD it is noted that FLP would like to expand its NMPS upper reservoir capacity (by up to 24%), how this may affect project operations and the habitats noted in this request is unknown. It is also noted that water is typically pumped to the upper reservoir in evening and generation back to the river occurs once to twice daily, in daytime hours, based upon power needs and power value. Under current license conditions, provided set thresholds for minimum flow and Turners Dam current license elevations are met, the NMPS may operate with no restriction in timing, frequency, or magnitude for pumping or generation. No data were provided on the operation of the NMPS plant over time relative to data on pumping and generation on an hourly basis, averaged values were provided over monthly periods. It is unclear what the actual timing, frequency and magnitude of these NMPS operations are over the course of a year and how that relates to; aquatic plant species establishment, growth, survival, littoral zone or other shallow water habitat fish spawning periods and their effects on these fishes (reproduction success and subsequent recruitment, e.g., bass and fall fish nests) in available and utilized habitat, and how the quantity and quality of these shallow water habitats are effected by project operational manipulation/alteration, as currently permitted or proposed.

The PAD provides lists of plant and wildlife species whose native ranges overlap with the project area, but it does not provide any baseline information on known occurrences of these species in the wetlands, riparian, littoral and shallow water habitats, within or adjacent to, the project area. Plant and wildlife occurring in these habitats may benefit from protection, mitigation, and enhancement (PMEs) measures, given the potential effects of continuing the current semiautomatic peaking operating regime. In addition, a large scale sediment discharge from NMPS resulted in regulatory actions by FERC, the EPA and MADEP in 2010. Continuing and as yet unresolved management plan measures relative to sediment and NMPS project operations, are further concerns for shallow water, littoral zone, and wetland habitats.

The Atlantic States Marine Fisheries Commission, Atlantic Coast Diadromous Fish Habitat: A Review of utilization, threats, recommendations for conservation, and research needs (ASMFC 2009), contains a review of habitat information for these species. Recommendations in this report include: Maintain water quality and suitable habitat for all life stages of diadromous species in all rivers with populations of diadromous species.

Nexus to Project Operations and Effects

Water level fluctuations due to project operations could affect EAV and SAV habitat as well as the quantity and quality littoral and shallow water habitat. These operational water level fluctuation effects are expected to impact fish species use of these habitats and may affect spawning fishes reproductive success and subsequent population recruitment including but not limited to American shad, blueback herring, sea lamprey, fall fish, and bluegill, which spawn in mid to late spring through early summer in areas subject to daily or more frequent water level fluctuations.

The current operating mode, as well as the unknowns with proposed upper reservoir expansion, may affect wetland riparian, littoral and other shallow water habitats and promote the introduction and expansion of invasive plant species through fluctuating water levels. A study that explains the relationship between the proposed mode of operation and the type and quantity or wetland, riparian, littoral, shallow water habitats, and invasive species affected would help inform a decision on the need for protection and/or control of these resources in the license.

Proposed Methodology

The PAD currently contains maps portraying general wetland types from the Cabot Station tailrace upstream to the Vernon Dam. In addition, the the detailed bathymetry exists for the Turners Falls impoundment. The proposed study should utilize this existing information in conjunction with field surveys designed to describe the characteristics of each mapped wetland, riparian, littoral and shallow water habitat including plant species composition, relative abundance/density, habitat quality, and land use. These surveys should be conducted to describe these habitats at the lowest water level operational range permitted on a daily operation schedule, under low flow conditions. Information collected should include:

- Plant species composition, and their relative abundance/density and condition/structure (e.g., seedlings);
- Structured data, including estimates of average heights and aerial cover of each vegetation layer (specifically denoting invasive species);
- Aquatic habitat substrate composition, quantity (i.e., percent types and area), wood structure (relative abundance measure applied by area), water depths (inundated, exposed, and water less than one foot);
- Predominate land use(s) associated with each cover type;
- Wildlife sightings should be noted;
- Field verified wetland, riparian, and littoral and shallow water habitats and invasive species occurrences, should be geo-referenced as polygons and overlain on orthophoto at a suitable scale.

Level of Effort and Cost

In the PAD, First Light identified impacts of the project operations on wetlands, riparian and littoral zone habitat as a potential issue to be addressed in relicensing, and proposed wetland vegetation mapping. However, additional analysis as described above is needed to understand the impacts of the project on these resources and habitats.

A wetlands, riparian, littoral/shallow water, invasive species inventory, of the scope envisioned, would likely require 6-8 months to complete and cost $40,000 to $50,000.

Literature Cited:

Atlantic States Marine Fisheries Commission. 2009. Atlantic coast diadromous fish habitat: A review of utilization, threats, recommendations, for conservation, and research needs. Habitat Management Series #9. Washington, D.C.

Study Request 23. Entrainment of Migratory and Riverine Fish from the Connecticut River into the Northfield Mountain Pump Storage Project.

Goals and Objectives

The goal of the study is to determine the impact of Northfield Mountain Pump Storage Project (NFMPS) during the pumping cycle on entrainment of juvenile American shad, adult shad, adult American eel, and riverine fish, including early life stages.

The objective of the study is to quantify the number of resident and migratory fishes entrained at the NFMPS intake on an annual basis in order to evaluate potential impacts to riverine fish populations in the Turners Falls pool and diadormous fish migrants moving through the project area. This will be accomplished through a combination of hydroacoustic monitoring and netting using various gear types to quantify and identify species of different life stages.

Relevant Resource Management Goals

Not applicable, requester is not an agency or Indian tribe.

Public Interest Consideration If Requester Is Not A Resource Agency

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. Fish and their habitats are important public resources. There is a strong public interest in protecting and conserving fish and their habitats. This study will determine the impact of Northfield Mountain Pump Storage Project (NFMPS) during the pumping cycle on entrainment of juvenile American shad, adult shad, adult American eel, and riverine fish, including early life stages. Specifically, this study will quantify the number of resident and migratory fishes entrained at the NFMPS intake on an annual basis in order to evaluate potential impacts to riverine fish populations in the Turners Falls pool and diadormous fish migrants moving through the project area.

Existing Information and Need for Additional Information

Limited project-specific information exists regarding entrainment of fish and aquatic organisms at the NFMPS. As part of a Memorandum of Agreement between then-owner Northeast Utilities Service Company (NUSCO) and regulatory agencies, NUSCO conducted studies to determine the impact of NFMPS on anadromous fishes, including Atlantic salmon, American shad, and blueback herring. Results of a pilot study conducted in the fall of 1990 indicated that trap netting at the intake was ineffective at collecting fish. Gill netting and boat-shocking did result in collection of some juvenile shad, but further refinement in both methods was recommended to improve effectiveness. A total of 78 fish were collected at the intake (77 of which were American shad) by gill netting and 11 shad were collected by boat electrofishing. Hydoacoustic monitoring was deemed an effective method for monitoring entrained fish during pumpback operation. Hydroacoustic sampling over a two-week period (September 12-27, 1990) produced hourly entrainment estimates that cumulatively equaled 14,816 fish.

Based on the results of the pilot study, NUSCO developed a two-year plan to quantitatively determine the number of shad and salmon entrained at NFMPS station. In 1992, an entrainment study targeting juvenile American shad life stages was conducted in the lower (mainstem river) and upper reservoirs of NMPS. The study used several gear types to quantify egg through juvenile shad densities in different areas. Entrained juveniles were sampled using an upper reservoir net. Pumping operations were modified to only run three (77% of sample time) and sometimes two (23% of sample time) of the station's four units during the study and effort was limited to a total of 80 hours over a period spanning 9 August through 27 October (80 days). An estimated total of 1,175,900 shad eggs, 2,744,000 yolk-sac larvae, 10,525,600 post yolk-sac larvae, and 37,260 juveniles were reported entrained.

There are no reliable data on the timing, magnitude and duration of entrainment of larval riverine fishes in the NFMPS area. Unlike anadromous shad and river herring, riverine species occurrence and susceptibility relative to space and time exposure windows to NFMPS pumping, are undocumented. The complete lack of any long-term fish population monitoring data for riverine species in the Turners Falls impoundment leaves questions unanswered on the types and extent of impacts to these populations that may be linked to the near daily cycling of river water up and down through the NFMPS operations system. As a starting point, it is necessary to obtain baseline data on project operation impacts for all species potentially impacted by NFMPS. An additional study request seeks to obtain a more accurate documentation of all fish species inhabiting or utilizing the Turners Falls impoundment.

Nexus to Project Operations and Effects

Entrainment of fish and aquatic organisms associated with water withdrawal and hydroelectric operations has been documented to result in injury or death of entrained organisms. Migratory and resident fish pass through the project area directly in front of the pump intakes. These organisms may be entrained and thus exposed to passage though the project pumps and reservoir supply tubes. How far from the intake these species and life stages may be drawn into the intake on a pumping cycle or how susceptible they are to the repeated daily cycles of pumping and discharge, and how these factors vary in relation to habitat and river conditions are unknown. Survival of fish subjected to entrainment on the pumping cycle is unknown, but regardless of whether fish survive the pumping process, they are lost to the Connecticut River system. Depending on the species, life stages, and numbers entrained, this loss could impact the ecosystem productivity of the Turners Falls pool and may hinder restoration goals for diadromous fishes.

Previous entrainment studies have been conducted at the project. Those studies, which were done 20 years ago, documented entrainment of American shad and Atlantic salmon at the project, including over 13 million yolk sac and post-yolk sac larvae of American shad. This level of entrainment is cause for concern, not only due to the resultant loss of potential adult returns, but for the important role early life history phases and juveniles play in their ecological contributions to the river system (e.g., trophic interactions).

No entrainment studies for other species of fish have been conducted at the project. The unknown extent of other riverine species ichthyoplankton entrained by the NFMPS requires evaluation. Studies conducted in 1969 and 1970 at the Muddy Run Pumped Storage Station documented significant entrainment of eggs and larval fish. In June and July of 1970, 5.3 million eggs and 56.6 million larvae were entrained (Snyder 1975). Muddy Run and NFMPS are of a similar size and both use a river as the lower reservoir. It is anticipated that a considerable number of eggs and larvae will be entrained by the NFMPS.

Since the previous studies were conducted, operations at the NFMPS facility have changed (e.g., the project increased the efficiency of its turbines, and raised the pumping capacity from 12,000 cfs up to 15,000 cfs), as have river conditions (e.g., Vermont Yankee has increased its thermal discharge and the Vernon Project has increased its station capacity). Further, the PAD indicates that FirstLight will evaluate the feasibility of utilizing an additional 3,009 acre-feet of storage capacity to generate an additional 1,990 MWhs (this represents a 23% increase over existing storage and stored generation levels). While not specified in the PAD, increasing storage and generation would mean longer periods of both pumping and generation at NFMPS. In addition, anticipated improvements in fish passage at the

Turners Falls Project will result in increased juvenile production above the NFMPS. These factors, individually or cumulatively, could increase the potential for entrainment at NFMPS station.

Proposed Methodology

Previous studies used varying methodologies for determining entrainment. The 1990 study concluded that hydroacoustic monitoring at the intake was a viable method for determining entrainment of later life stages, but does not allow for identification of the species being entrained. While trap netting was ineffective at collecting fish near the intake, gill netting and boat shocking did capture some fish. Both may prove to be viable sampling methods; however it is likely that additional testing and gear refinement will be necessary.

The 1992 study used nets at the pump discharge location into the upper reservoir to collect entrained fish. Testing showed that this method was only 10% efficient. Plankton netting in the nearfield area of intake was used to estimate entrainment of ichthyofauna. It is likely that a combination of methods would provide the most reliable results (e.g., hydroacoustic monitoring at the racks during pumpback operations, variable gear sampling in the vicinity of the intake immediately prior to initiation of pumpback operations to determine species composition, and plankton netting in the nearfield area of the intake to obtain information on entrainment of ichthyofauna). As these methodologies have previously been utilized at the site, they are consistent with accepted practice.

Although a previous entrainment study was conducted, we believe it should be repeated, using a modified study design. The 1992 study only collected a total of 330 juvenile shad over a three-month period (resulting in an overall estimate of 37,260 juveniles entrained, after accounting for poor net efficiency); whereas the hydroacoustic study conducted in 1990 estimated nearly 15,000 fish in 15 days (while these fish were not identified, 77 of the 78 fish collected at the intake during the study were juvenile shad). It also should be noted that in the 1992 study, juvenile shad were collected on the first day of sampling, indicating that the sampling did not begin early enough, which would mean the results are an underestimate of the number of juvenile shad that were actually entrained. In 1990, 27,908 adult shad passed the Turners Falls gatehouse, while in 1992 over 60,000 shad passed gatehouse. The fact that the numbers entrained were so variable between study years argues for repeating the study, using a combination of previously-used methodologies.

The study will require deployment of at least five hydroacoustic transducers (one per rack face and one offshore). These transducers would be operated during every pumping cycle from April 15 through May 14 to assess riverine fish entrainment, from May 15 through July 15 for spent adult shad, and from July 16 through November 30 for entrainment of adult silver eels, juvenile American shad, and riverine fishes. Concurrent field sub-sampling at the intake to determine species composition would need to occur.

Sampling for planktonic fish larvae should capture early spring spawning species (white suckers) through later season centrarchid species (bass and sunfish). Active plankton trawl surveys should utilize a sampling design that adequately captures temporal and spatial changes in water pumping cycle (i.e., early start-up is local water, later cycle pumping is drawn in from both upstream and downstream habitat areas).

Level of Effort and Cost

We know of no other tool that will provide for this type of assessments for all fish species and organisms that may pass through the project. Cost and effort are expected to be high.

The applicant did not propose any studies to meet this need in the PAD.

References

CRASC. 1992. A Management Plan for American Shad in the Connecticut River.

Harza Engineering Company. 1991. Draft Northfield Mountain Pumped Storage Project 1990 Field Sampling Program. February 1991. Northeast Utilities Service Company, Berlin, CT.

Lawler, Matusky and Skelly Engineers (LMS). 1993. Northfield Mountain Pumped-Storage Facility – 1992 American Shad Studies. February 1993. Northeast Utilities Service Company, Berlin, CT.

Memorandum of Agreement NUSCO. July 1990.

Snyder, D.E. 1975. Passage of fish eggs and young through a pumped storage generation station. J. Fish Res. Board Canada. 32: 1259-1266.

Requested Study 24. Impacts of Turners Falls Canal Drawdown on Fish Migration and Aquatic Organism Populations

Conduct a study to quantify impacts of the annual Turners Falls Canal drawdown on emigrating and resident fishes, freshwater mussels, state-listed dragonfly larvae, and mudpuppies in the canal.

Goals and Objectives

Quantitatively assess the effects of the Turners Falls Canal drawdown on diadromous fishes and other aquatic organisms known to be present in the canal during the annual drawdown.

Objectives of this study request include:

- Determine whether juvenile shad and American eel abundance in the canal increases leading up to the time of its closure, due to delays in downstream passage (e.g., is fish accumulation occurring?)
- Determine level of mortality for juvenile sea lamprey from exposure of burrow habitats;
- Conduct surveys to determine aquatic organisms (fishes, freshwater mussels, state-listed dragonfly larvae, and mudpuppies) present in the canal during the drawdown, their densities, status (stranded, dead, alive), and locations (mapping to document habitat, substrate type, wetted , at complete drawdown);
- Evaluate measures to minimize aquatic organism population impacts of the canal drawdown.

Other submitted Study Requests compliment or directly relate to this project activity and assessing project effects, including the resultant effects of all river flow being passed over the Turners Falls Dam as spill (e.g., downstream juvenile shad study request and American eel movement and survival request).

Relevant Resource Management Goals

Not applicable, requester is not an agency or Indian tribe.

Public Interest Consideration If Requester Is Not A Resource Agency

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. Fish, wildlife, plants, and their habitats are important public resources. There is a strong public interest in protecting, conserving, and enhancing these resources for public benefit, including wetlands, endangered species, and migratory species. This study will quantify impacts of the annual Turners Falls Canal drawdown on emigrating and resident fishes, freshwater mussels, state-listed dragonfly larvae, and mudpuppies in the canal.

Existing Information and Need for Additional Information

Existing information in the PAD does not provide data on the population size or survival rates of juvenile American shad, American eels, or juvenile sea lamprey located in the power canal during the de-watering process. The power canal is dewatered in early September of each year for over a one week period to perform facility maintenance, inspections, and repairs including substantial silt removal and bank repairs. Historically, the canal drawdown occurred in July, but approximately five years ago it was moved to September, where it has occurred annually since then, with the exception of 2010. The shift to September was at the request of the Independent System Operator –New England (ISO-NE) to avoid peak load months of June through August. Studies conducted by the previous operator, Northeast Utilities Service Company (NUSCO), to assess downstream clupeid survival and use (1991 and 1994 studies at Cabot Station) support the contention that juvenile shad out-migration is occurring within the current drawdown time frame. There are no data to suggest that out-migration would occur earlier than 1 August, but likely does begin in the month of August (O'Donnell and Letcher 2008). Based on these data, CRASC altered its Fish Passage Notification Letter for Downstream Passage Operations for juvenile shad and herring to require the Cabot Station downstream bypass to begin operating on 15 August in 2010 and then moved the date to 1 August in 2011.

It is unknown, whether the power canal may, through potential mechanism(s) of delay due to its configuration or operation, cause out-migrating juvenile shad to accumulate in the canal. This information gap leads to concerns that migrant numbers may be elevated beyond simple extrapolations of surface area comparison in the canal to main stem habitat. In the PAD, FLP indicates that the Cabot Station forebay in the vicinity of the intake has a maximum depth of 60 feet, while the existing near-surface downstream bypass structure at the Cabot Station is designed to operate only within a depth of six feet of the surface. As a result, the downstream bypass only operates effectively for a short period during the drawdown period (timing of this is unknown). The only points of egress, once the bypass becomes unavailable, are through the turbines at Cabot as well as at Station 1, and eventually at the Keith Street gate located well upstream from the Cabot Staion intakes. It is unknown what the survival rates are for these passage routes, what proportion of fish are using each route, what number may become stranded and their survival rates, and how many fish are subjected to this situation. The related Study Requests on downstream juvenile shad outmigration and American eel outmigration outline objectives that would address some of these information gaps.

There is also a paucity of information relative to the disposition of fish moving downstream in the impoundment during the canal drawdown. Once the Turners Falls Gatehouse closes its gates, all inflow passes over the dam; a situation unique to this brief one week annual time period. Survival rates for outmigrating juvenile American shad and adult American eel moving past the project during the period of spill are not known.

Lastly, there exists an information gap regarding the fate of juvenile sea-lamprey (known as ammocetes) that reside in the soft substrate materials located in much of the lower or downstream end of the canal (personal communication, Boyd Kynard). In previous drawdowns, thousands to tens of thousands of desiccated ammocetes have been observed (Matt O'Donnell, personal communication, USGS Conte Lab). However, the distribution and abundance of ammocetes in the canal as well as mortality rates for ammocetes during the drawdown period has not been quantitatively determined.

Nexus to Project Operations and Effects

Previous studies at Cabot Station have documented that juvenile American shad and American eel migrate through the project area during the canal drawdown period. During normal operations (where canal water level elevations are stable), downstream migrants are able to utilize the Cabot bypass facility; however, as the canal water level is drawn down, the bypass is no longer available, and the only routes of egress are through the turbines at Cabot Station and Station 1, unless the Cabot Station spill gates are utilized (the spill gates have a canal depth limitation of approximately 16 feet). Turbine entrainment at hydropower projects has been shown to cause injury and mortality to fishes.

The annual canal drawdown was formerly conducted in July. In response to ISO-NE's request that FL conduct the drawdown outside of the June through August period, FL moved the drawdown to a period of time when diadromous fishes are known to be moving through the project area.

Once the canal has been drawn down, isolated shallow pools are left standing until the canal is refilled. During this period, fish (including lamprey ammocetes), amphibians, and benthic invertebrates are prone to desiccation, predation or other sources of mortality or impact.

Proposed Methodology

The methods presented here are consistent with the study requests addressing downstream juvenile American shad passage and downstream American eel passage, with an emphasis on addressing survival and movement immediately prior to and during the canal draw down. Hydroacoustic monitoring immediately upstream of the Turners Falls Gatehouse, as well as upstream of opened dam gates for spill, will provide data on the timing, frequency and magnitude of natural wild juvenile shad movement into these areas, particularly the power canal. The abundance of juvenile shad moving into the canal can be derived and compared with similar data obtained with hydroacoustic equipment monitoring upstream of the Cabot Station intake and bypass, for comparisons. Juvenile shad will be PIT tagged, released, and monitored in the canal, for movements, timing and location including Station 1 canal and forebay. PIT tagged fish will be detected at the Cabot Bypass Sluice sampler. Juvenile fish should be specifically targeted for release immediately prior to drawdown to assess survival and movement in and through the canal. Surveys of sea lamprey ammocetes should be conducted by a stratified sampling design based upon substrate.

Lamprey density surveys, immediately after drawdown and in a subsequent later survey, may derive rates of change in observed densities and their status (live, moribund, dead); appropriate methods would need to be discussed. Surveys of remaining ponded water should be conducted immediately following drawdown and at later intervals (mid- week and end of week) to compare species occurrence and densities (relative abundance) which will be used to develop catch-curve analyses that can inform rates of mortality to the observed populations.

Assessments of freshwater mussels should also be conducted to quantify drawdown impacts. As with lamprey, the assessment can be based on sampling identified habitats in a stratified, random design, over the three time periods noted (initial drawdown, mid week, and end of week), tracking changes in densities and status of observed individuals among areas. Sub-sampling, with sufficient repeated measures to determine variability and acceptable level of precision of data will inform the required sampling intensity that will be needed. This sampling intensity will be determined as the study occurs and may vary among identified species. Comparisons among the three time periods for measures of density and status will inform the evaluation of project effects for juvenile shad, sea lamprey ammocetes, freshwater mussels and mudpuppies.

The canal drawdown mitigation assessment involves evaluating alternative drawdown protocols to minimize impacts to resident and migratory fish, mussels and amphibians inhabiting the canal. Alternatives should include: (1) moving the drawdown to a time of year outside of migration seasons; (2) keeping or moving the timing of the drawdown, but utilize technologies to keep the majority of the canal wetted during the drawdown (e.g., portadams in the forebay immediately upstream of the trashracks and at other canal intakes in need of maintenance); and (3) in combination with alternative #2, assess whether other existing infrastructure within the forebay could be used to pass fish safely out of the canal (e.g., low level outlets, deep gates, side spillway boards, etc.). The assessment should compare the merits and drawbacks of each alternative and provide an order of magnitude cost estimate for implementation.

Level of Effort and Cost

This Study Request has many elements that overlap directly with a larger scale downstream juvenile American shad passage and downstream American eel passage study requests. With equipment costs principally covered in those requests, many components of what has already been proposed will be used in this study. However this request does include some specific elements not specified in the other two larger requests. The study cost and effort are expected to be low to moderate. Some additional radio tags and balloon tags with additive days of field work to accurately assess impacts specific to the drawdown period will be required. Surveys for identified aquatic organisms will take several days during the drawdown period as well.

The canal drawdown mitigation assessment should require a low to moderate level of effort and cost. One staff person would evaluate alternative drawdown protocols. This should take less than one week to complete.

The applicant did not propose any studies to meet this need in the PAD.

Literature Cited:

O'Donnell, M and B. H. Letcher. 2008. Size and age distributions of juvenile Connecticut River American shad above Hadley Falls: influence on outmigration representation and timing. River Research Applications #24: 929-940.

Study Request 25. Evaluate the frequency and impact of: 1) emergency water control gate discharge events and: 2) bypass flume spill events, on shortnose sturgeon spawning and rearing habitat in the tailrace and downstream from Cabot Station

This evaluation should directly address the impact of sediment disturbance and excessive velocities on habitat in Cabot Station tailrace and downstream resulting from emergency water control gate discharge events and bypass spill events and effects of spill from the downstream fish bypass sluice on shortnose sturgeon spawning and incubation.

Goals and Objectives

The goal of this study is to determine appropriate scenarios for operation of the emergency water control gates and bypass flume that will be sufficiently protective of shortnose spawning and rearing below Cabot Station from excessive water velocities and exposure to abrasive sediments dislodged and transported across spawning and rearing areas. Furthermore, avoidance or minimization of rapid fluctuations in flow is also a goal of this study applicable to the operations of the emergency water control gates and bypass flume.

The objective of the study will be to determine how often the emergency water control gates are operated to discharge large quantities of water and evaluate the impact of these events on sediment transport and bottom velocities within known shortnose sturgeon spawning and rearing habitat below Cabot Station. Another objective is to understand the operation of the bypass flume that result in bypass flume spill events and evaluate the impacts of these spill events on sediment transport and bottom velocities within known shortnose sturgeon spawning and rearing habitat below Cabot station. Even when bottom velocities fall within the range optimum for shortnose sturgeon spawning, rapid fluctuations may result in sediment transport having a harmful impact on developing eggs and embryos.

Specific Objectives include:

- Emergency water control gate discharge events
    - Field verification during operation of the emergency water control gates during a range of spill and discharge conditions is necessary during years 2014 and 2015 if emergency water control gates will continue to be operated during shortnose sturgeon spawning and rearing (April 15th –June 22nd).
        - Collection of sedimentation and bottom velocity data during 2014 and 2015 is necessary to verify proposed alternative operation scenarios for the emergency water control gates that will avoid or minimize negative impacts to spawning and rearing habitat.
- Bypass flume spill events
    - Field verification during bypass flume spill events under a range of spill and discharge conditions is necessary during years 2014 and 2015 if bypass flume spill events continue to be a part of future project operations and will occur during shortnose sturgeon spawning and rearing (April 15th and June 22nd).
        - Collection of sedimentation and bottom velocity data during 2014 and 2015 is necessary to verify proposed alternative operation scenarios for the bypass flume that will avoid or minimize negative impacts to spawning and rearing habitat.

Relevant Resource Management Goals

Not applicable, requester is not an agency or Indian tribe.

Public Interest Consideration If Requester Is Not A Resource Agency

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. Fish and their habitats are important public resources. There is a strong public interest in protecting and conserving fish and their habitats. This study aims to assess current emergency water control gate bypass flume operations and associated impacts to determine potential operation scenarios that avoid or minimize negative effects on shortnose sturgeon spawning a rearing.

Existing Information and Need for Additional Information

The emergency water control gates are used to spill large amounts of water and Cabot Station also spills water from the bypass flume (Kynard et al. 2012, chapter 3, Kieffer and Kynard 2007). These large spill events created a plume of turbid turbulent flow, which caused some females to leave the area (Kynard et al. 2012, chapter 3, Kieffer and Kynard 2007). Additional spill events create a scour effect on the bottom and the scoured sediments are then pushed downstream over, or deposited on spawning and rearing shoals where an entire years class of ELS may be destroyed (Kynard et al. 2012, chapter 3, Kieffer and Kynard 2007). Information included in the PAD does not address operation of the emergency water control gates or bypass flume and impacts on shortnose sturgeon spawning and rearing.

Nexus to Project Operations and Effects

The large and rapid changes in flow releases from hydropower dams are known to cause adverse effects on habitat and biota downstream of the project. One of the two critical shortnose sturgeon spawning and rearing areas in the Connecticut River is located within the Cabot Station tailrace and impacted by the project's discharges, including spill from the emergency water control gates and bypass flume. This section of the Connecticut River also contains habitat that supports important spawning and rearing areas for migratory fish such as American shad and American eel. Current operations of the emergency water control gates and bypass flume create flow dynamics that are not sufficiently protective of shortnose sturgeon spawning and rearing. Results of this study will be used to determine recommendations for operation of the emergency water control gates and bypass flume that will avoid or minimize sedimentation and improve bottom velocities that are sufficiently protective of shortnose sturgeon spawning and rearing.

Proposed Methodology

River hydrology modeling is commonly employed at hydroelectric projects to assess implications of project operations on the river environment. It is assumed that the planned hydrologic modeling can incorporate emergency water control gate operations and associated impacts. Thus, an additional model would not be required for this request.

Field assessment will be needed to collect sedimentation and bottom velocity data at the emergency water control gates and fish bypass sluice discharge areas to determine what operational scenarios of those structures avoid or minimize impacts to shortnose sturgeon spawning and rearing. Velocity gauges will be employed to collect data on bottom velocities associated with project operations at Cabot Station. Coordination of gauge placement for this request with the field measurements for the instream flow study should help minimize the number of necessary gauges. Field assessment of sedimentation may be collected using a variety of techniques. One potential method of collection of sedimentation data would be to set fine-mesh nets similar to shortnose sturgeon larval collection nets; these nets may show changes in the amount of dislodged substrate material that travels along the spawning site as a result of powerful releases at both the Cabot spillway and bypass flume.

Level of Effort and Cost

Field verification for this study request will likely be coordinated with other field work for related study requests. It is not expected that the required field work for this request will result in significant additional cost and effort beyond what is expected for field work related to the instream flow study request. Post-fieldwork data analysis would be a moderate cost and effort. We anticipate that the level of effort and costs will be comparable to that experienced on similar FERC relicensing projects of this size (e.g., the Conowingo Project, FERC No. 405).

Study Request 26. Feasibility of New Portage Route Around Turners Falls Dam and Improved River Access Point Downstream of Turners Falls Canal

The current portage at Turners Falls requires making a phone call to the power company and getting driven several miles to the Poplar Street access point. This type of portage, one that relies on the power company and vehicle transport, is inconvenient, and may diminish the experience of some boaters who wish to make their portages under their own power. In addition, the Poplar Street access has very limited parking, is located in a quiet dead-end street neighborhood in which the residents seem to want to keep it quiet rather than busy with paddlers, and the slope down the bank from the parking area to the shore is very steep. The bank may be so steep as to be essentially inaccessible to some potential users.

Alternative locations should be evaluated, such as re-configuring the gates at Cabot Street and allowing parking and river access there, or evaluating buying land for suitable river access nearby.

Goals and Objectives

The goals of this study request are to explore a viable walking portage around the Turners Falls dam and to investigate alternative locations to or make significant improvements at the Poplar Street access.

Relevant Resource Management Goals

Not applicable, requester is not an agency or Indian tribe.

Public Interest Consideration If Requester Is Not A Resource Agency

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. When reviewing a proposed action, the Commission must consider the environmental, recreational, fish and wildlife, and other non-developmental values of the project, as well as power and developmental values. The Connecticut River is a public resource that among many public values offers a place of recreation for boaters. The public has a strong interest in having safe, accessible, and convenient access to the river for boaters and others, and having convenient portages around dams. This study seeks to addresses the significant limitations at the Poplar Street access through exploring potential alternative nearby access points or making improvements at the Poplar Street access point, and it seeks to explore a viable walking portage around the Turners Falls dam.

Existing Information and Need for Additional Information

FirstLight's predecessor company, Northeast Generating Services, hired the Conway School of Landscape Design to recommend improvements to the Poplar Street boat ramp in 2004 or 2005 or so. To our knowledge, none of these improvements ever happened. We know of no other information or plans for addressing the significant limitations at the Poplar Street access point.

Nexus to Project Operations and Effects

The Turners Falls dam is an obstacle for paddlers and boaters who are traveling past the dam. The power company is required to provide portage around the dam and, in our opinion, the current system presents problems that can be significantly improved.

Proposed Methodology

- Analyze options for a walkable route around Turners Falls Dam on either side of the river. Provide cost estimates, security issues, safety issues, historical issues, if applicable. Explore the possibility of dovetailing with re-establishing a historic walking route along the river.
- Provide an assessment of paddle routes in the bypass reach and the level of difficulty of these routes.
- Assess possible improvements at Poplar Street access point, including the Conway School recommendations and buying land to expand parking.
- Evaluate alternative locations to Poplar Street access, including but not limited to, re-configuring the gates at Cabot St and allow parking and river access, or buying land elsewhere.

Level of Effort and Cost

This is largely a desktop exercise and costs would be minimal, in the few thousand dollar range.

Stefanie Krug, Greenfield, MA.
NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT
(FERC NO. 2485-063)

Northfield Mountain, site of the pumped storage hydroelectric facility owned and operated by FirstLight Hydro Generating Company, is an integral part of Franklin County. It currently boasts over 26 miles of shared-use trails that are loved by many for summertime activities ranging from hiking, trail running and mountain biking to rock climbing and horseback riding. In the winter, the cross country skiing is some of the best in New England (if there’s snow). Beautiful scenery, impressive lookouts and a combination of green meadows, deep forests, bubbling streams, ledges and rock features give this park its unique character that attracts visitors from near and far.

The 26 miles of trail consist of a combination of unpaved roads, double track and single track shared-use trails. At the time the last license was issued for Northfield Mountain, mountain biking was still a fairly young sport but it has gained popularity ever since and now represents 20% of all outdoor recreation in the US [1]. A 2006 survey revealed that more than 1 million Massachusetts residents mountain bike [2]. While Northfield Mountain allows mountain biking, the trails were designed for activities like hiking, horseback riding and snowshoeing, and strategic addition or alteration of some of the existing trails would greatly improve the riding. In addition, the science of sustainable, low-impact, low-maintenance trail design has come a long way over the past forty years. Given the importance of mountain biking to the Franklin County community, it should be integrated into the new license, and a study evaluating the trail system at Northfield Mountain should be conducted as part of the pre-license proceedings.

The variety of terrain, pitch and naturally occurring features at Northfield Mountain make it a perfect candidate for an exciting, well-balanced trail system of beginner, intermediate and expert shared-use trails. The National Scenic Trail crosses Northfield Mountain, connecting Northfield to other area trail networks. Northfield Mountain’s proximity to major highways, the spacious lodge and abundance of parking add to its appeal, and with all these pieces in place Northfield Mountain could be developed into a supreme outdoor recreation destination. Outdoor recreation in the United States is an almost $700 billion industry, and despite the economic recession has grown about 5% annually between 2005 and 2011 [3].   The US Department of Agriculture Economic Research Report found that recreation and tourism development contributes to rural well-being, increasing local employment, wage levels, and income, reducing poverty, and improving education and health [4]. If Northfield Mountain was developed into an outdoor recreation destination it could bring a substantial, sustainable inflow of cash to the Pioneer Valley. The area surrounding Kingdom Trails in East Burke, VT has greatly benefitted from visiting mountain bikers, with approximately $5 million spent by Kingdom Trail visitors in 2011 [5]. The impact tourism could have on the socioeconomic state of the region makes this project a high priority of public concern.

Thank you for your time and for taking our comments into consideration. Please contact me at any time.

Sincerely,

Stefanie Krug
President, New England Mountain Biking Association (NEMBA), Pioneer Valley Chapter
pvnemba@gmail.com

References:

[1] Outdoor Industry Foundation. 2004. The Active Outdoor Recreation Economy. Boulder, CO.
[2] Outdoor Industry Foundation. 2006. Outdoor Recreation Participation & Spending Survey. A State-by-State Perspective.
[3] Outdoor Industry Foundation. 2012. The Outdoor Recreation Economy. Boulder, CO.
[4] US Department of Agriculture. 2005. Economic Research Report ERR-7.
[5] boston.com: http://www.boston.com/news/local/vermont/articles/2012/06/10/mountain_bikers_flock_to_northeast_vermont/

Stefanie Krug, Greenfield, MA.
Over the past few years, deep water bars have been dug diagonally across the 10th Mountain road at Northfield Mountain to help with drainage. These water bars have been challenging to negotiate on a bike or on horseback from the beginning, and I have personally witnessed two accidents that resulted in extensive road rash, bruising, whip lash and concussion-like symptoms. After these accidents, the water bars have been dug out even further, making traveling on 10th Mountain extremely dangerous. For public safety, the condition of this trail should be carefully assessed and alternative drainage solutions considered (i.e., underground water pipes).

NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT
(FERC NO. 2485-063)
Letter of Support for Study Request (Accession No. 20130301-5029)

Dear Federal Energy Regulatory Commission,

Northfield Mountain, site of the pumped storage hydroelectric facility owned and operated by FirstLight Hydro Generating Company, is an integral part of Franklin County. It currently boasts over 26 miles of shared-use trails that are loved by many for summertime activities ranging from hiking, trail running and mountain biking to rock climbing and horseback riding. In the winter, the cross country skiing is some of the best in New England (if there's snow). Beautiful scenery, impressive lookouts and a combination of green meadows, deep forests, bubbling streams, ledges and rock features give this park its unique character that attracts visitors from near and far.

The 26 miles of trails consist of a combination of unpaved roads, double track and single track shared-use trails. At the time the last license was issued for Northfield Mountain, mountain biking was still a fairly young sport but it has gained popularity ever since and now represents 20% of all outdoor recreation in the US[1]. A 2006 survey revealed that more than 1 million Massachusetts residents mountain bike[2]. While Northfield Mountain allows mountain biking, the trails were designed for activities like hiking, horseback riding and snowshoeing, and strategic addition or alteration of some of the existing trails would greatly improve the riding experience. In addition, the science of sustainable, low-impact, low-maintenance trail design has come a long way over the past forty years. Given the importance of mountain biking to the Franklin County community, it should be integrated into the new license, and a study evaluating the trail system at Northfield Mountain should be conducted as part of the pre-license proceedings.

Trail conditions should also be assessed for safety hazards. For example, over the past few years, deep water bars have been dug diagonally across the 10th Mountain road at Northfield Mountain to help with drainage. These water bars have been challenging to negotiate on a bike or on horseback from the beginning, and I have personally witnessed two accidents that resulted in extensive road rash, bruising, whip lash and concussion-like symptoms. After these accidents, the water bars have been dug out even further, making traveling on 10th Mountain extremely dangerous. For public safety, the condition of this trail should be carefully assessed and alternative drainage solutions considered (i.e., underground water pipes).

The variety of terrain, pitch and naturally occurring features at Northfield Mountain make it a perfect candidate for an exciting, well-balanced trail system of beginner, intermediate and expert shared-use trails. The National Scenic Trail crosses Northfield Mountain, connecting Northfield to other area trail networks. Northfield Mountain's proximity to major highways, the spacious lodge and abundance of parking add to its appeal, and with all these pieces in place Northfield Mountain could be developed into a supreme outdoor recreation destination. Outdoor recreation in the United States is an almost $700 billion industry, and despite the economic recession has grown about 5% annually between 2005 and 2011[3]. The US Department of Agriculture Economic Research Report found that recreation and tourism development contributes to rural well-being, increasing local employment, wage levels, and income, reducing poverty, and improving education and health[4]. If Northfield Mountain was developed into an outdoor recreation destination it could bring a substantial, sustainable inflow of cash to the Pioneer Valley. The area surrounding Kingdom Trails in East Burke, VT has greatly benefitted from visiting mountain bikers, with approximately $5 million spent by Kingdom Trail visitors in 2011[5]. The impact tourism could have on the socioeconomic state of the region makes this project a high priority of public concern.

We anticipate that the assessment of the interest and need for mountain bike trails at Northfield Mountain could be included in other proposed studies to assess the recreational offering at Northfield Mountain using standard survey methods for needs assessment. We would gladly collaborate and assist in outreach efforts for survey information from our membership.

Thank you for your time and for taking our comments into consideration. Please contact me at any time.

Sincerely,

Stefanie Krug

President, New England Mountain Biking Association (NEMBA), Pioneer Valley Chapter

pvnemba@gmail.com

References:

[1] Outdoor Industry Foundation. 2004. *The Active Outdoor Recreation Economy.* Boulder, CO.
[2] Outdoor Industry Foundation. 2006. Outdoor Recreation Participation & Spending Survey. A State-by-State Perspective.
[3] Outdoor Industry Foundation. 2012. *The Outdoor Recreation Economy.* Boulder, CO.
[4] US Department of Agriculture. 2005. *Economic Research Report* ERR-7.
[5] boston.com: http://www.boston.com/news/local/vermont/articles/2012/06/10/mountain_bikers_flock_to_northeast_vermont/

FEDERAL ENERGY REGULATORY COMMISSION
Washington, DC 20426
March 1, 2013

OFFICE OF ENERGY PROJECTS

Project No. 1889-081 – Massachusetts
Project No. 2485-063 – Massachusetts
FirstLight Hydro Generating Company

Mr. John S. Howard
Director - FERC Hydro Compliance
FirstLight Hydro Generating Company
Northfield Mountain Station
99 Millers Falls Road
Northfield, MA 01360

Subject: Identification of PAD Deficiencies, Additional Information Requests, and Study Requests

Dear Mr. Howard:

After reviewing the Turners Falls Project and Northfield Mountain Pumped Storage Project Pre-Application Document (PAD) and the transcripts of our January 30 and 31, 2013 scoping meetings, we determined that there are some deficiencies in the PAD. We also have determined that there is a need for additional information and study requests in order to gain information necessary for our preparation of environmental documents.

We identify the PAD deficiencies and existing additional information needs in the attached Schedule A, and we provide our study requests in the attached Schedule B. Please provide the deficiencies and additional information requested in Schedule A when you file your proposed study plans, on or before April 15, 2013. The last part of Schedule A includes comments on the PAD which should be used during the preparation of the Preliminary License Proposal and the License Application. Please note that if you propose any plans for measures to mitigate project impacts, drafts of those plans should be filed with the PLP and finalized and filed with the license application.

Finally, please note that we may determine a need for additional studies or information upon receipt and review of scoping comments/study requests and FirstLight Hydro Generating Company's proposed study plans.

The Commission strongly encourages electronic filings via the Internet in lieu of paper. See 18 CFR § 385.2001(a)(1)(iii) and the instructions on the Commission's website (http://www.ferc.gov) under the "e-Filing" link.

Commission staff will participate in your study plan meeting on Tuesday, May 14 and Wednesday, May 15, 2013, from 10 a.m. to 4 p.m. at the Northfield Mountain Visitor's Center, 99 Millers Falls Road, Northfield, MA, 01360. This meeting will be held to discuss your proposed study plans and study requests filed by the Commission, agencies, and other parties. Interested individuals are invited to attend and should contact John Howard at (413) 659-4489, or via email at John.Howard@gdfsuezna.com if they plan to attend.

If you have any questions, please contact Kenneth Hogan at (202) 502-8434 or via email at: kenneth.hogan@ferc.gov.

Sincerely,

Timothy J. Welch, Chief
West Branch
Division of Hydropower Licensing

Enclosures: Schedule A
Schedule B

cc: Mailing List
Public Files

Turners Falls Hydroelectric Project, Project No. 1889-081
Northfield Mountain Pumped Storage Project, Project No. 2485-063
Schedule A

PRE-APPLICATION DOCUMENT DEFICIENCIES, ADDITIONAL INFORMATION REQUESTS, AND COMMENTS

Based on our review of the Turners Falls Project and the Northfield Mountain Pumped Storage Project Pre-Application Document (PAD), we identified (a) some deficiencies in the PAD and (b) additional information that we require for continuing to process the relicensing of the project. Please file the requested supplemental information to resolve the deficiencies and responses to the additional information requests (AIRs) by April 15, 2013.

A. Deficiencies

Turners Falls and Northfield Mountain Pumped Storage Projects

1) Project Facilities and Operations

Please provide the dependable capacity of the Turners Falls Project and the Northfield Mountain Pumped Storage Project and the basis for the determination of the dependable capacity as required per § 5.6(d)(2)(iii)(E) of the regulations.

Please provide land use maps which include key features as required per § 5.6(d)(2)(ii) of the regulations.

2) Geology & Soils

The PAD describes the soils and occurrences; however, it does not provide descriptions of chemical characteristics, erodability and potential mass movement as required by section 5.6(d)(3)(ii)(B) of the Commission's regulations. Therefore, to the extent known, please provide a description of chemical characteristics, erodability and potential mass movement of soils in each project's area.

Additionally, section 5.6(d)(3)(ii)(C) specifies that the PAD provide information on the erosion within the project area. However, while the PAD provides information on erosion around the Turners Falls reservoir, it did not provide any information on the presence of erosion, mass soil movement, slumping or other forms of instability along the bypass reach or the project's power canal. Therefore, pursuant to section 5.6(d)(3)(ii)(C)(2) of the Commission's regulations please provide a description of all known erosion sites within the Turners Falls project's bypass reach and/or along its power canal, and to the extent known, a determination as to the cause of the erosion. The description of each site should include the length of shoreline affected by erosion, the height of the eroded area, and the soil type.

As specified in § 5.6(d)(3)(ii)(C), please provide a description of reservoir shorelines within the Northfield Mountain upper reservoir. The description should include a description of soils, geometry, and existing armoring and stabilization measures.

As specified in § 5.6(d)(3)(ii)(B), please provide a description of the sediment management in the Northfield Mountain upper reservoir, including monitoring, removal and disposal.

3) Water Resources

Please provide the Northfield Mountain upper reservoir maximum, minimum and mean depth as well as the shoreline length as required per § 5.6(d)(3)(iii)(H) of the regulations.

4) Recreation and Land Use

For Turners Falls Fishway Viewing Area and Bennett Meadow Wildlife Management Area (WMA) please address the ownership information as specified in § 5.6 (d)(3)(viii)(A).

5) Aesthetic Resources

The PAD did not provide information on the description of aesthetic and visual characteristics of the Turners Falls Project dam and adjacent facilities as required by § 5.6(d)(3)(ix). Please provide this information with accompanying photos (if available).

6) Cultural

Please provide a description of existing discovery measures for locating, identifying, and assessing the significance of resources as specified in § 5.6(d)(3)(x)(B).

Please provide available information on Indian traditional cultural and religious properties as specified in § 5.6(d)(3)(x)(C).

B. Additional Information Requests

Turners Falls Project

1) Proposed Changes to Project

In the PAD you identify alternatives you will consider through the licensing process for potential changes to facilities and operation of the Turners Falls Project including the following: (1) upgrade Station No. 1 with new or rehabilitated turbines, (2) close Station No. 1 and add a turbine generator at Cabot of similar hydraulic capacity to Station No. 1's, and (3) use the full hydraulic capacity of Cabot Station turbines. However, you do not describe the extent or range of the possible modifications to the hydraulic capacity of Cabot Station and Station No. 1. Therefore, so that we may fully understand and evaluate your proposal and determine the appropriate studies needed, please provide detail on the physical and operational changes contemplated at the Turners Falls Project.

2) Cultural Resources

In section 5.2.10 of the PAD you propose to conduct a Phase IA Archaeological Survey and Historic Structures Survey of the APE. You also indicate that FirstLight may propose to conduct a Phase IB archaeological and an intensive-level architectural level survey, depending on the results of the Phase IA investigation and after consultation with the Massachusetts, New Hampshire, and Vermont SHPOs. However, you have not provided a map specifically defining the APE, and we are unclear on how you would specifically carry out the various tasks involving your proposed study.

As a result, we ask you to include the following in your study proposal for cultural resources:[1]

a) Define an APE for the project that would include all lands enclosed by the project boundary including both in-water and on-shore project lands and facilities, and lands or properties outside the project boundary where project operations or other project-related activities may directly or indirectly cause changes in the character or use of historic properties, if any historic properties exist. Your study proposal should also include a record

[1] Include in your study proposal that you would also consult with the Vermont, Massachusetts, and New Hampshire SHPOs, and any involved Indian tribe or other interested parties in formulating each of the tasks listed below.

of consultation with the Vermont, Massachusetts, and New Hampshire SHPOs, involved Indian tribes, and other interested parties regarding the APE.[2] Include a detailed map showing all aspects of the APE, including designations of land ownership**.**

b) Include the specific techniques on how you would carry out the Phase IA investigation, in addition to any other methods (if needed) by which other cultural resources that may be directly or indirectly affected by the project will be inventoried. Your proposal should include methods for inventorying all archaeological and historic resources that may lie within the APE, including project facilities, non-project architectural resources, and properties of traditional religious or cultural significance.[3]

c) Develop and include in your study proposal a process for evaluating the National Register of Historic Places (National Register) eligibility of all cultural resources during the field inventory stage, and afterwards, through additional second season field investigations (if necessary)[4], including a strategy for examining, testing, or excavating cultural resources. This process should take into account applicable guidelines and standards promulgated by the Vermont, Massachusetts, and New Hampshire SHPOs.

d) Elaborate on what methods you would use to identify any existing project-related effects (both direct and indirect) on historic properties recorded during the field inventory, and determine how project operations may affect or potentially affect them.

e) Include in any study report: (1) a background section on previous work in and around the APE; (2) a culture history of the research area; (3) definition and map of the APE; (4) methods used for the archival research and field pedestrian survey and how the APE was systematically inventoried; (5) the results of the survey and detailed descriptions of the cultural resources

[2] Once you have defined your APE, send your APE definition and APE map to the Vermont, Massachusetts, and New Hampshire SHPOs and seek their concurrence. The APE definition and map should be included in your study proposal, along with a record of consultation.

[3] Attention should be given on the assessment of the Turner Falls Ceremonial Site and proposed Great Falls Native Cultural Park, and potential project-related effects to these places (see Town of Montague filing, dated February 6, 2013 and filed on February 20, 2013).

[4] If all National Register eligibility determinations cannot be done in either the first or second season of field investigations, a program to follow-up on completing all National Register eligibility determinations of properties located within the APE could be developed and included in the Historic Properties Management Plan (HPMP).

found (including a table depicting type of cultural resources, age, property location, and land ownership associated artifacts, existing and potential effects, and National Register eligibility status); (6) results of National Register evaluations for all cultural resources located within the APE;[5] and (7) site or resource specific descriptions of existing and potential project-related effects on cultural resources considered to be eligible for inclusion in the National Register. Put a statement in your study proposal you will also prepare a HPMP in consultation with the involved parties and will file a draft HPMP along with your preliminary licensing proposal, and a final HPMP with your final license application.[6] Among other things, the HPMP should provide site-specific measures to resolve any potential project-related adverse effect to historic properties located within the project's APE.[7]

f) Provide a schedule for carrying out all of the various tasks involving your study, including the filing of draft and final reports and HPMPs.

g) Provide estimated costs associated with the various tasks in your study, along with the costs of report production and crafting the HPMP.

3) Socio-economic

In PAD section 4.11.1., you cite a document referred to as "PVPC". However, you do not provide the complete citation. Therefore, so that we may fully understand the supporting documentation for the PAD, please provide the complete citation for the

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[5] In consultation with the involved parties, once you have determined which cultural resources may, or may not be eligible for the National Register, submit your evaluations to the Vermont, Massachusetts, and New Hampshire SHPOs (as applicable) for concurrence.

[6] Note that once the Commission finds the HPMP to be final, we would attach it to a programmatic agreement and after noticing the Advisory Council on Historic Preservation, we would execute the programmatic agreement with the Vermont, Massachusetts, and New Hampshire SHPOs, if the Advisory Council on Historic Preservation declines to participate. Execution of the programmatic agreement would evidence that the Commission has resolved any potential adverse effects to historic properties involved with the proposed project.

[7] You should use the Guidelines for the Development of Historic Properties Management Plans for FERC Hydroelectric Projects, developed by the Advisory Council on Historic Preservation and Commission in May 2002.

PVPC reference in PAD section 4.11.1. If this document is not readily available to the public please provide a copy of the document.

4) Recreation and Land use

In the PAD, the current project boundary maps are presented. However, it is difficult to discern ownership and extent of shoreline buffer from the maps and associated narrative in the PAD. Therefore, so that we may fully understand and evaluate your proposal and determine the appropriate studies needed, please describe the project boundary (i.e., is it a metes and bounds survey, and elevation contour, or some combination), and shoreline buffer (e.g., typical distance from normal reservoir elevation to the project boundary, vegetative cover types).

In the PAD, there is no information on the recreation facilities and public access and use on the unnamed island located to the west of the power canal and east of the bypassed reach of the Connecticut River. The PAD also lacks information regarding how access to the island may be restricted by project uses. During the scoping meetings, we learned that the island is accessible by two walkway bridges which are currently closed. Therefore, please provide information on the ownership and management of the walkway bridges, and an explanation of why the bridges are closed.

Northfield Mountain Pumped Storage Project

1) Proposed Changes to Project

In the PAD you propose potential changes to facilities and operation of the project including the following: (1) utilize more storage in the Northfield Mountain Project's upper reservoir and, (2) increase the unit and station capacity. However, you do not describe the extent of possible modifications to the hydraulic capacity and to the storage operations within the upper reservoir. Therefore, so that we may fully understand and evaluate your proposal and determine the appropriate studies needed, please provide detail on the physical and operational changes contemplated at the Northfield Mountain Pumped Storage Project.

2) Recreation and Land Use

In the PAD, the project boundary maps are presented. However, it is difficult to discern ownership and extent of shoreline buffer from the maps and associated narrative in the PAD. Therefore, so that we may fully understand and evaluate your proposal and determine the appropriate studies needed, please describe the project boundary (i.e., is it a metes and bounds survey, and elevation contour, or some combination), and shoreline buffer (e.g., typical distance from normal reservoir elevation to the project boundary, vegetative cover types).

3) Cultural Resources

In section 4.10.4 of the PAD, you state that, by letter dated September 30, 2011, the Massachusetts SHPO has recommended that a qualified cultural resources consultant research and compile the information necessary to identify historic and archaeological resources and archaeologically sensitive areas within the project's APE. In section 5.2.10 of the PAD you propose to conduct a Phase IA Archaeological Survey and Historic Structures Survey of the APE. You also indicate that FirstLight may propose to conduct a Phase IB archaeological and an intensive-level architectural level survey, depending on the results of the Phase IA investigation and after consultation with the Massachusetts, New Hampshire, and Vermont SHPOs. However, you have not provided a map specifically defining the APE, and we are unclear on how you would specifically carry out the various tasks involving your proposed study.

As a result, in your study proposal for cultural resources we ask you to include the same information, specific to the Northfield Mountain Project, as outlined above for the Turners Falls Project.[8]

[8] Include in your study proposal that you would also consult with the Vermont, Massachusetts, and New Hampshire SHPOs, and any involved Indian tribe or other interested parties in formulating each of the tasks listed below.

Turners Falls Hydroelectric Project, Project No. 1889-081
Northfield Mountain Pumped Storage Project, Project No. 2485-063
Schedule B

STUDY REQUESTS

After reviewing the information in the Pre-Application Document (PAD), we identified a gap between the information in the PAD and the information needed to assess project effects. The intent of the following studies is to fill the gap between existing and needed information. On February 22, 2013, FirstLight filed a draft study plan for an Instream Flow Habitat Assessment of the Connecticut River from Turners Falls Dam to the Holyoke Impoundment below Sunderland Bridge. We will review this proposed study and reserve the right to request an instream flow study of this reach at such time as our review is complete. In addition, we recognize that there may be additional existing information that currently has not been identified and may be sufficient to address our additional information needs. As such, please note that we can further discuss the extent of the information gap, additional information, and the relative scope of the requested studies at the study plan meeting(s). As required in section 5.9 of the Commission's regulations, we address the seven study request criteria for the following requested studies.

Study Request #1 - Water Level Fluctuation Study

Projects: Turners Falls & Northfield Mountain

<u>Goals and Objectives</u>

§5.9(b)(1) – *Describe the goals and objectives of each study proposal and the information to be obtained.*

The goal is to identify hourly reservoir elevations throughout the upstream and downstream reaches affected by the project in order to assess project effects on aquatic and terrestrial resources under current and proposed operation. Specifically the study should identify hourly water levels and flows within the upstream and downstream reaches under project operation conditions for the full range of inflows to provide information and inform FirstLight's proposed Erosion Causation Study, and inform an analysis of project-related effects on aquatic resources and terrestrial resources.

§5.9(b)(2) – *If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.*

Not applicable.

§5.9(b)(3) – *If the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study*.

The Federal Energy Regulatory Commission must decide whether to issue a new license to FirstLight for the Turners Falls and Northfield Mountain projects. Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. In making its license decision, the Commission must equally consider the environmental, recreational, fish and wildlife, and other non-developmental values of the project, as well as power and developmental values. Any license issued shall be best adapted to a comprehensive plan for improving or developing a waterway or waterways for all beneficial public uses.

Project operations affect reservoir and tailrace water levels on an hourly basis (or finer increment), which may affect several environmental resources. Understanding the projects' influence on hourly water levels and flows within the Connecticut River is essential to understand the effect of project operations on these environmental resources; and therefore, is relevant to the Commission's public interest determination.

Background and Existing Information

§5.9(b)(4) – *Describe existing information concerning the subject of the study proposal, and the need for additional information*

The PAD provided general information about the magnitude of the licensed limits for water level fluctuation in the Turners Falls reservoir (lower reservoir) and referenced information on the hydrology, hydraulics, and erosion conditions along the river reach below the Vernon Project and above Turners Falls. For instance, FirstLight cited an Army Corps of Engineers (USACE) *Report on Connecticut River Streambank Erosion Study, Massachusetts, New Hampshire and Vermont*.[9] This report looked at erosion along a 141 mile reach of the River from the Turners Falls dam to the headwaters of the Wilder Project.[10] FirstLight also noted its Full River Reconnaissance (FRR) studies to

[9] Simons, D.B., Andrew, J.W., Li, R.M., & Alawady, M.A. (1979). Connecticut River Streambank Erosion Study: Massachusetts, New Hampshire, and Vermont. Waltham, MA: US Army Corps of Engineers (USACE).

[10] We note that the USACE's report quantified multiple contributing factors to bank erosion, and summarized that the erosional forces on river banks due to the project operation fluctuation of water levels was 15 to 18 percent of the shear stress forces

document existing bank conditions within the Turners Falls Impoundment in 1998, 2001, 2004, and 2008. Based on this existing information, FirstLight proposes an Erosion Causation Study.

While this information is available, it is insufficient to fully inform FirstLight's proposed Erosion Causation Study. For example, the USACE's study and corresponding report was completed in 1979 and, while it considered the hydraulics of the Connecticut River at that time, water fluctuations may have changed as a result of alterations to project operations since 1979.[11] Additionally, FirstLight's FRR studies did not take into consideration river hydraulics and only monitored and assessed the conditions of the streambank along the Turners Falls impoundment.

FirstLight noted during the scoping meetings that normal fluctuations are generally lower than the licensed limits. However, the PAD did not provide information on the variability, rate of change or the frequency of fluctuation within the lower reservoir, the Turners Falls bypass reach, and in the Connecticut River downstream of the Turners Falls Project tailraces. The data from this water fluctuation study, coupled with information in the PAD, and the proposed Erosion Causation Study should provide information to fully understand the effect of project operations on multiple environmental resources (e.g. geology and soils, aquatic resources, and terrestrial resources).

<u>Project Nexus</u>

§5.9(b)(5) – *Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.*

The applicant notes the project-related effects of water level fluctuations upon soils and geology resources in the PAD, as well the potential impact to terrestrial and aquatic resources. Operation of the Northfield Mountain pumped storage project results in the transfer of water volume between the upper and lower reservoirs, producing water level fluctuations throughout the Turners Falls reservoir. The water levels in this lower reservoir are lower during pump-back operations and higher during generation cycles, potentially occurring several times per day. The fluctuation in water levels effect the

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caused by the flowing water.

[11] See Transcripts of Northfield Mountain Pumped Storage Project and Turners Falls Hydroelectric Project evening Scoping Meeting filed on January 31, 2013.

soils along the reservoir through saturation and dewatering of the embankment materials potentially increasing their susceptibility to erosion.

The information from this requested study should provide the variations in water elevations and fluctuation rates for various project pump/generation cycle operations during a variety of inflow conditions, identifying the ranges of water level fluctuations rates and variability with inflow and location along the reservoir. The results of this study will be used along with soils information within the PAD and the Applicant-proposed Erosion Causation Study to help identify operation related effects. Additionally, this information would help inform an analysis of project-related effects on aquatic resources and terrestrial resources.

Proposed Methodology

§5.8(b)(6) – *Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.*

Conduct the water fluctuation study using an unsteady one-dimensional hydraulic model such as HEC-RAS, verified with in-situ measurements using level loggers at multiple sites within Turners Falls reservoir, canal, bypass reach, and in the tailrace downstream to the upper limit of the Holyoke impoundment. FirstLight should modify its proposed HEC-RAS model to include an unsteady model to analyze the combined influences of inflow fluctuations from the Vernon Hydroelectric Project, tributaries, and the operation of the Northfield Mountain Project.

The study should provide quantification of the water level fluctuations at erosion sites along the reservoir under various inflow conditions, including rates of elevation change and changes to mean velocity in the reservoir. FirstLight should use the results of this study to support its proposed Baseline Inventory to gather information necessary to fully understand the potential effects of project-related water level fluctuations on terrestrial resources (e.g., wetlands and waterfowl). Additionally, the results of this study should allow assessment of project operational effects on aquatic habitat as part of our Requested Study - Aquatic Habitat Mapping of the Turners Falls Impoundment.

Level of Effort and Cost

§5.9(b)(7) – *Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.*

The estimated incremental cost of the study is approximately $80,000, which includes an estimate of 22 hours for a project manager and quality assurance, 500 hours for engineering and field staff, and 55 hours for support staff. An alternative study using just the level loggers might capture the water level fluctuation data, but would not identify the dynamic river flows or isolate the effects of upstream discharges to fluctuations at the upper limit of reservoir influences downstream of the Vernon project.

Study Request #2– Aquatic Habitat Mapping of the Turners Falls Impoundment

Project: Turners Falls

Goals and Objectives

§5.9(b)(1) – *Describe the goals and objectives of each study proposal and the information to be obtained.*

The goal of this study is to map the aquatic habitat within the Turners Falls Project impoundment in the Connecticut River, evaluate the types of aquatic habitats that occur there, and identify any potential effects the Turners Falls and Northfield Mountain project operations may have on this habitat.

Specifically, the objectives of the study are to:

1. Survey and map the aquatic habitat types distributed within the Turners Falls Project impoundment in the Connecticut River from the upper extent of the Turners Falls Project's impoundment to the Turners Falls dam.

2. Describe the potential influences of the Turners Falls and Northfield Mountain projects' operations on aquatic habitats within the Turners Falls impoundment.

§5.9(b)(2) – *If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.*

Not applicable.

§5.9(b)(3) – *If the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study*.

The Federal Energy Regulatory Commission must decide whether to issue a new license to FirstLight for the Turners Falls and Northfield Mountain projects in the Connecticut River. Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. In making its license decision, the Commission must equally consider the environmental, recreational, fish and wildlife, and other non-developmental values of the projects, as well as power and developmental values. Any license issued shall be best adapted to a comprehensive plan for improving or developing a waterway or waterways for all beneficial public uses.

Aquatic habitats in the Connecticut River support a sustainable riverine ecosystem that provides public opportunities, including a sport fishery. Ensuring that the effect of project operations pertaining to this resource is considered in a reasoned way is relevant to the Commission's public interest determination.

<u>Background and Existing Information</u>

§5.9(b)(4) – *Describe existing information concerning the subject of the study proposal, and the need for additional information*

Review of FirstLight's PADs, as well as a preliminary review of scientific literature, revealed aquatic habitat mapping data available for the riverine reaches from approximately 30 miles downstream of Turners Falls to the Turners Falls Project, including the bypassed reach. However, information on aquatic habitat within the Turners Falls impoundment is not available. As such, additional aquatic habitat information, including the mapped locations of aquatic habitats in the Turners Falls impoundment is needed to evaluate the projects effects on aquatic resources.

<u>Project Nexus</u>

§5.9(b)(5) – *Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.*

Currently, water levels in the Turners Falls impoundment fluctuate due to the current peaking operations of the Turners Falls Project and because the impoundment also serves as the lower reservoir, through the pumped storage operations of the Northfield Mountain Project. As a result, any aquatic habitat exposed under low water levels may be adversely effected and/or inhibit the utilization of aquatic habitats by aquatic species during various life stages. These events may also cause fish or other aquatic species (e.g., mussels and macroinvertebrates) stranding and associated mortality.

This requested study would help establish a baseline condition and the health of the aquatic habitat and aquatic species of the Connecticut River in the Turners Falls impoundment under current operations. These data would also assist in forming the basis for inclusion of potential license articles to protect aquatic resources in the Connecticut River.

<u>Proposed Methodology</u>

§5.8(b)(6) – *Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.*

Using generally accepted practices in the scientific community:

1. Conduct field surveys of aquatic habitat during the low flow season (i.e. summer months) from the head of the Turners Falls Project impoundment to the Tuners Falls dam.

2. Categorize habitat survey information per accepted practices in the scientific community (e.g., riverine habitat type, substrate type, depths, etc.) and plotted on aerial maps. Also record in-situ water quality conditions (temperature, DO, pH, conductivity).

3. Prepare a report that includes a summary of the data collected. Include in the report, aerial habitat maps, habitat descriptions, project operations and flow conditions during the survey, and in-situ water quality data. Include all data used to develop the report in an appendix.

<u>Level of Effort and Cost</u>

§5.9(b)(7) – *Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.*

The estimated cost of this work is approximately $38,000 and may be completed within one study season.

It is anticipated that two technicians and a biologist would spend about 40 hours each to conduct field work. Report preparation would require a one week by a biologist, and a GIS specialist.

Study Request #3 – Baseline Fisheries Population Study

Project: Turners Falls

<u>Goals and Objectives</u>

§5.9(b)(1) – *Describe the goals and objectives of each study proposal and the information to be obtained.*

The goal of this study is to gather baseline fisheries data upstream and downstream of the Turners Falls dam in the Connecticut River. These data are needed to identify the fish species that occur in the Turners Falls impoundment, tailwaters, bypassed reach, and downstream riverine corridors, and to evaluate any potential project effects. Specifically, the objectives of the study are to:

1. Determine the relative abundance and distribution of resident/riverine and diadromous fish species within the Turners Falls impoundment, bypassed reach, tailwaters, and downstream riverine corridors outside of the Turners Falls Project area. This includes all areas in the Connecticut River from the upper extent of the Turners Falls impoundment and downstream to the upper extent of the Holyoke project impoundment.

2. Describe the distribution of resident/riverine and diadromous fish species within the reaches of the river and in relationship to data gathered by the Aquatic Mapping Study.

§5.9(b)(2) – *If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.*

Not applicable.

§5.9(b)(3) – *If the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.*

The Federal Energy Regulatory Commission must decide whether to issue a new license to FirstLight for the Turners Falls and Northfield Mountain projects. Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. In making its license decision, the Commission must equally consider the environmental, recreational, fish and wildlife, and other non-developmental values of the projects, as well as power and developmental values. Any license issued shall be best adapted to a comprehensive plan for improving or developing a waterway or waterways for all beneficial public uses.

Fish populations in the Connecticut River support a sport fishery. The effect of project operation on this resource is relevant to the Commission's public interest determination.

Background and Existing Information

§5.9(b)(4) – *Describe existing information concerning the subject of the study proposal, and the need for additional information*

Review of FirstLight's PAD, as well as a preliminary review of scientific literature revealed minimal information on fisheries resources in the Connecticut River potentially affected by the project. While sparse site-specific data on general species presence and absence are provided in the PAD, additional fisheries population data are needed to evaluate the projects effects on this resource.

Project Nexus

§5.9(b)(5) – *Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.*

Potential project effects on fishery resources may include fish entrainment through the generating units, minimum instream flows, and peaking flow operations. Information on the abundance and distribution of the existing fish community would help to identify whether adverse effects are occurring.

The applicant is proposing to continue providing the existing minimum flows. Flow releases (and withdrawals) from the projects have the potential to affect the suitability of aquatic habitat in these reaches, and in turn fishery resources. This requested study would help establish a baseline condition on the health of the fishery of the Connecticut River in the project vicinity under current operations. These data would also assist in informing potential license articles to protect fishery resources in the Connecticut River.

Proposed Methodology

§5.8(b)(6) – *Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.*

Using generally accepted practices in the scientific community:

1. Conduct electrofishing surveys in the Turners Falls impoundment, tailwaters, bypassed reach, and downstream riverine corridor. This sampling should occur during late-summer or fall so that juvenile production for that year would be observable (juvenile fish would be large enough to collect). Sampling locations should be established to represent the full extent and types of habitat throughout the entire study area.

2. Separately target upstream and downstream migrating American eels for sampling using generally accepted methods, such as electrofishing, trap/fyke netting, eel pots, etc to provide data on the abundance of

American eels at various life stages, and where they tend to congregate, including the Northfield Mountain project's intake/tailrace. This study should occur in late spring/early summer to target upstream migration juvenile eels (i.e., elvers and yellow eels), and during the fall to target downstream migrating adults eels (i.e. silver eels).

3. Identify to species and count all collected fish while weighing and measuring only a subsample. Measure eye diameters of captured American eels for use in the evaluating silver eels phase. Identify and record the habitat type and substrate of each sampling location, and record in-situ water quality conditions (temperature, DO, pH, conductivity).

4. Prepare a report that includes a summary of the data from the above studies. Include tabular summaries of fish species collected by station, plus data on lengths, weights, condition factors, and in-situ habitat conditions. Also include specific information relating to American eel populations characteristics, such as areas at the base of the dams where elvers congregate, and the abundance of potentially downstream migrating silver eels. Include all data used to develop the report (including date and time of collection) within an appendix to the report.

<u>Level of Effort and Cost</u>

§5.9(b)(7) – *Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.*

The estimated cost of this work is approximately $85,000, and may be completed within one study season.

It is anticipated that three technicians and a biologist would spend about 150 hours to conduct field work. Report preparation would require about 3 weeks by a biologist.

Study Request #4 – Assessment of Fish Impingement, Entrainment, and Survival Study

Projects: Turners Falls & Northfield Mountain

Goals and Objectives

§5.9(b)(1) – *Describe the goals and objectives of each study proposal and the information to be obtained.*

The goal of this study is to use the data gathered from the baseline fisheries population study to assess fish trashrack impingement, turbine entrainment, and survival at the Turners Falls and Northfield Mountain projects in the Connecticut River. This information would be used to evaluate the effects from passage through project turbines and other passage routes on fish populations that occur throughout the project areas. Specifically, the objectives of the study are to:

1. Describe the physical characteristics of the Turners Falls and Northfield Mountain projects that may influence fish impingement and entrainment rates, including intake location and dimensions, the velocity distribution in front of the intake structure, and the clear spacing between the trashrack bars;

2. Identify current and any future routes for fish movement past the two projects, and the risks of injury or mortality for each, taking into consideration seasonality of movement, flow direction and velocity, and current and future flow management regimes;

3. Analyze target species (i.e., individual species and guilds/groups) for factors that may influence their vulnerability to entrainment and mortality;

4. Assess the potential for target fish species impingement;

5. Estimate entrainment rates and numbers for target fish species;

6. Estimate turbine passage survival rates and numbers for target fish species; and

7. Estimate total project survival considering all passage routes for American shad, river herring, American eel, Atlantic salmon, and sea lamprey at the Turners Falls and Northfield Mountain projects.

§5.9(b)(2) – *If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.*

Not applicable.

§5.9(b)(3) – *If the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.*

The Federal Energy Regulatory Commission must decide whether to issue a new license to FirstLight for the Turners Falls and Northfield Mountain projects in the Connecticut River. Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. In making its license decision, the Commission must equally consider the environmental, recreational, fish and wildlife, and other non-developmental values of the projects, as well as power and developmental values. Any license issued shall be best adapted to a comprehensive plan for improving or developing a waterway or waterways for all beneficial public uses.

Fish populations in the Connecticut River support a sustainable riverine ecosystem that is critical in providing public opportunities, such as the important sport fishery. Ensuring that the effect of project operations pertaining to this resource is considered in a reasoned way, is relevant to the Commission's public interest determination.

Background and Existing Information

§5.9(b)(4) – *Describe existing information concerning the subject of the study proposal, and the need for additional information*

Review of FirstLight's PAD, as well as a preliminary review of scientific literature revealed sparse and dated information pertaining to fish impingement, entrainment, and survival at the Turners Falls and Northfield Mountain projects on the Connecticut River. Additional up-to-date information on fish impingement, entrainment, and survival is needed to evaluate the projects effects on this resource.

Project Nexus

§5.9(b)(5) – *Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.*

Potential t effects of project operations and facilities include fish impingement on the trashracks and entrainment through the generating units. Any fish moving downstream as a part of their life cycle would encounter a series of dams and intakes at hydroelectric projects in the Connecticut River, potentially resulting in exposure of these fish to multiple sources of mortality. Information pertaining to these effects would help identify any adverse effects from the projects.

This requested study would help establish a baseline condition and be considered when evaluating the health of the fishery of the Connecticut River in the project reaches. These data would also assist in forming the basis for inclusion of potential license conditions to protect fishery resources in the Connecticut River.

Proposed Methodology

§5.8(b)(6) – *Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.*

Using generally accepted practices in the scientific community:

1. Utilize the fish population data to develop a target species list that represents species of conservation interest and all fish guilds/groups in consultation with the state fishery resource agencies.

2. Conduct an assessment on the probability of trashrack impingement at two projects considering the site-specific variables at each project, such as clear spacing, intake configurations, flow velocities, fish size, fish swim speeds, and life histories.

3. Conduct a literature review of entrainment studies conducted at other hydroelectric facilities, including the EPRI (1997)[12] database to derive entrainment rates for the target species at Turners Falls and Northfield Mountain projects. Correlate entrainment rates with flow through the units of each project and the relative abundance of each target species to estimate the levels of entrainment for each target species.

4. Using the site-specific specifications from each of the two projects, conduct a blade strike assessment to derive survival rates of each target species. Correlate these survival rates with the entrainment estimates to estimate fish survival through the turbines of each of the two projects.

5. Use flow distributions through the projects turbines and other passage routes, as well as survival rates through alternative passage routes to estimate total project survival of migratory species at the Turners Falls Project.

6. Prepare a report that includes a summary of the results from the assessments described above. Include all data used to develop the report in an appendix.

Level of Effort and Cost

§5.9(b)(7) – *Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.*

The estimated cost of this work is approximately $35,000. It is anticipated that a biologist and a hydrologist would spend approximately 200 hours total to conduct the impingement, entrainment, and survival assessments and prepare a report.

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[12] Electric Power Research Institute (EPRI). 1997. Turbine survival and entrainment database – Field tests. EPRI Report No. TR-108630. Prepared by Alden Research Laboratory, Inc. Holden, MA.

Study Request #5 – American Shad Upstream Migration and Behavioral Study

Projects: Turners Falls & Northfield Mountain

Goals and Objectives

§5.9(b)(1) – *Describe the goals and objectives of each study proposal and the information to be obtained.*

The goal of this study is to track adult American shad within the Connecticut River, through inter-project riverine reaches, project reservoirs, and project facilities and within the species' historic range. These data would be used to evaluate the effects the hydroelectric projects operations and facilities on upstream American shad passage in the Connecticut River. Specifically, the objectives of the study are to:

1. Collect and tag upstream migrating adult American shad downstream of the projects to track their migration and behavior.

2. Identify any project operations and facilities contributing to migration delay, mortality, increased predation, upstream passage avoidance, or any other project related factors contributing to alterations in natural upstream migration and behavior.

§5.9(b)(2) – *If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.*

Not applicable.

§5.9(b)(3) – *If the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.*

The Federal Energy Regulatory Commission must decide whether to issue a new license to FirstLight for the Turners Falls and Northfield Mountain projects in the Connecticut River. Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. In making its license decision, the Commission must equally consider the environmental, recreational, fish and wildlife, and other non-developmental values of the projects, as well as power and developmental values. Any license issued shall be best adapted to a comprehensive plan for improving or developing a waterway or waterways for all beneficial public uses.

American shad populations in the Connecticut River represent a valuable aquatic resource to the region, as well as a recreational and cultural resource. Identifying effects of project operations pertaining to this resource is relevant to the Commission's public interest determination.

Background and Existing Information

§5.9(b)(4) – *Describe existing information concerning the subject of the study proposal, and the need for additional information*

Review of FirstLight's PAD, as well as a preliminary review of scientific literature revealed sparse and dated information pertaining to upstream American shad migration and behavior on the Connecticut River. Although fish passage efficiency studies have been conducted within the passage facilities themselves, we are not aware of any studies on the potential effects of project operations on the migration efficiency of shad in the general project vicinity. Therefore, additional information on adult American shad migration and behavior is needed to evaluate the projects effects on this resource.

Project Nexus

§5.9(b)(5) – *Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.*

Potential effects of project operations at the Turners Falls and Northfield Mountain projects may influence adult American shad migration and behavior in the Connecticut River. Any adult shad moving upstream would be exposed to a series of dams and unnatural flow conditions, potentially resulting in migration delay, increased predation, and other project-related effects. Information pertaining to these effects would help identify if adverse effects from the projects are occurring.

This requested study would help identify any project-specific conditions adversely affecting upstream American shad passage conditions in the Connecticut River. These data would also assist in forming the basis for inclusion of potential license articles to protect adult American shad.

Proposed Methodology

§5.8(b)(6) – *Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.*

Using generally accepted practices in the scientific community:

1. Capture upstream migrating adult American shad downstream of the projects during their upstream migration season. Telemetry tag captured American shad and record biological data before release and track their upstream migration and behavior, especially as these fish approach hydroelectric facilities. Closely monitor behavior of these shad as they approach and ascend fishways, as well as behavior within the projects impoundments.

2. Prepare a report that includes a summary of the results of the collected telemetry data. Include statistically justifiable analyses of American shad migration and behavior throughout the study area in the Connecticut River, and consider collected biological information, water quality data, river conditions, project operations and flow conditions, and the condition of project facilities during the time of the study. Also include graphics displaying the tagged-shad movements during the study. Include all data used to develop the report in an appendix.

Level of Effort and Cost

§5.9(b)(7) – *Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.*

The estimated cost of this work is approximately $200,000. It is anticipated that a few technicians and a biologist would spend approximately 200 hours to conduct the field work and report. This study should be conducted over two seasons.

Study Request #6 – Recreation Facility Inventory and Use & Needs Assessment

Projects: Turners Falls & Northfield Mountain

Goals and Objectives

§5.9(b)(1) – *Describe the goals and objectives of each study proposal and the information to be obtained.*

The goals of the Recreation Facility Inventory and Use & Needs Assessment Study are to: (1) obtain information about the condition of existing recreation facilities and access sites at the projects; and existing recreation use, access, and demand at the projects; (2) conduct an assessment of the need to enhance recreation opportunities and access at the project; and (3) develop a Recreation Management Plan for the implementation of any enhancement measures and long-term monitoring of recreation demand and adequacy of facilities at the projects over the terms of a new licenses.

§5.9(b)(2) – *If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.*

Not applicable.

§5.9(b)(3) – *If the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study*.

The Federal Energy Regulatory Commission must decide whether to issue a license to FirstLight for the Turners Falls and Northfield Mountain Pumped Storage Hydroelectric projects. Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. In making its license decision, the Commission must equally consider the environmental, recreational, fish and wildlife, and other non-developmental values of the project, as well as power and developmental values. Any license issued shall be best adapted to a comprehensive plan for improving or developing a waterway or waterways for all beneficial public uses.

Recreation has been identified as a legitimate project purpose by the Commission. Applicants are encouraged to develop recreation resources in such a matter that is "consistent with the needs of the area to the extent that such development is not inconsistent with the primary purpose of the project" (18 C.F.R. §2.7). Identifying effects of project operations pertaining to this resource is relevant to the Commission's public interest determination.

Background and Existing Information

§5.9(b)(4) – *Describe existing information concerning the subject of the study proposal, and the need for additional information*

Section 4.8.2 of the PAD provides a summary of FERC Form 80 Recreation Use Report annual visitation estimates for 2008. Section 4.8.1.1 provides a general description of public recreation facilities, activities, and demand at the projects. However, the PAD provides no detailed information regarding the condition of existing facilities or type or location of various uses. We do acknowledge that a recreation facility inventory and conditions study has taken place as referenced in the PAD Section 5.2.8.2.; however, the PAD did not display the full results from this study. The PAD provides no project-specific information regarding visitor perceptions and identified needs at the projects. Information on current use and whether existing access facilities in the area are meeting recreation demand would inform a decision on whether additional, designated public access at the projects is necessary to meet existing and future recreation demand at the projects.

Project Nexus

§5.9(b)(5) – *Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.*

The projects include a reservoir, tailwater areas, and a bypassed reach at Turners Falls, which are inherently attractive recreation features. Additionally, there are numerous recreational opportunities for hiking and skiing within the Northfield Mountain Project. An analysis of existing recreation use and access at the projects would help form the basis for determining the projects' ability to enhance public recreation access opportunities. Also, an assessment of the current level of recreation use would provide information necessary to develop a Recreation Management Plan for efficient management of the recreational components of the project over the term of a new license.

Proposed Methodology

§5.8(b)(6) – *Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.*

1. Provide the methods and results of the investigation of the existing recreation facilities conditions, as referenced in the PAD Section 5.2.8.2. We reserve our right to request an additional inventory study if the deemed necessary.

2. At Turners Falls, the facility inventory will include characterization of the suitability of the bypassed reach for whitewater boating (e.g., gradient, length, character of potential flows) and the feasibility of incorporating a self-service portage (i.e., a path that does not require shuttle service).

3. The use and needs assessment will include all recreation activity types know to occur or potentially occurring at the project. Specific methods should include visitor observations; on-site visitor intercept surveys at formal and informal public recreation areas at the project reservoirs, tailraces, and riverine areas, including the Turners Falls bypassed reach; and mail and/or internet surveys targeting unique stakeholder groups that may not be practically accessed through on-site surveys (e.g., adjacent residential land owners, residents of the counties in which the projects are located, rock climbers, whitewater boaters).

4. Specific methods for each sampling approach in the use and needs assessment include: (1) the visitor observations should capture information such as location, date, time, weather, number of vehicles, watercraft (if any), number of recreation users or party size, and recreation activity engaged in; (2) the methodology for the visitor survey sampling will be based on a stratified random sample that includes all seasons, various locations, and various times of week and day to enable representative responses from the visitors, while ensuring interview coverage during key times (e.g., holiday and weekend days, shoulder seasons, hunting seasons) (Note: surveys of fisherman and hunters should include additional pertinent information related to game and harvest); (3) the mail back survey will

follow the Dillman Method or modified Dillman method, and include items such as frequency and duration of visits to the projects, qualitative ratings of existing public access and recreation facilities of the project area, and reasons for visiting or not visiting the projects for recreation.

5. The needs assessment will include the demand for whitewater boating in the bypassed reach of Turner Falls, existing boating opportunities within the project region (including at the project impoundments and immediately downstream of the project), feasibility of providing additional public access at the project reservoir and riverine reaches (potential locations, type of facilities and access, and any associated costs), identifying visitor perceptions regarding the adequacy of recreation facilities, and access in the project area, and assessing future recreation demand and facility needs at the project.

6. Annual recreation use by activity type and season should be quantified, to include, at a minimum, the project tailraces and the following locations: Cabot Woods Fishing Access, Turners Falls Branch Canal Area, Turners Falls No. 1 Station Fishing Access, Unity Park, Turners Falls Fishway Viewing Area, Barton Cove Natural Area and Campground, Barton Cove Canoe and Kayak Rental Area, Cabot Camp, Northfield Mountain Boat Tour and Riverview Park Area, Northfield Mountain Tour and Trail Center, Northfield Mountain Trail System, Northfield Mountain Mountaintop Observation Area, Munn's Ferry Boat Camping Recreation Area, Turners Falls Canoe Portage, and the Turners Falls bypassed reach.

7. Assess visitor perceptions of the effects of project operations and management on recreation and recreation opportunities at the project (including fluctuating reservoir levels, minimum flow releases, and anticipated changes over a new license term. Identify potential measures to alleviate any negative effects as well as to enhance existing recreation opportunities and access.

8. A Recreation Management Plan for the projects should be included in the license application and should include, at a minimum: (1) description of any proposed protection, mitigation, and enhancement measures, including: location of any proposed facilities and/or access areas (including description and figure depicting the relationship of any proposed facilities to the existing project boundaries), proposed ownership and management of

any proposed facilities, associated capital, and operation and maintenance costs; and a timeline for implementation; (2) description of operation and management measures associated with project-related recreation access and facilities; and (3) description of measures for future monitoring of recreation demand and adequacy of project-related facilities to meet this demand over the term of new licenses.

Level of Effort and Cost

§5.9(b)(7) – *Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.*

The estimated cost of the Recreation Facility Inventory and Use & Needs Assessment Study for the Turners Falls and Northfield Mountain projects is about $120,000, including field studies, study report development, and drafting of a Recreation Management Plan. One field season should be sufficient to collect the required data and prepare the report.

Study Request #7 – Whitewater Boating Flow Assessment

Projects: Turners Falls

Goals and Objectives

§5.9(b)(1) – *Describe the goals and objectives of each study proposal and the information to be obtained.*

The goal of this study is to assess the effects of a range of bypassed reach flows on whitewater recreational opportunities. The objectives of the study are to:

- Determine what whitewater boat-types (e.g., rafts, canoes, and kayaks) would be appropriate to utilize any potential whitewater flows in the bypassed reach.

- Determine the range of flows (minimum through optimal) needed to support various whitewater boating opportunities (by watercraft type) in the project bypassed reach.

- Determine whether current or future demand exists for whitewater boating in the bypassed reach.

- Determine the number of days per month the minimum and optimum flows for whitewater boating would be available under the project's current and any proposed mode of operation.

- Determine any competing recreational uses (e.g., climbing or fishing) or other resource needs (e.g., aquatic habitat) that may be adversely affected by any scheduled releases.

§5.9(b)(2) – *If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.*

Not applicable.

§5.9(b)(3) – *If the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study*.

The Federal Energy Regulatory Commission must decide whether to issue a license to FirstLight for the Turners Falls Hydroelectric Project. Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. In making its license decision, the Commission must equally consider the environmental, recreational, fish and wildlife, and other non-developmental values of the project, as well as power and developmental values. Any license issued shall be best adapted to a comprehensive plan for improving or developing a waterway or waterways for all beneficial public uses.

Comments provided during scoping indicate an interest in studying flows for boating opportunities on the 2.7-mile-long segment of the Connecticut River from Turners Falls dam to Cabot Station. Comments received stated that releasing an appropriate amount of water into the bypassed reach could potentially provide whitewater boating opportunities for public use.

Background and Existing Information

§5.9(b)(4) – *Describe existing information concerning the subject of the study proposal, and the need for additional information*

The PAD includes limited information on the bypassed reach in Section 3.2.1. After reviewing this information and the comments provided during the January 30 and 31, 2013 scoping meetings, we have identified a gap between existing information and the information needed to analyze whether flows could be provided to enhance whitewater boating opportunities and whether there is demand for whitewater boating in the bypassed reach. We are unaware of any information on the characteristics or boatability of the Turners Falls bypassed reach, or the range of boatable flows.

Project Nexus

§5.9(b)(5) – *Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.*

Project operation diverts flows from a 2.7-mile-long bypassed reach of the Connecticut River that could provide whitewater boating opportunities. Specifically, instream flows for the Connecticut River divert approximately 18,000 cfs from Turners Falls dam to Station No. 1and Cabot Station. From May 1 through approximately November 15 of each year, FirstLight maintains a seasonal minimum flow that ranging from 120 cfs to 400 cfs in the bypassed reach. These flows may be too low to accommodate whitewater boating. An analysis of project operation relative to a range of boatable flows would help form the basis for informing potential license articles pertaining to whitewater boating opportunities.

Proposed Methodology

§5.8(b)(6) – *Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.*

1. Use accepted practices for a controlled flow study as described in Whittaker et al. (2005) to visually assess whitewater boating flows in coordination

with flows scheduled for the instream flow study, and any opportunities that may be provided by river flows in excess of 18,000 cfs at the Turners Falls dam; and to the extent practicable based on these visual observations, determine the acceptable minimum and optimal instream flow needed for whitewater boating in the bypassed reach.

2. Prepare a study report that (1) describes the whitewater boating attributes of the range of flows examined, including level of difficulty, portage requirements, etc; (2) identifies the acceptable and optimal flows for the reach and the frequency of availability of the identified flows under current and any proposed project operation, and (3) incorporates relevant results from the Recreation Facility Inventory and Use & Needs Assessment including characterization of the suitability of the bypassed reach for whitewater boating (e.g., gradient, length, character of potential flows), annual recreation use by activity type and season of the bypassed reach, and (4) assesses whether or not there is demand for whitewater boating in the bypassed reach.

3. The report should also describe any competing recreation uses or other resources (e.g., fishing, rock climbing) in the bypassed reach that could be adversely affected by providing scheduled releases of minimum and optimum flows for whitewater boating.

<u>Level of Effort and Cost</u>

§5.9(b)(7) – *Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.*

This study should be conducted in coordination with the instream flow study; cost of coordinating, scheduling, and providing flows to the bypassed reach should be reflected in aquatics study plan. The estimated cost of the whitewater boating flow assessment is approximately $30,000, depending upon the extent of fieldwork conducted.

Study Request #8 – Effects of Project-related Land Management Practices and Recreation Use on Terrestrial Habitats

Projects: Northfield Mountain

Goals and Objectives

§5.9(b)(1) – *Describe the goals and objectives of each study proposal and the information to be obtained.*

The goal of this study is to gather the information necessary to understand the potential effects of land management practices and recreational use on wildlife and botanical resources within the Northfield Mountain Project area.[13] The objectives of the study are to:

- Identify and describe FirstLight's project-related land management practices (including the maintenance of project-related recreation areas) occurring in the Northfield Mountain project's boundary.
- Provide information pertinent to describe existing wildlife and botanical habitats occurring in the Northfield Mountain Project area.
- Determine if project-related land management and maintenance practices and the use of project-related recreation areas has the potential to facilitate the growth and spread of invasive plant species.
- Provide information to identify if project-related land management and maintenance practices and the use of project-related recreation areas may affect existing wildlife and botanical resources (e.g., clearing of vegetation).

§5.9(b)(2) – *If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.*

Not applicable.

[13] For the purposes of this study, the Northfield Mountain Project area includes the lands around project facilities (e.g., the upper reservoir, parking areas, access roads), and recreational areas (e.g., picnic areas, trails, hiking areas).

§5.9(b)(3) – *If the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study*.

The Federal Energy Regulatory Commission must decide whether to issue a new license to FirstLight for the Northfield Mountain Project in the Connecticut River Basin. Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a project is located, and what conditions should be placed on any license that may be issued. In making its license decision, the Commission must equally consider the environmental, recreational, fish and wildlife, and other non-developmental values of the projects, as well as power and developmental values. Any license issued shall be best adapted to a comprehensive plan for improving or developing a waterway or waterways for all beneficial public uses.

Wildlife and botanical resources in the Connecticut River watershed support a diverse assemblage of plant and wildlife communities that provide various public opportunities, such as bird watching, hiking, and hunting. Consideration of the effect of project operations, maintenance, land management, and recreational use on these resources is relevant to the Commission's public interest determination.

Background and Existing Information

§5.9(b)(4) – *Describe existing information concerning the subject of the study proposal, and the need for additional information*

Review of FirstLight's PAD revealed minimal information pertaining to the effects of project operation, maintenance, land management, and recreation use on wildlife and botanical habitats and the location of invasive plant species within the Northfield Mountain Project area. FirstLight is proposing to conduct wildlife and botanical study for the Turner Falls Project; however, that study only addresses the Turner Falls reservoir (lower reservoir for the Northfield Mountain Project) and not any of the other habitats associated with the Northfield Mountain Project. Additional information on the location and abundance of invasive plant species and the impacts on wildlife and botanical resources as a result of project-related maintenance and land management practices in the Northfield Mountain Project area is needed to evaluate the project's full effects on wildlife and botanical resources.

Project Nexus

§5.9(b)(5) – *Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.*

The Northfield Mountain Project has many recreational features (e.g., a trail system with over 26 miles of trails, observation area, picnic areas), that are inherently attractive recreation features. Public recreation sites can affect wildlife behavior (both attracting and displacing) and impact botanical resources (e.g., trampling and spreading invasive species). An analysis of the effects of the maintenance, land management practices, and use of these recreational features on wildlife and botanical resources would help form the basis for determining the project's effect on these resources.

This requested study would help establish a baseline condition for evaluating the health of the terrestrial resources of the Northfield Mountain Project area. This information would also assist in forming the basis for any potential license conditions necessary to protect wildlife and botanical resources in the project area.

Proposed Methodology

§5.8(b)(6) – *Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.*

Use generally accepted practices in the scientific community to document the type and distribution of wildlife and botanical habitats (including wetlands) that are potentially impacted by project-related recreational use, maintenance, or land management practices within the Northfield Mountain Project area. Identify and describe vegetation communities and plant species, wildlife species, invasive species, and vegetation management.

Conduct field surveys with respect to floristic characterization and observations of wildlife species over the entire area affected by project operations and maintenance activities, including all recreational areas during appropriate periods. Describe invasive species occurrence and distribution in conjunction with other aspects of this study. Characterize the current extent of terrestrial weed infestations throughout the Northfield

Mountain Project area, identify the species that occur, and describe the relative abundance of these species.

Prepare a report that includes:

- A summary of the data collected, with habitat descriptions;
- A description of and assessment of the extent to which project-related actions and recreation activities may affect the spread of invasive weed populations;
- A description of project-related land management and maintenance practices, including invasive weed site information, such as population size and area;
- A map(s) of the location of wildlife and botanical resources and showing the relationship to project facilities and management and maintenance activities; and
- All data used to develop the report, in an appendix.

Level of Effort and Cost

§5.9(b)(7) – *Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.*

The estimated cost of this work is approximately $50,000 - $60,000, depending upon the extent of fieldwork conducted. It is anticipated that one field biologist and one technician would spend approximately two weeks to conduct the field work and prepare a report. This cost and effort estimate considers that this study would be implemented in conjunction with FirstLight's proposed Baseline Inventory of Botanical Resources in the Turners Falls Impoundment, the Bypass Reach, and Below Cabot Station presented in section 5.2.5 of the PAD.

United States Department of the Interior

FISH AND WILDLIFE SERVICE

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In Reply Refer To: FirstLight Hydro Generating Company
Turners Falls Hydroelectric Project, FERC No. 1889
Northfield Mountain Pumped Storage Project, FERC No. 2485
Connecticut River
COMMENTS ON PRE-APPLICATION DOCUMENT
STUDY REQUESTS
SCOPING DOCUMENT 1

March 1, 2013

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E., Room 1A
Washington, DC 20426

Dear Secretary Bose:

This responds to the Pre-Application Document (PAD) for the Turners Falls Hydroelectric Project and the Northfield Mountain Pumped Storage Project (NMPS), located on the Connecticut River in Franklin County, Massachusetts; Windham County, Vermont; and Cheshire County, New Hampshire. The PAD is being provided in preparation of an application for a new federal license for the projects. We offer the following comments based on the PAD (submitted to us by FirstLight Power Resources [FirstLight] on October 30, 2012) and information we obtained at the site visit held on October 4, 2012, the joint agency meeting held on October 5, 2012, and the Federal Energy Regulatory Commission (Commission) scoping meetings held on January 30-31, 2013.

PRE-APPLICATION DOCUMENT

PROPOSAL

Turners Falls Project

The Turners Falls Project consists of two dams separated by an island that impound 2,110 acres of water at the normal pool elevation of 185.0 feet mean sea level (msl). The Montague Dam is 630 feet long and has four bascule gates. The Gill Dam is 493 feet long and consists of three tainter gates. Adjacent to the dam is a gatehouse that leads to a 2.1-mile-long canal. The canal provides water to a number of users, including the Turners Falls Project's Station No. 1 and

Cabot Station hydropower generating facilities. The canal has a capacity of approximately 18,000 cfs and a target elevation of 173.5 feet msl.

Station No. 1 is located at the end of a short side canal that branches off the main power canal 0.9 miles downstream of the canal gatehouse. The powerhouse intake is covered with trashracks that have clear spacing of 2.625 inches and an approach velocity of 1.2 feet per second. Behind the racks are four penstocks that feed water to seven horizontal Francis turbines. Five of the seven turbines are currently operable. The combined nameplate capacity is 5.693 MW and the total hydraulic capacity of the project is 2,210 cfs.

The Cabot Station is located at the end of the main power canal. The intake to the powerhouse is covered with trashracks that have 1-inch-clear spacing on the upper 11 feet and 5-inch-clear spacing on the bottom 20 feet. The average approach velocity at the maximum hydraulic capacity of 13,728 cfs is approximately 2.0 feet per second. Behind the racks, six penstocks feed water to six vertical Francis turbines. The total nameplate capacity of the station is 62.016 MW, with each turbine having a maximum hydraulic capacity of 2,288 cfs.

The Turners Falls Project bypasses 2.7 miles of the Connecticut River. The project is required to release 200 cfs to the bypass beginning May 1. When FirstLight is notified that the fish passage season has begun, the bypassed reach flow release is increased to 400 cfs until July 15 (or until the fishways are closed), when it is reduced to 120 cfs until river temperature drops below 7°C. No minimum flow to the bypassed reach is required from the time when the river temperature drops to 7°C through April 30.

The project is operated as a peaking facility when flows are within the hydraulic capacity of the two stations, with allowable headpond fluctuations of up to nine feet (from elevation 176.0 feet msl to 185.0 feet msl). Station No. 1 typically only operates during low flow periods or when flows exceed the hydraulic capacity of Cabot Station. The project is required to release a minimum below-project flow of 1,433 cfs, or inflow (whichever is less).

FirstLight operates both upstream and downstream fish passage facilities at the project. These facilities include an upstream anadromous fish ladder at the spillway, another fish ladder adjacent to the Cabot Station powerhouse that conveys fish to the canal, a third fishway at the canal gatehouse that conveys fish from the canal and spillway fishways to the headpond, and a downstream fish bypass in the Cabot Station forebay.

Northfield Mountain Pumped Storage Project

NMPS consists of an intake located along the banks of the Connecticut River (which acts as the lower reservoir), a powerhouse, a pressure shaft, and a 286-acre upper reservoir. The powerhouse contains four reversible pump/turbines that have a total nameplate capacity of 1,119.2 MW. The project pumps at a maximum hydraulic capacity of 15,200 cfs and generates at a capacity of 20,000 cfs. The intake to the lower reservoir is covered with trashracks that have 6-inch-clear spacing and an approach velocity of 3.5 feet per second.

NMPS operates as a peaking facility, typically pumping at night when power prices are low and generating during peak power periods during the day. The upper reservoir is allowed to fluctuate 62.5 feet (from elevation 1,000.5 feet msl down to elevation 938 feet msl). During the spring, the project limits pumping operation to three pumps and deploys a seasonal barrier net to minimize entrainment of Atlantic salmon (*Salmo salar*) smolts.

Average annual generation for the Turners Falls Project was 320,140 MWh for the period 2000 to 2010, and for the NMPS Project was 1,143,038 MWh for the period 2000 to 2009.

FirstLight is considering a number of potential modifications as part of the subject relicensing proceedings, including: (1) upgrading Station No. 1 with new or rehabilitated turbines; (2) closing Station No. 1 and adding capacity at Cabot Station similar to Station No. 1's capacity; (3) utilizing Cabot Station's full hydraulic capacity; (4) utilizing more storage in the NMPS upper reservoir; and (5) increasing the unit and station capacity at NMPS.

In the PAD, FirstLight has proposed no additional protection, mitigation and enhancement (PME) measures.

COMMENTS

3.2 Project Facilities

FirstLight provided a detailed description of the project facilities associated with the three stations (Station No. 1, Cabot Station, and NMPS); however, several important pieces of information are missing:

- the minimum hydraulic capacities, runner diameters and speeds of the turbines at Station No. 1 and Cabot Station; and
- the "lower reservoir" pool elevation that was used to calculate the approach velocity at the NMPS intake trashrack.

4.3.1.3 Overview of Water-Related Project Features

FirstLight discusses the gages that are installed at the Turners Falls and NMPS projects to monitor water level, discharges, generation and pumping conditions. The PAD provides monthly and annual summaries of these data. Unfortunately, monthly data do not provide the level of detail necessary to understand fully how these peaking projects operate individually and together; therefore, we are requesting that FirstLight provide hourly data (water surface elevations, dam discharge, generation, and pumping data) from both projects (three stations) for the past five years.

FirstLight states that it maintains hourly data on daily log sheets. This statement should be clarified; are data manually recorded, or does each gage electronically record hourly readings?

In the PAD, FirstLight states that generation can only take place at NMPS if releases can be stored in the Turners Falls impoundment without increasing the headpond elevation above allowable levels. While this statement might technically be accurate, there are other ways to maintain the elevation of the Turners Falls pool within allowable levels (e.g., opening a bascule gate). This statement should be clarified to address whether the bascule or tainter gates are ever opened to accommodate NMPS generation. If so, under what operation conditions of the Turners Falls Project has this occurred and is that operation proposed to continue?

4.3.1.6 2012 Water Level Monitoring Baseline Study

FirstLight undertook a water level monitoring effort in 2012, in consultation with state and federal resource agencies. Water level recorders were installed at various locations within the Turners Falls Project (i.e., the impoundment, bypass reach, and downstream of the Cabot Station tailrace). The recorders were deployed from April through early August. Appendix E of the PAD provides figures depicting the water level data. The results are helpful in understanding how water levels vary on a daily basis within different project areas. However, including additional information relevant to a particular location would provide even more insight (e.g., overlaying gate discharge and Station No. 1 generation data on the bypass reach graphs; overlaying Cabot Station and/or Station No. 1 generation data on the below-Cabot graphs, etc.).

4.3.2. Water Quality

The Turners Falls Project lies within three state boundaries: Vermont, New Hampshire, and Massachusetts. All three states classify the Connecticut River in the vicinity of the Turners Falls Project as Class B (although the criteria to meet Class B standards vary by state).

Impairments

Vermont lists the stretch of the Connecticut River from downstream of Vernon Dam to the state line as impaired due to flow alteration, with aquatic life support use impacted by fluctuating flows due to hydropower production. Likewise, New Hampshire lists the same stretch of river as impaired, with aquatic life use impacted by aluminum, copper, and low pH. Massachusetts lists the Connecticut River as impaired, with specific causes linked to specific locations as follows:

Location	Cause
State line to the Route 10 bridge	Other flow regime alterations; alteration in stream-side or littoral vegetative covers
Route 10 bridge down to the Turners Falls Dam	Alteration in stream-side or littoral vegetative covers; non-native aquatic plants
Downstream of Turners Falls Dam to confluence with Deerfield River	Suspended solids; low flow alterations; other flow regime alterations
From confluence with Deerfield River downstream to the Holyoke Dam	*E. coli* bacteria

Existing Data

The PAD provides a summary of existing water quality data. While a number of monitoring efforts have taken place and include sample sites within the project boundary, none of those studies were designed to comprehensively investigate whether all relevant project areas currently meet Class B standards:

- the Massachusetts Department of Environmental Protection's Connecticut River watershed assessment monitoring occurred in 2003, only had two stations located within the project area (both upstream of the Turners Falls dam), and only collected five to six samples from late April to early October;

- the Connecticut River Watershed Council's volunteer monitoring program only had one sample site within the project area (at Barton's Cove in the Turners Falls headpond), and while those data are more recent, only three samples were collected in 2007, and only six samples in 2008 (over the course of three to four months each year); and

- the U.S. Geological Survey's long-term water quality monitoring station, located downstream of the Cabot Station tailrace, stopped taking samples in 2007, only collected information roughly once per month, and sampled dissolved oxygen even less frequently.

No directed, site-specific surveys have been conducted to determine whether waters within the project area meet state standards. This information gap needs to be filled so resource agencies can properly evaluate and determine the potential impact of project operations on water quality. In the PAD, FirstLight proposes to conduct a water quality study during the summer period. The U.S. Fish and Wildlife Service (Service) supports FirstLight conducting water quality monitoring to verify compliance with state standards and herein submits a request for such a study.

4.4 Fish and Aquatic Resources

Resident Fish

In the PAD, FirstLight summarizes data from resident fish surveys conducted by the State of Massachusetts Division of Fisheries and Game (MA DFG, now the Division of Fisheries and Wildlife) in the early-to-mid-1970s, as well as a limited 2008 sampling effort by Midwest Biodiversity Institute (MBI) (Yoder *et al.* 2009). The MA DFG sampled eight stations within the Turners Falls pool every two weeks from April through October. MBI took a single sample at four sites within the Turners Falls pool during late September/early October.

Based on the very old MA DFG data and the limited sampling by MBI, 16 fish species were collected within the project area. However, we are aware that resident species such as northern pike (*Esox lucius*), tessellated darter (*Etheostoma olmstedi*), burbot (*Lota lota*), eastern silvery minnow (*Hybognathus regius*), and channel catfish (*Ictalurus punctatus*) also inhabit project waters (Ken Sprankle, USFWS, and Jessie Leddick, MADFW, personal communication). It is unknown how many other species may inhabit or utilize aquatic habitats in the project area, potentially including species of greatest conservation need.

The Turners Falls impoundment and below-dam riverine reach contain a diversity of habitat. Existing studies are of limited value due to being outdated, of too short duration, or gear-restricted (i.e., both studies only used electrofishing to sample fish), and thus do not provide a thorough understanding of the fish assemblages inhabiting the Turners Falls pool and riverine reach below the dam. This information is needed in order to determine whether project operations (at Turners Falls and NMPS) are impacting the health of the fish community within the project area. FirstLight has not proposed any studies to address this deficiency; therefore, the Service is herein submitting a request for such a study.

Headpond Fluctuations

The Turners Falls Project operates in a peaking mode. In the PAD, FirstLight states that while it is allowed to fluctuate the impoundment up to nine feet, it typically operates over a much narrower range. However, given that FirstLight is not proposing to formalize those operating ranges, it still could utilize the full drawdown levels. Regardless, even at the narrower operating bands, there is the potential for the project to dewater littoral areas important to shallow water nesting species.

The PAD contains no site-specific information on littoral spawners residing within the impoundment, or potential impacts of project operations on those species. This information gap needs to be filled so that the agencies can determine appropriate recommendations relative to headpond fluctuation restrictions. The Service herein provides such a request.

In addition to potentially impacting littoral spawners, daily drawdowns also may impact species that move from mainstem habitat into tributaries to spawn or fulfill other life history requirements. The PAD provides no information regarding how far upstream the influence of the impoundment extends into tributaries entering the mainstem. It is possible that when the headpond is at the lower end of its operating range, the mouths of tributaries could become perched, creating a barrier to upstream movement. This issue needs to be investigated so that agencies can use the results to develop recommendations regarding future project operations. The Service herein submits a request to address this issue.

Migratory Fish Species

American shad

FirstLight provides detailed descriptions of the life histories, restoration efforts, and passage status of migratory fish species known to occur within the project area. The Service offers one point of clarification with respect to American shad (*Alosa sapidissima*). In the PAD, FirstLight states that the seaward migration out of the Connecticut River begins in September; however, results of a study conducted by O'Donnell and Letcher (2008) examining juvenile shad early life history and migration upstream and downstream of the Turners Falls Dam suggest that outmigration begins in the month of August.

American shad are known to spawn downstream from the Turners Falls Project. Layzer (1974) identified six spawning sites from an area below the mouth of the Deerfield River (river mile 191.9) to river mile 161.7 below the Mill River in Hatfield, Massachusetts. Kuzmeskus (1977) verified 16 different spawning sites ranging from downstream of the Cabot tailrace to just upstream of the Holyoke dam (river mile 87.1). The only parameter that all spawning sites had in common was current (Kuzmeskus 1977). The Service is not aware of any more recent studies that document whether these 16 sites are still viable spawning locations for shad. We are not aware of any studies that have determined American shad spawning habitat or spawning sites upstream of the Turners Falls Dam, although juvenile shad have been collected within the Turners Falls pool, which suggests that spawning is occurring.

Peaking releases from Cabot Station produce rapid flow changes, and operations at Turners Falls and NMPS result in fluctuations of the Turners Falls pool. Both peaking releases and pond fluctuations affect physical parameters (i.e., water depth and velocity) that are important for shad spawning success. The Service is not aware of any studies being conducted specifically designed to determine if project operations at Turners Falls and NMPS affect American shad spawning behavior, habitat use, and egg deposition.

Fish Passage

The PAD provides an overview of the fish passage facilities that exist at both projects, when they began operating, and studies that have been conducted to determine their effectiveness at passing target species. We would like to offer some points of clarification. First, the Applicant states that the log sluice at Cabot Station is operated for American eels (*Anguilla rostrata*). While the sluice is operated during the eel outmigration period, the downstream bypass facility was not designed with eels in mind, and studies conducted by Alex Haro of the U.S. Geological Survey's Conte Anadromous Fish Research Center indicate that the bypass is not effective in preventing entrainment of eels at the intake (although an unknown proportion of silver phase eels do use the bypass).

Second, FirstLight states that effectiveness studies conducted in the 1990s estimated that 90 percent of the juvenile clupeids exited via the log sluice. The Service has reviewed the 1991 study conducted by Harza Engineering Company and RMC Environmental Services (full citation contained in Appendix G of the PAD) and the results clearly state that an estimated 58 percent of the juvenile clupeids approaching Cabot Station were bypassed via the log sluice.

Third, FirstLight cites two entrainment studies at NMPS involving intake netting of juvenile shad in the upper reservoir; however, both of the studies referenced relate to studies of Atlantic salmon smolts.

Canal Drawdown

FirstLight provides no information on the annual canal drawdown. Each year, the power canal is dewatered in September for over a one-week period to perform facility maintenance, inspections, and repairs. Historically, the canal drawdown occurred in July, but approximately five years ago, it was moved to September, where it has occurred annually since then (with the exception of

2010 when no drawdown took place). The agencies were informed in a letter by FirstLight that the shift to September was at the request of the Independent System Operator–New England to avoid peak load months of June through August.

Moving the drawdown event to September presents a number of concerns to the Service. First, the drawdown now coincides with the juvenile shad and adult eel outmigration period. Once the canal is drawn down to below the invert of the downstream bypass facility, the only way for fish to move out of the canal is through the intake and turbines. The fate of migrants that do not leave the canal is unknown, but they are certainly at risk for desiccation and predation.

Second, the canal contains substantial amounts of rearing habitat for sea lamprey (*Petromyzon marinus*) ammocoetes. The ammocoetes reside in the soft substrate materials located in much of the downstream end of the canal (Dr. Boyd Kynard, BK-Riverfish, LLC, personal communication). The number of ammocoetes that have died during recent drawdowns has been estimated qualitatively at tens of thousands (Matt O'Donnell, USGS Conte Lab, personal communication).

Third, the canal provides habitat for resident fishes, herptiles, and benthic invertebrates such as freshwater mussels. While a mussel survey conducted in 2011 by BioDrawversity (PAD, page 4-151) found no state listed or federally threatened or endangered mussel species, the eastern floater (*Pyganodon cataracta*) was found in the canal. All of these inhabitants potentially are impacted by the drawdown.

FirstLight is not proposing to conduct any studies relative to the canal drawdown. The Service believes the potential impacts to resources resulting from the canal drawdown warrants evaluation, and herein submits a study request intended to fill this information gap.

<u>Climate Change</u>

The Turners Falls Project has a very long impoundment capable of storing a large volume of water, as does the Northfield Mountain upper reservoir. The Turners Falls pool effectively has converted a large portion of the Connecticut River into an in-river "lake." Because water velocities slow in these impounded sections of river, it allows for increased thermal loading and resultant higher water surface temperatures than in free-flowing sections of river. The PAD provides a summary of existing water quality data compiled by FirstLight, including water temperature data obtained from the Service. The PAD also notes a 1991 study by the former licensee that modeled thermal effects of pumping to the upper reservoir. That model reported a maximum temperature difference attributable to NMPS operation of 0.21°C in the Turners Falls reach of the Connecticut River in low flow (4,000 cfs) simulation.

The most recent climate change prediction models specific to the Northeast forecast warmer air temperatures, more frequent high precipitation events, more heat waves, and an increase in the incidence of short-term droughts (Karl *et al.* 2009). The increase in air temperature will increase thermal loading into the impoundment and upper reservoir, which will then be discharged downstream of the dam.

The PAD contains no information relative to climate change and how climate change predictions may impact future operation of the hydroelectric plants, nor of how the projects either mitigate for or exacerbate predicted climate change impacts to freshwater ecosystems. These information gaps need to be filled so resource agencies can assess the relative and cumulative impact of project operations with respect to the Service's management goals and objectives, including those identified in its draft Climate Adaptation Strategy document (Anonymous 2012).

4.6 Wetland, Riparian, and Littoral Habitat

Wetland Habitat

The PAD provides a general description of invasive plant species within the Turners Falls pool. FirstLight identifies common reed (*Phragmites australis*) and Japanese knotweed (*Fallopia japonica*) as occurring in the impoundment, but the Service is aware that Eurasian watermilfoil (*Myriophyllum spicatum*) and water chestnut (*Trapa natans*) also are found within the Turners Falls pool. In fact, the abundance of water chestnut is increasing; in 2012, FirstLight and the Conte National Fish and Wildlife Refuge (Conte Refuge) removed over 3,500 pounds of water chestnut from the river immediately upstream from the dam (which, unfortunately, was not the entire population; thus, the plants that remained likely produced a seedbank that now will pose a reinfestation and expansion risk for the next 12 years).

With respect to invasive species, FirstLight should be aware that in the Connecticut River watershed, six Cooperative Invasive Species Management Area (CISMA) partnerships of varying scales are working on invasive species projects, including public outreach, inventory and on-the-ground invasive plant control. In addition, a full Connecticut River watershed-wide initiative networks these CISMAs as well as additional state and regional partners to prioritize invasive plant control actions and to plan and implement early detection and rapid response to new invaders to the watershed.

Wetland, Riparian and Littoral Vegetation and Wildlife

The PAD provides no site-specific vegetation or wildlife information. Baseline information on wildlife and botanical resources is needed in order for the agencies to determine if project operations may be impacting wetland, riparian or littoral species and their habitats.

FirstLight is proposing to conduct a baseline inventory of terrestrial wildlife and botanical resources in the Turners Falls impoundment, the bypass reach, and below Cabot Station. The Service supports FirstLight conducting a wildlife and botanical resources inventory and herein submits a request for such a study that also includes an assessment of the impacts of project-induced water level fluctuations on wetlands, and littoral and riparian vegetation and wildlife.

4.7 Critical Habitat and Threatened and Endangered Species

Puritan Tiger Beetle (*Cicindela puritan*)

The Puritan tiger beetle is listed as threatened, and inhabits Rainbow Beach, a point bar located within the Connecticut River in Northampton, Massachusetts. Within the Massachusetts section of the river, Rainbow Beach is the only known suitable habitat for the Puritan tiger beetle. The water levels at Rainbow Beach, which is within the Holyoke Project (FERC No. 2004), while controlled to some extent by the presence of Holyoke Dam and the operation of the Holyoke Project, are also impacted by the peaking generation operations of the Turners Falls Project. Given that the Holyoke Project is licensed as a run-of-river facility, and due to unique channel restrictions in the Holyoke impoundment, peaking flow releases from Cabot Station result in increased water levels at Rainbow Beach, which may lead to the periodic inundation of occupied Puritan tiger beetle habitat.

How the operations of the Turners Falls and Holyoke projects interact, and what operational changes to the Turners Falls Project can be implemented to reduce water level fluctuations at Rainbow Beach, need to be evaluated to ensure that relicensing of the Turners Falls Project does not result in adversely affecting the Puritan tiger beetle, which includes harm resulting from habitat modification or degradation. The Service is providing herein a modeling study request that includes this evaluation. If the results of that study indicate that water levels associated with the relicensing may affect the Puritan tiger beetle or its habitat, further consultation with this office under the Endangered Species Act is recommended.

5.2 Potential Studies and Information Gathering

Water Resources

FirstLight proposes to develop a calibrated operations model that would simulate existing operations of the Turners Falls Project and NMPS, and allow for evaluation of potential modifications to the projects (e.g., upgrade or decommission Station No. 1, upgrade Cabot Station, increase storage at NMPS, etc.), as well as assess alternative operations.

While FirstLight would use the model to understand how any changes would impact generation at the stations, the Service supports this study because it will allow the agencies to understand what, if any, limitations there may be to changing project operations to benefit natural resources within and beyond the project areas. The Service herein submits a request for such a study.

Water Quality

As noted above, the Service supports FirstLight conducting a water quality monitoring study and is submitting a request to that effect.

Fish and Aquatic Resources

Downstream Passage at Turners Falls

FirstLight proposes to evaluate the need for potential improvements to existing downstream fish passage and protection measures for American shad and American eel at the Turners Falls Project by utilizing information from previously conducted studies and ongoing studies. To date, the studies that have been conducted indicate that the downstream bypass is not effective for juvenile shad or American eel. No studies have been undertaken to evaluate the effectiveness of the existing downstream bypass for post-spawned adult shad.

The Service believes that new studies need to be conducted to fully understand how post-spawned adult shad, juvenile shad, and silver phase eels move through the lower Turners Falls pool, Turners Falls canal system, intakes and bypass. In addition, turbine and gate discharge mortality studies are needed for all of these species/life stages and should be used in conjunction with the results of the passage routing studies to calculate total through-project survival rates. The Service herein provides study requests in order to address these information needs.

Upstream Passage at Turners Falls

FirstLight proposes to evaluate the need for potential improvements to existing upstream fish passage facilities for American shad and American eel at the Turners Falls Project by utilizing information from previously conducted studies and ongoing studies. To date, the studies that have been conducted indicate that the Cabot fish ladder is not effective for passing American shad. No studies have been undertaken to evaluate the effectiveness of the existing fish ladders for juvenile American eels.

Relative to American eels, the Service believes that new studies are needed to determine where juvenile eels concentrate in relation to various project features, so that eel-specific upstream passage facilities can be sited properly. Previous studies have identified a number of problems with respect to American shad at the Cabot ladder and gatehouse fishway entrances, and the Service believes that a comprehensive radiotelemetry study is needed to understand the relationship between project operations, including spill flows, and shad movement through the Connecticut River, including attraction to and passage through these three ladders. Additionally, a study to define the relationship of the complex hydraulic conditions at the spillway fishway entrance and the gatehouse fishway entrances is needed in order to evaluate data on fish behavior and passage at those locations. Therefore, the Service is providing herein study requests to address these information needs.

Passage Past NMPS

FirstLight proposes no studies to address false attraction and entrainment at the NMPS facility. Previously conducted studies documented entrainment of juvenile shad. No studies have been undertaken to determine annual entrainment of resident fishes or entrainment of silver phase eels during outmigration.

Operations at NMPS have the potential to significantly impact movement of migratory fishes past the project and recruitment of migratory and resident riverine fishes within the impoundment. The extent of NMPS' influence on fish movement and entrainment needs to be determined. The adult shad radiotelemetry study referred to above should allow for evaluation of false attraction and entrainment of adult American shad. Separate studies are needed to assess entrainment of other species and life stages (including ichthyoplankton). In addition, hydraulic modeling of the NMPS intake area and the main river channel near the project are needed to understand the flow fields and intake/discharge velocities at the project that influence entrainment and passage past the project. Therefore, the Service is providing herein study requests to address these information needs.

Effects of Project Operations on Shortnose Sturgeon

FirstLight proposes to assess effects of discharges from Cabot Station and Station No. 1 on shortnose sturgeon (*Acipencer brevirostrum*) spawning. The Service agrees that station generation, as well as other project operations, including generation flows, spill flows, canal trash sluice discharges, and downstream passage sluice discharges have the potential to impact sturgeon spawning and egg incubation; therefore, we are providing study requests in order to address these information needs.

Instream Flows in the Turners Falls Bypass and Below Cabot Station

FirstLight is proposing to assess the effects of discharges from Cabot Station on zone of passage and habitat. The methodology outlined in the PAD to conduct a mesohabitat survey and then determine what level of additional studies, if any, are necessary, is inadequate. The bypass reach is 2.7 miles long and contains diverse habitat, including important spawning habitat for the federally endangered shortnose sturgeon. There are 10 miles of free-flowing river downstream of the Cabot Station that also contain a diversity of habitat, including important spawning and rearing habitat for migratory fish species such as American shad.

No studies have been conducted to assess the adequacy of the existing bypass flow protocol, or to evaluate the effect of peaking operations on instream and littoral habitat in the reach of river downstream of the Cabot tailrace. The Service herein submits study requests intended to address these information gaps.

<u>Terrestrial Wildlife and Botanical Resources</u>
<u>Wetland, Riparian, and Littoral Habitat</u>
<u>Critical Habitat and Threatened and Endangered Species</u>

FirstLight proposes to conduct a baseline inventory of botanical resources in the Turners Falls impoundment, bypass reach, and below Cabot Station. The inventory would include documenting wildlife and vegetative resources (including rare, threatened, endangered, and invasive species) in littoral, riparian, wetland and upland habitats. As noted above, the Service supports this study and is submitting a request to that effect.

5.3 Comprehensive Waterway and Resource Management Plans

In the PAD, FirstLight identifies 18 federal plans recognized by the Commission as Comprehensive Waterway Development Plans. In addition to those plans, the Service hereby submits the following plan to the Commission for consideration in determining whether it qualifies as a comprehensive plan pursuant to Section 10(a)(2)(A) of the Federal Power Act (Attachment A):

Addendum II to the Fishery Management Plan for American Eel. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

If the Commission determines that the plan identified above does not qualify as a comprehensive plan, we request that it be considered as a relevant resource management plan.

ADDITIONAL INFORMATION

The following information is needed:

- the minimum hydraulic capacities, runner diameters and speeds of the turbines at Station No. 1 and Cabot Station;
- the "lower reservoir" pool elevation that was used to calculate the approach velocity at the NMPS intake trashrack;
- a more thorough description of how project operations are monitored and recorded;
- the linear length of the Turners Falls impoundment so that the agencies can determine the distance of free-flowing river downstream of the Vernon Dam;[1]
- hourly data (water surface elevations, dam discharge, generation, and pumping data) from both projects (three stations) in spreadsheet format for the past five years; and
- updates to the figures in Appendix E of the PAD to include additional information relevant to a particular location (e.g., overlay gate discharge and Station No. 1 generation data on the bypass reach graphs; overlay Cabot Station and/or Station No. 1 generation data on the below-Cabot graphs, etc.).

RECOMMENDED STUDIES

The Applicant already has undertaken a mussel survey and water level monitoring effort. In addition, FirstLight is proposing to conduct a number of studies, including water quality monitoring, an instream flow assessment, and a baseline wildlife and botanical resources inventory. Enclosed please find our formal study requests (Attachment B) in the format required pursuant to 18 CFR §4.38(b)(5).

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[1] The Service is aware that FirstLight has collected data that indicate the Turners Falls pool does not extend up to the base of the Vernon Dam (as originally thought).

SCOPING DOCUMENT 1

3.6.3 Project Decommissioning

The Commission proposes to eliminate this alternative from detailed study in the environmental analysis, because no party has suggested project decommissioning would be appropriate in this case. The Commission asserts that there would be significant costs involved with decommissioning the project, including lost energy production.

We recommend that the Commission include project decommissioning in the environmental analysis. We note that while no party has suggested this alternative, up to this point in the Integrated Licensing Process, there has been no formal opportunity to provide such a recommendation. Further, the Commission has supplied no supporting information to justify the contention of significant decommissioning costs (which could run the gamut from "locking the door" to full dam removal at the Turners Falls Project, and from sealing the intake to draining and filling the upper reservoir at NMPS); and given the substantial increase in the numbers of proposed renewable energy projects, it is possible that there may be no net loss of energy production when viewed on a regional basis. Also, we are requesting a number of studies to understand the impacts of the NMPS project. Study results could identify impacts that either cannot be mitigated or would be prohibitively expensive to mitigate. In light of that possibility, decommissioning of the NMPS project should be retained as a potential alternative that the Commission may need to address.

4.1.2 Geographic Scope

The Service recommends that the geographic scope of the Commission's environmental analysis of the impacts to cumulatively affected fishery, water quantity and water quality resources extend from the upstream extent of the Wilder Project impoundment, downstream to Long Island Sound. For terrestrial resource issues, the geographic scope should be from the upstream extent of the Turners Falls Project impoundment to the upstream extent of the Holyoke headpond (i.e., the "impact" zone of the current peaking operation). For threatened and endangered species, the geographic scope should be from the Turners Falls Dam to the Holyoke Dam.

4.3.3 Aquatic Resources

Effects of project facilities and operations on fish migration should be analyzed cumulatively as well as for individual projects.

Effects of entrainment should not be limited to fish populations, but should include impacts to food web interactions and overall ecosystem productivity.

The annual drawdown of the Turners Falls canal should be included as an issue to analyze (i.e., effects of the canal drawdown on migratory and resident fish, herptiles and benthic invertebrates).

4.3.5 Threatened and Endangered Species

The federally threatened puritan tiger beetle (*Cicindela puritan*) should be included as a species to be analyzed. While the tiger beetle does not occur within the Turners Falls project boundary, flow releases from the project do affect water surface elevations, which in turn affect the beetle's habitat on Rainbow Beach in Northampton, Massachusetts.

Thank you for this opportunity to comment. If you have any questions regarding these comments, please contact John Warner of this office at (603) 223-2541.

Sincerely yours,

Thomas R. Chapman
Supervisor
New England Field Office

Attachments

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O'Donnell, M.J. and B.H. Letcher. 2008. Size and age distributions of juvenile Connecticut River American shad above Hadley Falls: influence on outmigration representation and timing. River Research and Applications 24:929-940.

Yoder, C.O., L.E. Hersha and B.R. Apell. 2009. Fish Assemblage and Habitat Assessment of the Upper Connecticut River. A Preliminary Report and Presentation of Data. MBI Technical Report MBI/2009-8-3. Final Project Report to U.S. EPA, Region 1.

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Reading File

ES: MGrader:3-1-13:(603)223-2541

ATTACHMENT A

Comprehensive Waterway Development Plans

ATTACHMENT B

Study Requests

FirstLight Study Request #1

Model River Flows and Water Levels Upstream and Downstream from the Turners Falls Project and Integrate Project Modeling with Upstream and Downstream Project Operations

(Turners Falls, P-1889; Northfield Mountain, P-2485)

Develop a river flow model(s) that is designed to evaluate the hydrologic changes to the river caused by the physical presence and operation of the Turners Falls Hydroelectric Project and the interrelationships between the operation of all five hydroelectric projects up for relicensing (i.e., P-1889 Turners Falls Hydroelectric Project, P-2485 Northfield Mountain Pumped Storage (NMPS), P-1904 Vernon Hydroelectric Project, P-1855 Bellows Hydroelectric Project, P-1892 Wilder Hydroelectric Project) and river inflows. The flow studies should assess the following topics:

1. Conduct quantitative hydrologic modeling of the hydrologic influences and interactions that exist between the water surface elevations of the Turners Falls Project impoundment and discharges from the Turners Falls Dam and generating facilities and the upstream and downstream hydroelectric projects. Data inputs to and outputs from the model(s) should include:

    a. withdrawals from the Turners Falls impoundment by NMPS;
    b. discharges to the Turners Falls impoundment by NMPS;
    c. discharges into the Turners Falls impoundment from the Vernon Project and other sources;
    d. existing and potential discharges from the Turners Falls Project generating facilities and spill flows;
    e. existing and potential water level fluctuation restrictions (maximum and minimum pond levels) of the Turners Falls impoundment and downstream flows from the project;
    f. existing and potential required minimum flows and/or other operation requirements at each of the four upstream projects; and
    g. minimum discharge flows ranging between 2,500 and 6,300 cfs in the bypass reach from April 15 through June 22 to support spawning, rearing, and outmigration of shortnose sturgeon at Rock Dam.

2. Document how the existing and potential outflow characteristics from the four upstream projects affect the operation of the Turners Falls Project, including downstream flow releases and Turners Falls impoundment levels.

3. Assess how the operation of the existing Turners Falls Project and upstream projects affect Holyoke Project (P-2004) operations, including:

a. how Turners Falls Project flow fluctuations affect Holyoke impoundment water levels, with emphasis on the influence of the water levels on federally listed Puritan tiger beetle habitat at Rainbow Beach in Northampton, Massachusetts, and assess what changes would be needed in Turners Falls operations to stabilize water levels at Rainbow Beach;
b. how Turners Falls Project operations affect Holyoke Project discharges and what changes in Turners Falls operations would be needed to reduce fluctuations in the discharges from the Holyoke Project.

4. To the extent predictable and practical, incorporate the potential effects of climate change on project operations over the course of the license.

Goals and Objectives

Determine the extent of alteration of river hydrology caused by operation of the project and the interactions between upstream project operations, Turners Falls operations and downstream operations at the Holyoke Project. The models will provide necessary information on what changes can be made to each of the five projects' flow releases and/or water levels restrictions, and how those changes affect downstream resources.

Specifically for the Turners Falls Project, continuous minimum discharge flows in its bypass reach need to be no less than 2,500 cfs during shortnose sturgeon spawning, rearing, and outmigration (April 15–June 22). Incorporating these parameters into the model will inform what changes, if any, need to be made to operations of upstream projects to accommodate such flows.

As other specific modifications of the operations of each of the projects are identified based on results of other requested studies, these desired conditions will need to be input into the models to assess how each change affects that project and other project operations and the implications of those changes on other resources and/or the ability to achieve desired operational changes at other projects.

Resource Management Goals

The U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the project.
3. Assist the Federal Energy Regulatory Commission to ensure that the continued operation of the facility is not likely to jeopardize the continued existence of shortnose sturgeon.

Specific to aquatic resources, the Service's goals are:

1. Protect, enhance, or restore, diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by project operations.
3. Minimize current and potential negative project operation effects on water quality and aquatic habitat.
4. Ensure that project operations are not likely to jeopardize the continued existence of shortnose sturgeon.
5. Avoid or minimize the current negative effect of project operations on shortnose sturgeon spawning and rearing within the Montague spawning area (i.e., Rock Dam and Cabot Station spawning sites and associated early life stage rearing areas).

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), and the Federal Power Act (16 U.S.C. §791a, *et seq.*).

Public Interest

The requestor is a resource agency.

Existing Information

Available information in the PAD does not indicate how project operations have altered downstream hydrology, which may affect resident and migratory fish, macroinvertebrates, rare, threatened, and endangered species, aquatic plants and other biota and natural processes in the Connecticut River from below the Vernon Dam downstream to the Holyoke Dam.

Information in the PAD also does not reflect data analyzed in Kynard *et al.* 2012, which identifies minimum discharge thresholds for shortnose sturgeon spawning and rearing at the Rock Dam spawning site. Spawning success was observed at Rock Dam when discharge was between 2,500 cfs and 22,000 cfs during the spawning period (April 27–May 22) (Kynard *et al.* 2012, chapter 3). In 1995 at the Cabot spawning area, the greatest level of spawning and spawning success occurred (i.e., 21 late stage females present, 342 early life stage sturgeon captured; spawning period was 17 days), even though no spawning was detected at Rock Dam (Kynard *et al.* 2012, chapter 3). Discharges in 1995 at Rock Dam had dropped below 2,500 cfs by March 26 (Kynard *et al.* 2012, chapter 3), indicating that even though 1995 saw the largest number of pre-spawning adults, none spawned at Rock Dam. This may indicate the need to have adequate flow well in advanced of spawning. Discharge reductions at the Rock Dam site that occurred during spawning caused females to leave the spawning cite and not return even if flow increased to acceptable levels later during the spawning period. Researchers observed that substrate did not change during fluctuating flows and thus cessation of spawning is likely due to velocities falling below the range preferred by gravid females. Given the current flow dynamics at Rock Dam, spawning does not occur most years (Kynard *et al.* 2012, chapter 3). These data represent the best available scientific information and indicate that the current minimum flow thresholds at the project are not adequate for the protection of endangered shortnose sturgeon. All modeling efforts described above must incorporate the identified minimum flow and temporal parameters.

Nexus to Project Operations and Effects

The Turners Falls Project is currently operated with a seasonally varying minimum bypass flow (400 cfs from May 1 through July 15, then 120 cfs through the winter until river temperature rises to ≥ 7°C) and year-round minimum flow below the project of 1,433 cfs. The project operates as a daily peaking project, often with large, rapid, daily flow fluctuations between the minimum and project capacity (15,928 cfs) and fluctuations in headpond elevation (175' to 186' MSL). These changes affect biotic habitat and biota upstream and downstream of the project. Project operations and potential changes to operations to mitigate impacts are influenced by inflows and operations of upstream peaking projects and NMPS operations, and potential changes in operations of each project could affect the ability to achieve desired operational changes at other projects. Results of river flow analyses will be used to develop flow-related license requirements and/or other mitigation measures.

Methodology Consistent with Accepted Practice

River hydrology statistics and modeling are commonly employed at hydroelectric projects to assess implications of project operations on the river environment.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

Level of effort and cost of model development are expected to be moderate, but to be valuable in developing license conditions, the model(s) will need to be run under various scenarios throughout the relicensing process to assess the implications of changes to the operations of each project on other projects and other resources. Therefore, ongoing consultation and re-running of the model(s) are likely to be needed throughout the relicensing process. The modeling exercise will also require coordination and cooperation between FirstLight and the upstream licensee to assure that the model inputs and outputs can be accurately related.

We would anticipate that the expected level of effort and anticipated costs will be comparable to those experienced on similar Federal Energy Regulatory Commission relicensing projects of this size (e.g., Conowingo, FERC No. 405).

REFERENCES

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FirstLight Study Request #2

Instream Flow Habitat Assessment Downstream of Cabot Station
(Turners Falls, P-1889)

Conduct an instream flow habitat study to assess the impacts of the range of the proposed project discharges on the wetted area and optimal habitat for key species. The study should include non-steady flow approaches to assess effects of within-day flow fluctuations due to peaking power operations on target fish species and benthic invertebrate communities. Target fish species include the federally endangered shortnose sturgeon, American shad, fallfish, and white sucker.

Goals and Objectives

The goal of this study is to determine an appropriate flow regime that will protect and enhance the aquatic resources from the Cabot tailrace of the Turners Falls Project downstream to the Route 116 bridge in Sunderland, Massachusetts. Specifically, the objective of the study is to conduct an instream flow habitat assessment of the impacts of a range of flows on the wetted area, and on the quantity and location of aquatic habitat for key species, including the impacts of hydropeaking flow fluctuations.

The study should include non-steady flow approaches to assess effects of within-day flow fluctuations due to peaking power operations on target fish species and benthic invertebrate communities. Target fish species include the federally endangered shortnose sturgeon, American shad, fallfish, white sucker and walleye.

For shortnose sturgeon, the flow study will need to evaluate bottom velocities in spawning and rearing areas during discharge conditions normally observed from April 15 to June 22. Protection of shortnose sturgeon spawning will necessitate establishment of discharges that create bottom velocities suitable for spawning and rearing over a sustained period of time and avoid dramatically fluctuating flows. To protect shortnose sturgeon rearing, adequate discharge without dramatic flow fluctuations is needed to ensure the rearing shoals are wetted and velocities are sufficiently protective for early life stage (ELS) rearing.

Field verification will be necessary to confirm the flow modeling results that identify the flows needed to provide sustained bottom velocities for spawning also maintain flows, depths, and water release regime adequate for spawning and rearing.

Resource Management Goals

The U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.

2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the project.

Specific to aquatic resources, the Service's goals are:

1. Protect, enhance, or restore diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.

2. Provide an instream flow regime that meets the life history requirements of resident and migratory fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by project operations.

3. Minimize current and potential negative project operation effects on water quality and aquatic habitat.

4. Avoid or minimize the current negative effect of project operations on shortnose sturgeon spawning and rearing at the Cabot Station spawning and rearing site.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), and the Federal Power Act (16 U.S.C. §791a, *et seq.*).

Public Interest

The requestor is a fish and wildlife resource agency.

Existing Information

Presently, FirstLight is required to release 1,433 cfs below the project. Information included in the PAD does not provide a detailed description of how this minimum flow was established and the Service is not aware of any previously conducted studies that evaluated the adequacy of this minimum flow in protecting aquatic resources in the 10+ miles of riverine habitat below the Cabot Station. Therefore, in order to fill this important information gap, an empirical study is needed to provide information on the relationship between flow and habitat in the Connecticut River downstream of the Cabot tailrace. Results will be used by the Service to determine an appropriate flow recommendation.

Kynard *et al.* (2012, chapter 3) examined the effects of water manipulation at the Turners Falls project on shortnose sturgeon spawning over the course of 17 years. This data does not support 1,433 cfs as an adequate minimum flow to support successful shortnose sturgeon spawning at

Cabot Station. Peaking operations at Cabot Station cause discharge fluctuations to rapidly change bottom velocities from 0.4 m/s to 1/3 m/s over 30 minutes (Kynard *et al.* 2012, chapter 3). Shortnose sturgeon have not evolved to adapt to such artificial rapid changes in velocities and therefore continue to spawn during fluctuations, even though conditions may be unsuitable and likely result in high egg mortality. During the 10 years when spawning succeeded at Cabot Station, discharge flow decreased to less than 35,460 cfs by April 29. The lowest discharge level observed while females remained on the spawning site was 4,700 cfs. Spawning behavior was not monitored during Cabot Station discharges at or below 3,500 cfs, so it is unclear what the minimum flow threshold is for spawning at Cabot Station. During naturally low flow periods, when water is held in storage for generation at a later time, tailrace shoals (including shoals along river banks), likely used by shortnose sturgeon ELS were exposed (observed during years 1995, 1998-1999, 2004) and may have resulted in ELS stranding and exposure mortality (Kynard et al 2012, chapter 3). Researchers observed that shoal exposure began when river flow below Cabot Station dropped below 7,062 cfs (Kieffer and Kynard 2007). Thus, total flow at Cabot, which may include flow from the Turners Falls Dam or Station 1, must be at least 7,062 cfs to both support adequate bottom velocities and prevent shoal exposure.

Furthermore, the emergency water control gates at Cabot Station that are used to sluice trash from the canal and balance canal flows spill large amounts of water. These large spill events create a plume of turbid turbulent flow, which cause some females to leave the area. These spill events scour bottom sediments which are then carried downstream over the spawning and rearing shoals where an entire year class of early life stages may be destroyed (Kynard *et al.* 2012, chapter 3). Information included in the PAD does not address adequate flows for shortnose sturgeon spawning and rearing. Results of the requested modeling will be used by the Service to determine an appropriate flow recommendation.

Researchers have also looked at suitable depth and velocity habitat for spawning (Kieffer and Kynard 1996; Kynard *et al.* 2012, chapter 3). Spawning sites are characterized by moderate river flows with average bottom velocities between 0.4 and 0.8 m/s (Hall *et al.* 1991, Kieffer and Kynard 1996; NMFS 1998). Water depth at the spawning site appears to be a less important habitat feature than substrate type and flow. A recent study by Kynard *et al.* (2012, chapter 6) demonstrated that females in an artificial stream will readily accept a shallow water depth of 0.6 m, with a rubble bottom, and 0.3–1.2 m/s bottom velocity. In addition, although eggs and embryos can likely tolerate very low depths, researchers measuring water depths between Turners Falls Dam and Cabot Station in order to recommend minimum flows suitable for an escape route for shortnose sturgeon trapped in the Turners Falls Dam plunge pool used a minimum depth of 1.5 x adult body depth. Because adults spawning in an artificial spawning channel frequently positioned themselves on top of one another (Kynard *et al.* 2012, Chapter 6), a minimum depth to facilitate spawning within the known Cabot Station spawning area is 3.0 body depths, or 19.2 inches.

Nexus to Project Operations and Effects

The project is currently operated with a minimum flow release that was not based on biological criteria or field study. Further, the project generates power in a peaking mode, resulting in significant within day flow fluctuations between the minimum and project capacity on an hourly or daily basis. The large and rapid changes in flow releases from hydropower dams are known to cause adverse effects on habitat and biota downstream of the project (Cushman 1985; Blinn *et al.* 1995; Freeman *et al.* 2001). There are more than ten miles of lotic habitat below the project's discharge that are impacted by peaking operations at Cabot Station. This section of the Connecticut River contains habitat that supports native riverine species, including important spawning and rearing habitat for migratory fish such as American shad and federally endangered shortnose sturgeon. Shortnose sturgeon larval migrants initially become bottom dwellers and transition from living off of yolk sacs to orally feeding, which is a critical stage in their life history. While the existing license does require a continuous flow of 1,433 cfs below the project (0.20 cubic feet per second flow per square mile of drainage area - cfsm), that is equal to only 40 percent of the Aquatic Base Flow.[1] this flow does not sufficiently protect the aquatic resources, including endangered species, in this substantial reach of river, especially in the context of the magnitude, frequency, and duration of changes in habitat that likely occur between minimum and generation flows.

Results of the flow study will be used by the Service to determine an appropriate flow recommendation that will protect and/or enhance the aquatic resources below the project.

Methodology Consistent with Accepted Practice

Instream flow habitat assessments are commonly employed in developing plant operational regimes that will reduce impacts or enhance habitat conditions downstream of hydroelectric projects.

The Service requests a flow study be conducted at the project. Given the length of the river reach (10+ miles) impacted by project operations, we believe a study methodology that utilizes an IFIM approach is appropriate for this site. This same protocol was used during the relicensing of the Housatonic River Project (FERC No. 2576),[2]and has been accepted by the Federal Energy Regulatory Commission (Commission) in other licensing proceedings.[3]

At a minimum, the study design should involve collecting wetted perimeter, depth, velocity, and substrate data along transects located in the reach of river below Cabot Station. The measurements should be taken over a range of test flows. This information then should be synthesized to quantify habitat suitability (using mutually agreed upon HSI curves) of each test flow for target species identified by the fisheries agencies. Habitat modeling using standard PHABSIM one dimensional modeling is acceptable for the river channel downstream from the railroad bridge below the mouth of the Deerfield River. The area from the Cabot Station discharge to the railroad bridge should be modeled using two dimensional 2D modeling to better characterize flows and velocities in this complex channel area.

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[1] The Aquatic Base Flow equates to the August Median Flow as determined using unregulated hydrography or on drainage area at the project site (0.5 cfs per square mile of drainage area) if unregulated hydrography is unavailable.

[2] Housatonic River Project License Application, Volume 4, Appendix F. Connecticut Light and Power Company, August 1999.

[3] Glendale Project (FERC No. 2801) Final Bypass Reach Aquatic Habitat and Instream Flow Study in Glendale Hydroelectric Project Application for Subsequent License (FERC No. 2801), Volume 2, Appendix B, pp. 7-8, October 2007.

The types of data collected with this study should be sufficient to perform a dual-flow analysis and habitat time series or similar approaches that will permit assessment of how quality and location of habitat for target species changes over a range of flows between existing minimum flow and maximum project generation flows.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

Field work for instream flow studies can be reasonably extensive but will depend on consultation with the Applicant on study methodology and on-site decisions on locations for data collection and the number of collection locations. Post-field work data analysis would result in a moderate cost and effort. We anticipate that the level of effort and costs will be comparable to those experienced on similar Commission relicensing projects of this size (e.g., the Conowingo Project, FERC No. 405).

REFERENCES

Blinn, W., J.P. Shannon, L.E. Stevens and J.P. Carder. 1995. Consequences of fluctuating discharge for lotic communities. Journal of the North American Benthological Society 14: 233–248.

Cushman, R.M. 1985. Review of ecological effects of rapidly varying flows downstream from hydroelectric facilities. North American Journal of Fisheries Management 5: 330–339.

Freeman, M.C, Z.H. Bowen, K.D. Bovee and E.R. Irwin. 2001. Flow and habitat effects on juvenile fish abundance in natural and altered flow regimes. Ecological Applications 11: 179–190.

Hall, W.J., T.I.J. Smith and S.D. Lamprecht. 1991. Movements and habitats of shortnose sturgeon *Acipenser brevirostrum* in the Savannah River. Copeia 1991:695-702.

Kieffer, M.C. and B. Kynard. 1996. Spawning of the shortnose sturgeon in the Merrimack River, Massachusetts. Transactions of the American Fisheries Society 125:179-186.

Kieffer, M.C. and B. Kynard. 2007. Effect of Water Manipulation by the Turners Falls Dam Hydroelectric Complex on Rearing Conditions for Connecticut River Shortnose Sturgeon Early Life Stages. S.O. Conte Anadromous Fish Research Center, Turners Falls, MA.

Kynard, B., P. Bronzi and H. Rosenthal, eds. 2012. Life history and behaviour of Connecticut River shortnose and other sturgeons. Special Publication no. 4. World Sturgeon Conservation Society, Norderstedt, Germany.

National Marine Fisheries Service (NMFS). 1998. Recovery plan for the shortnose sturgeon (*Acipenser brevirostrum*). Prepared by the Shortnose Sturgeon Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland.

FirstLight Study Request #3

Instream Flow Habitat Assessment of the Turners Falls Bypassed Reach

(Turners Falls, P-1889)

Goals and Objectives

The goal of this study is to determine an appropriate flow regime that will protect and enhance the aquatic resources in the bypassed reach between Turners Falls Dam and the Cabot Station discharge. Specifically, the objective of the study is to conduct an instream flow habitat study to assess the impacts of the range of the proposed project discharges on the wetted area and optimal habitat for key species.

Target fish species include the federally endangered shortnose sturgeon, American shad, fallfish, white sucker, freshwater mussels and benthic macroinvertebrates.

Resource Management Goals

The U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the project.

Specific to aquatic resources within the Turners Falls bypassed reach, the Service's goals are:

1. Protect, enhance, or restore diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
2. Provide a flow regime in the bypassed reach that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels), federally listed species, and diadromous fishes.
3. Minimize the current negative effects of project operations on shortnose sturgeon spawning and rearing within known spawning areas of the bypassed natural river reach (i.e., the Rock Dam).
4. Minimize current and potential negative project operation effects on water quality and aquatic habitat.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), and the Federal Power Act (16 U.S.C. §791a, *et seq.*).

Public Interest

The requester is a natural resource agency.

Existing Information

The Turners Falls Project bypasses a 2.7-mile-long section of the Connecticut River. Presently, the only required spill releases from the Turners Falls Dam to the bypassed reach are 400 cfs from May 1 through July 15, and 120 cfs from July 16 until the river temperature reaches 7°C.

In addition to these flows provided at the Turners Falls Dam, the bypassed reach receives flow from one small tributary (the Fall River, drainage area of 34.2 square miles), which enters the mainstem approximately 0.16 mile below the dam. The bypassed reach also receives the discharge from Station 1, when it is generating (typically when there is flow in excess of Cabot Station's needs). This discharge enters the bypassed reach approximately 0.9 mile below the dam.

Available information in the PAD does not indicate how project operations have altered downstream hydrology, habitat quantity and quality, and water quality, which may affect resident and migratory fish, macroinvertebrates, listed species, aquatic plants and other biota and natural processes in the Connecticut River from below the Turners Falls Dam downstream to the Cabot Station discharge. The PAD also provides no detailed description of the physical or biological characteristics of the bypassed reach.

Limited information exists on the adequacy of the existing bypass flow regime to protect water quality and aquatic life. However, there is existing information (not included in the PAD) relative to minimum flows necessary for shortnose sturgeon spawning and rearing at the Rock Dam spawning site (Kynard *et al.* 2012). Spawning success was observed at Rock Dam when discharge was between 2,500 cfs and 22,000 cfs during the spawning period of April 27 through May 22 (Kynard *et al.* 2012, chapter 3). In 1995, at the Cabot spawning area, the greatest level of spawning and spawning success occurred (i.e., 21 late stage females present, 342 early life stage sturgeon captured, and the longest spawning period of 17 days) even though no spawning was detected at Rock Dam (Kynard *et al.* 2012, chapter 3). Discharges in 1995 at Rock Dam had dropped below 2,500 cfs by March 26 (Kynard *et al.* 2012, chapter 3), which may indicate the need to have mitigated flow well in advance of spawning. Flow reductions at the Rock Dam site that occurred during spawning caused females to leave the spawning site and not return even if flow later increased to acceptable levels. Researchers observed that the rubble substrates remained dominant during fluctuating flows, and cessation of spawning is likely due to velocities falling outside the range preferred by females. Given the current flow dynamics at Rock Dam, spawning does not occur most years (Kynard *et al.* 2012, chapter 3). These data represent the best available scientific information and do not support current minimum flow thresholds at the project.

An empirical study is needed to provide information on the relationship between flow and habitat in the bypassed reach for the Service to use in determining a flow recommendation.

Nexus to Project Operations and Effects

The project includes a 2.7-mile-long bypassed reach. The Turners Falls Project is currently operated with a seasonally varying minimum bypass flow (200 cfs starting on May 1, increasing to 400 cfs when fish passage starts through to July 15, then reduced down to 120 cfs until river temperature drops below 7°C). The 400 cfs release is primarily to facilitate upstream movement of anadromous migrants to the spillway fish ladder at Turners Falls Dam, and the 120 cfs was intended to provide protection to shortnose sturgeon by maintaining a wetted habitat 1.5 times the maximum adult body depth through connections between pools within the bypassed reach. Neither of the currently required flows were based on quantitative, rigorous scientific studies.

This section of the Connecticut River contains habitat that supports native riverine species, including important spawning and rearing habitat for the federally endangered shortnose sturgeon. While the existing license does require seasonally varying flow releases from the Turners Falls Dam, we do not believe these flows sufficiently protect the aquatic resources, including endangered species, inhabiting the bypassed reach.

Results of the flow study will be used by the Service to determine an appropriate flow recommendation that will protect and/or enhance the aquatic resources in the bypassed reach for the duration of any new license issued by the Federal Energy Regulatory Commission (Commission).

Methodology Consistent with Accepted Practice

The Service requests a bypass flow study be conducted at the project. Bypass flow habitat assessments are commonly employed in developing flow release protocols that will reduce impacts or enhance habitat conditions in reaches of river bypassed by hydroelectric projects.

Given the size of the bypassed reach (2.7 miles long) and the important resources known to inhabit the reach (i.e., federally endangered shortnose sturgeon and diadromous fishes), we believe a study methodology that utilizes an IFIM approach is appropriate for this site. This same protocol was used during the relicensing of the Housatonic River Project (FERC No. 2576),[1] and has been accepted by the Commission in other licensing proceedings.[2]

At a minimum, the study design should involve collecting wetted perimeter, depth, velocity, and substrate data within a range of discharge levels along transects located in the reach of river between the dam and the Cabot Station discharge. The measurements should be taken over a range of test flows up to 6,300 cfs or over a sufficient range of flows to model flows up to 6,300

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1 Housatonic River Project License Application, Volume 4, Appendix F. Connecticut Light and Power Company, August 1999.

2 Glendale Project (FERC No. 2801) Final Bypass Reach Aquatic Habitat and Instream Flow Study in Glendale Hydroelectric Project Application for Subsequent License (FERC No. 2801), Volume 2, Appendix B, pp. 7-8, October 2007.

cfs. This information then should be synthesized to quantify habitat suitability (using mutually agreed upon HSI curves) of each test flow for target species/life stages identified by the fisheries agencies. Habitat modeling using standard PHABSIM one dimensional modeling is acceptable for the bypassed reach from the area downstream of the spillway where the river channel constricts to Rawsons Island upstream from the Rock Dam. The area from Rawson Island to the Cabot station discharge should be modeled using two dimensional 2D modeling to better characterize flows and velocities in this complex channel area. Likewise, we recommend 2D modeling in the spillway area and mouth of the Falls River to the point where the channel constricts, given this complex area with numerous potential flow discharge locations.

The flow study should incorporate the identified minimum flow and temporal parameters for shortnose sturgeon discussed in the Background and Existing Information section of this request.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

Field work for flow studies can be reasonably extensive but will depend on consultation with the applicant on study methodology and on-site decisions on locations for data collection and the number of collection locations. Post-field work data analysis would result in a moderate cost and effort. Field work associated with this study could be done in conjunction with the below-project instream flow study request. We anticipate that the level of effort and costs will be comparable to those experienced on similar Commission relicensing projects (e.g., the Glendale Project, FERC No. 2801).

REFERENCES

Kynard, B., P. Bronzi and H. Rosenthal, eds. 2012. Life history and behaviour of Connecticut River shortnose and other sturgeons. Special Publication no. 4. World Sturgeon Conservation Society, Norderstedt, Germany.

FirstLight Study Request #4

Evaluate the Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Spill Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream from Cabot Station

(Turners Falls, P-1889)

This evaluation should directly address the impact of sediment disturbance and excessive velocities on habitat in the Cabot Station tailrace and downstream resulting from emergency water control gate discharge events and bypass spill events and effects of spill from the downstream fish bypass sluice on federally threatened shortnose sturgeon spawning and incubation.

Goals and Objectives

The goal of this study is to determine appropriate scenarios for operation of the emergency water control gates and bypass flume that will be sufficiently protective of shortnose spawning and rearing below Cabot Station from excessive water velocities and exposure to abrasive sediments dislodged and transported across spawning and rearing areas. Furthermore, avoidance or minimization of rapid fluctuations in flow is also a goal of this study applicable to the operations of the emergency water control gates and bypass flume.

The objective of the study will be to determine how often the emergency water control gates are operated to discharge large quantities of water and evaluate the impact of these events on sediment transport and bottom velocities within known shortnose sturgeon spawning and rearing habitat below Cabot Station. Another objective is to understand the operation of the bypass flume that results in bypass flume spill events, and evaluate the impacts of these spill events on sediment transport and bottom velocities within known shortnose sturgeon spawning and rearing habitat below Cabot station. Even when bottom velocities fall within the range optimum for shortnose sturgeon spawning, rapid fluctuations may result in sediment transport having a harmful impact on developing eggs and embryos.

Specific Objectives include:

1. Emergency water control gate discharge events

    a. Field verification during operation of the emergency water control gates during a range of spill and discharge conditions is necessary during years 2014 and 2015 if emergency water control gates will continue to be operated during shortnose sturgeon spawning and rearing (April 15–June 22).

1) Collection of sedimentation and bottom velocity data during 2014 and 2015 is necessary to verify proposed alternative operation scenarios for the emergency water control gates that will avoid or minimize negative impacts to spawning and rearing habitat.

2. Bypass flume spill events

   a. Field verification during bypass flume spill events under a range of spill and discharge conditions is necessary during years 2014 and 2015 if bypass flume spill events continue to be a part of future project operations and will occur during shortnose sturgeon spawning and rearing (April 15-June 22).

      1) Collection of sedimentation and bottom velocity data during 2014 and 2015 is necessary to verify proposed alternative operation scenarios for the bypass flume that will avoid or minimize negative impacts to spawning and rearing habitat.

Resource Management Goals

The U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the projects. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the project.

Relative to this study request, the Service seeks to understand current emergency water control gate bypass flume operations and associated impacts to determine potential operation scenarios that avoid or minimize negative effects on shortnose sturgeon spawning a rearing.

Public Interest

The requestor is a natural resource agency.

Existing Information

The emergency water control gates are used to spill large amounts of water, and Cabot Station also spills water from the bypass flume (Kynard *et al.* 2012, chapter 3; Kieffer and Kynard 2007). These large spill events created a plume of turbid turbulent flow, which caused some females to leave the area (Kynard *et al.* 2012, chapter 3; Kieffer and Kynard 2007). Additional spill events were observed to scour bottom sediments which are then pushed downstream over, or deposited on spawning and rearing shoals where an entire year's class of early life stage sturgeon may be destroyed (Kynard *et al.* 2012, chapter 3; Kieffer and Kynard 2007). Information included in the PAD does not address operation of the emergency water control gates or bypass flume and impacts on shortnose sturgeon spawning and rearing.

Nexus to Project Operations and Effects

The large and rapid changes in flow releases from hydropower dams are known to cause adverse effects on habitat and biota downstream of the project (Cushman 1985; Blinn *et al.* 1995; Freeman *et al.* 2001). One of the two critical shortnose sturgeon spawning and rearing areas in the Connecticut River is located within the Cabot Station tailrace and impacted by the project's discharges, including spill from the emergency water control gates and bypass flume. This section of the Connecticut River also contains habitat that supports important spawning and rearing areas for migratory fish such as American shad and American eel. Current operations of the emergency water control gates and bypass flume create flow dynamics that are not sufficiently protective of shortnose sturgeon spawning and rearing. Results of this study will be used by the Service to determine recommendations for operation of the emergency water control gates and bypass flume that will avoid or minimize sedimentation and improve bottom velocities that are sufficiently protective of shortnose sturgeon spawning and rearing.

Methodology Consistent with Accepted Practice

River hydrology modeling is commonly employed at hydroelectric projects to assess implications of project operations on the river environment. It is assumed that the planned hydrologic modeling can incorporate emergency water control gate operations and associated impacts. Thus, an additional model would not be required for this request.

Field assessment will be needed to collect sedimentation and bottom velocity data at the emergency water control gates and fish bypass sluice discharge areas to determine what operational scenarios of those structures avoid or minimize impacts to shortnose sturgeon spawning and rearing. Velocity gauges will be employed to collect data on bottom velocities associated with project operations at Cabot Station. Coordination of gauge placement for this request with the field measurements for the instream flow study should help minimize the number of necessary gauges. Field assessment of sedimentation may be collected using a variety of techniques. One potential method of collection of sedimentation data would be to set fine-mesh nets similar to shortnose sturgeon larval collection nets; these nets may show changes in the amount of dislodged substrate material that travels along the spawning site as a result of powerful releases at both the Cabot spillway and bypass flume.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

Field verification for this study request will likely be coordinated with other field work for related study requests. It is not expected that the required field work for this request will result in significant additional cost and effort beyond what is expected for field work related to the instream flow study request. Post-field work data analysis would be a moderate cost and effort. We anticipate that the level of effort and costs will be comparable to that experienced on similar Federal Energy Regulatory Commission relicensing projects of this size (e.g., the Conowingo Project, FERC No. 405).

REFERENCES

Blinn, W., J.P. Shannon, L.E. Stevens and J.P. Carder. 1995. Consequences of fluctuating discharge for lotic communities. Journal of the North American Benthological Society 14: 233–248.

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Kynard, B., P. Bronzi and H. Rosenthal, eds. 2012. Life history and behaviour of Connecticut River shortnose and other sturgeons. Special Publication no. 4. World Sturgeon Conservation Society, Norderstedt, Germany.

FirstLight Study Request #5

Impact of the Operations of the Turners Falls, Northfield Mountain Pumped Storage, Vernon and Bellows Falls Projects on Shad Spawning, Spawning Habitat, and Egg Deposition

(Turners Falls, P-1889; Northfield Mountain, P-2485; Bellows Falls, P-1855; Wilder, P-1892; Vernon, P-1904)

Conduct a field study of spawning by American shad in the Connecticut River mainstem downstream of Turners Falls Dam, in the Turners Falls Dam impoundment, in the Vernon Dam Project area, and downstream of Bellows Falls Dam to determine if project operations (including operations of the Northfield Mountain Pump Storage) (NMPS) negatively impact shad spawning behavior, spawning habitat use, areal extent and quality of those spawning areas, and spawning activity in terms of egg deposition in those areas.

Goals and Objectives

Determine if project operations (under the permitted and proposed operational ranges) affect American shad spawning site use and availability, spawning habitat quantity and quality, and spawning activity in the river reaches downstream from Cabot Station and in the project bypass reach of Turners Falls Dam, in the Turners Falls Dam impoundment, and in relation to NMPS operations, downstream and upstream of the Vernon Dam, and in the project area downstream of Bellows Falls Dam. The following objectives will address this request:

1. determine areas utilized by American shad for spawning by conducting nighttime visual observation of spawning activity, identify and define areas geospatially, and obtain data on physical habitat conditions affected by project operations (e.g., water depth, velocity, discharge, substrate, exposure and inundation of habitats);
2. determine project operation effects on observed spawning activity, under a range of permitted or proposed project operation conditions;
3. quantify effects (e.g., water velocity, depths, inundation, exposure of habitats) of project operation on identified spawning areas for a range of conditions, over the complete period of spawning activity; and
4. quantify spawning activity as measured by nighttime spawning/splash surveys and egg collection in areas of spawning activity, and downstream of these areas, to further determine project operation effects (location and extent of exposure from changing water levels and flows).

If it is determined that the project operations are adversely affecting the spawning activity of American shad and impacting spawning habitat, identify operational regimes that will reduce and minimize impacts to spawning habitat and spawning success. This study will require two years of field data to capture inter-annual variability to river discharge and water temperatures and to allow for evaluation of alternative flow regimes if year one studies determine that the present peaking regime negatively affects spawning.

Resource Management Goals

The Connecticut River Atlantic Salmon Commission (CRASC) developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management objectives in the plan include the following:

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.
2. Achieve annual passage of 4 percent to 60 percent of the spawning run (based on a five-year running average) at each successive upstream barrier on the Connecticut River mainstem.

The Atlantic States Marine Fisheries Commission, Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010, includes the following objective:

Maximize the number of juvenile recruits emigrating from freshwater stock complexes:

1. to mitigate hydrological changes from dams, consider operational changes such as turbine venting, aerating reservoirs upstream of hydroelectric plants, aerating flows downstream, and adjusting instream flows;
2. natural river discharge should be taken into account when instream flow alterations are being made to a river (flow regulation) because river flow plays an important role in the migration of diadromous fish;
3. ensure that decisions on river flow allocation (e.g., irrigation, evaporative loss, out of basin water transport, hydroelectric operations) take into account instream flow needs for American shad migration, spawning, and nursery use, and minimize deviation from natural flow regimes; and
4. when considering options for restoring alosine habitat, include study of impacts and possible alteration of dam-related operations to enhance river habitat.

The U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the projects. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the projects.

Specific to American shad, the Service's goal is:

Minimize current and potential negative project operation effects on American shad spawning and recruitment.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), the Silvio O. Conte National Fish and Wildlife Refuge Act (P.L. 102-212; H.R. 794), the Federal Power Act (16 U.S.C. §791a, *et seq.*), the Atlantic States Marine Fisheries Compact (P.L. 539, 77th Congress, as amended by P.L. 721, 81st Congress), and the Atlantic Coastal Fisheries Cooperative Management Act (16 U.S.C. 5107).

Public Interest

The requestor is a resource agency.

Existing Information

Since the construction of the first fish lift facility at Holyoke Dam in 1967, American shad have had access to spawning and rearing habitat upstream from Holyoke Dam. A number of improvements to the Holyoke fishway have occurred since that time, but while the numbers of shad lifted at Holyoke have reached as much as 721,764, and the overall shad population to the river exceeded 1.6 million shad in 1992 (CRASC 1992), total shad population, and numbers of shad passing Turners Falls and Vernon Dam have not met CRASC management plan objectives. Population number and passage numbers past Holyoke have declined substantially from those totals in recent years, with average Holyoke passage numbers over the last 10 years of 211,850. Since historically approximately half of the returning population of shad to the river passed upstream of Holyoke, recent returns are far below management goals. Effective upstream and downstream passage and successful in-river spawning and juvenile production are necessary to help achieve shad management goals for the Connecticut River.

American shad broadcast spawn in congregations over shallow flats and rocky or sandy substrates (Mansuetti and Kolb 1953) at depths less than 10 feet and often far shallower with spawning fish swimming vigorously near the surface in a closely packed circle (Marcy 1972; MacKenzie *et al.* 1985). Fertilized eggs drift downstream until hatching (MacKenzie *et al.* 1985).

American shad are known to spawn downstream from the Turners Falls Project. Layzer (1974) identified six spawning sites from an area below the mouth of the Deerfield River (river mile 191.9) to river mile 161.7 below the Mill River in Hatfield, Massachusetts. Kuzmeskus (1977) verified 16 different spawning sites ranging from downstream of the Cabot tailrace to just upstream of the Holyoke Dam (river mile 87.1). The only parameter that all spawning sites had in common was current (Kuzmeskus 1977). The Service is not aware of any more recent studies that document whether these 16 sites are still viable spawning locations for shad. We are not aware of any studies that have determined American shad spawning habitat or spawning sites upstream of Vernon Dam to Bellows Fall Dam (historic extent of upstream range).

FirstLight Power conducted studies in the late spring and summer of 2012, and examined habitat conditions downstream of the Turners Falls Dam. The study documented that in low flow conditions, Cabot Station project operations produced fluctuations in water level elevations that can range over 4 feet in magnitude (daily operation) at the USGS Montague Gage Station, to lower values of 2 to 3 feet at the Route 116 Bridge, Sunderland, Massachusetts (PAD). Similar short-term, limited monitoring in the upper Turners Falls Dam impoundment identified water level changes due to project operations that cyclically varied several feet on a sub-daily frequency.

Nexus to Project Operations and Effects

American shad are known to spawn at five locations downstream from the Turners Falls Project from an area below the mouth of the Deerfield River (river mile 191.9) and ten other locations downstream to river mile 161.7 below the Mill River in Hatfield (Layzer 1974; Kuzmeskus 1977).

Shad spawning is likely influenced by river flow, which fluctuates greatly due to the project's peaking mode of operation. These fluctuations may impact shad spawning activity by altering current velocities and water depth at the spawning sites. Effects on spawning behavior could include suspension of spawning activity, poor fertilization, flushing of eggs into unsuitable habitat due to higher peaking discharges, eggs dropping out into unsuitable substrate and being covered by sediment deposition, and/or eggs becoming stranded on dewatered shoal areas as peak flows subside.

While a number of shad spawning and egg deposition studies were conducted in the 1970s, that research was aimed at assessing the potential impact of developing a nuclear power station in the Montague Plains section of the Connecticut River. The Service is not aware of any studies being conducted to assess the relationship between spawning behavior, habitat use and egg deposition, and operations of the Turners Falls, NMPS, Vernon and Bellows Falls projects.

The Service is concerned that peaking operations may be altering spawning behavior and contributing to the failure of the Connecticut River shad population to meet management targets.

Methodology Consistent with Accepted Practice

The first year of study should examine known spawning areas downstream of the Turners Falls Dam project, to determine operation effects on shad spawning behavior, activity, and success. In areas upstream of Turners Falls Dam to the Bellow Falls Dam tailrace, the study should identify areas utilized for spawning by American shad. In the second year, should results from year one determine project operations affected spawning activity, access to habitat, or success downstream of Turners Falls Dam, an identical more detailed assessment (identified objectives) should be conducted in spawning areas upstream of Turners Falls Dam to the Bellows Falls Dam tailwater. Measures to reduce or eliminate any documented project operation impacts should be explored and evaluated in year two downstream of Turners Falls Dam.

The impacts to spawning behavior would best be studied by nighttime observations of actual in-river spawning behavior (Ross *et al.* 1993). Project discharge increases or decreases during actual observed spawning activity will provide empirical evidence of change in behaviors. The observational methodology should follow the protocol specified in Layzer (1974) and/or as described in Ross *et al.* (1993). The analysis should utilize the observational field data in conjunction with operational data from the projects (station generation and spill on a sub-hourly basis). To assess the impacts of changes in generation flows, the study should include scheduled changes in project operation to ensure that routine generation changes that occur during the nighttime spawning period affect downstream spawning habitats selected for study while shad are spawning. Stier and Crance (1985) provide optimal water velocities during spawning to range between 1 to 3 ft/sec.

In areas used for spawning, the characteristics of those areas (e.g., location, depth, flow, substrate) should be recorded. The effect of project operations (discharge, water velocity, inundation and exposure) should be assessed. Drift nets will be used to collect eggs to quantify egg production before and after flow changes at the spawning site.

In the reaches above the Turners Falls Dam, nighttime observations of splashing associated with shad spawning should be done in each reach as sufficient numbers of shad are passed above each dam. Observations should be done regularly until the end of the spawning season. The use of radio-tagged adult shad from a separate study request will aid in this effort. An estimate of the total area used for spawning and an index of spawning activity should be recorded for each site.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

Neither FirstLight nor TransCanada propose any studies to meet this need. Estimated cost for the study is expected to be moderate (up to $40,000) for each owner, with the majority of costs associated with field work labor.

REFERENCES

Atlantic States Marine Fisheries Commission. 2010. Amendment #3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management). Washington, D.C.

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FirstLight Study Request #6

Telemetry Study of Upstream and Downstream Migrating Adult American Shad to Assess Passage Routes, Effectiveness, Delays, and Survival

(Turners Falls, P-1889; Northfield Mountain, P-2485; Bellows Falls, P-1855; Vernon, P-1904)

Goals and Objectives

Assess behavior, approach routes, passage success, survival, and delay by adult American shad as they encounter the projects during both upstream and downstream migrations, under permitted project operations conditions, proposed operational conditions, and study treatment operational conditions at FirstLight Power's Turners Falls and Northfield Mountain Pumped Storage (NMPS) projects and TransCanada's Vernon Project. There are multiple fishways and issues related to both upstream and downstream passage success at the projects. Some of these issues at the Turners Falls Project are similar to and/or pertain directly to the NMPS and Vernon projects. Therefore, it is reasonable to address passage issues at all projects in a similar manner.

Telemetry Study - This requested study requires use of radio telemetry using both radio and Passive Integrated Transponder (PIT) tag types to provide information to address multiple upstream and downstream fish passage issues. The following objectives shall be addressed in these studies:

1. assessment of any migration delays resulting from the presence of the dam and peaking flow operations of the Turners Falls Project;
2. determine route selection and behavior of upstream migrating shad at the Turners Falls Project under various spill flow levels (e.g., movement to the dam, attraction to Cabot Station, attraction to Station 1 discharge, movement between locations, delay, timing, etc.). A plan and schedule for dam spill flow releases will need to be developed that provides sufficient periods of spill flow conditions, and various generating levels from Turners Falls #1 Station coupled with Cabot Station generation flows (e.g., treatments will require multiple days of consistent discharge). Evaluated spill flows should include flows between 2,500–6,300 cfs, which relate to bypass flows identified as providing spawning opportunities for shortnose sturgeon in the lower bypass reach at the Rock Dam (Kieffer and Kynard 2012). Sturgeon spawning and upstream shad passage occur concurrently;
3. assess near field, attraction to and entrance efficiency of the spillway ladder by shad reaching the dam spillway, under a range of spill conditions;
4. evaluate the internal efficiency of the Turners Falls spillway ladder;
5. continue data collection of Cabot Station ladder and gatehouse ladder efficiency, to include rates of approach to fishway entrances, entry into fishways, and passage through them, under different operational conditions that occur in these areas;
6. evaluate modifications to the Cabot Station and/or spillway fishways recommended by the U.S. Fish and Wildlife Service (Service) if they are implemented;

7. assess upstream migration from Turners Falls to the Vernon Dam in relation to NMPS's pumping and generating operations and Vernon Project peaking generation operations. Typical existing and proposed project operation alterations should be evaluated;
8. assess near field, attraction to and entrance efficiency of the Vernon Dam ladder;
9. assess internal efficiency of the Vernon Dam ladder;
10. assess upstream passage past Vermont Yankee's thermal discharge (also located on the west bank of the river 0.45 mile upstream of fish ladder exit);
11. assess upstream migration from Vernon Dam in relation to the peaking generation operations of the Bellows Falls Project. Typical existing and proposed project operation alterations should be evaluated;
12. determine post-spawn downstream migration route selection, passage efficiency, delays and survival related to the Vernon Project, including evaluation of the impact of the Vermont Yankee heated water discharge plume on downstream passage route, migrant delay/timing, efficiency and survival;
13. assess impacts of NMPS operations on up- and downstream adult shad migration, including delays, entrainment, and behavioral changes and migration direction shifts under existing and proposed project operations;
14. determine downstream passage route selection, timing/delay, and survival under varied project operational flows into the power canal and spill flows at Turners Falls Dam;
15. determine downstream passage route selection, timing/delay in the canal, Cabot Station fish bypass facility effectiveness, and survival of Cabot Station-bypassed adult shad that enter the Turners Falls canal system;
16. compare rates and or measures of delay, movement and survival, etc., among project areas or routes utilized (e.g., spill at dam vs. power canal) under the range of permitted and proposed conditions; and
17. utilize available data sets and further analyze raw data (e.g., 2003-2012 U.S. Geological Survey's Conte Anadromous Fish Research Center [Conte Lab] studies) where possible to address these questions and inform power analyses and experimental design.

Information to address all of these questions would rely on the tagging of upstream migrating adult shad at Holyoke Dam and releasing them to migrate naturally from Holyoke through the Turners Falls and Vernon projects and back downstream after spawning. Additional tagged individuals would likely need to be released farther upstream (Turners Falls canal, upstream of Turners Falls Dam, and upstream of Vernon Dam) to ensure that enough tagged individuals encounter project dams on both upstream and downstream migrations, that these individuals are exposed to a sufficient range of turbine and operational conditions to test for project effects, and to provide adequate sample sizes for statistically valid data analyses to address the many objectives listed. This study will require two years of field data collection to attempt to account for inter-annual variability in river discharge and water temperatures.

Evaluation of Past Study Data - In addition to collection and analysis of new telemetry data, substantial data has already been collected at Turners Falls from multiple years of passage assessments conducted for FirstLight by Conte Lab researchers, and there are also data from the 2011 and 2012 full river study conducted by the Conte Lab that address Turners Falls, NMPS and Vernon project migration and passage questions that have not yet been analyzed. These data include several million records each year from more than 30 radio telemetry receivers deployed between Middletown, Connecticut and Vernon Dam. This data will provide substantial information free from the field data collection costs and therefore should be analyzed as part of this study. This data analysis should be completed in 2013 to help inform the design of subsequent field studies.

Evaluation of Methods to Get Shad Past Cabot Station for Spillway Passage at the Turners Falls Dam – The poor passage efficiency of the Cabot Station ladder, the first and most used fishway encountered by shad arriving at the Turners Falls Project, and at the entrance to the gatehouse ladder, which all Cabot Station fishway-passed fish must use, has resulted in very poor overall shad passage efficiency at the project. An alternative to passing fish at the Cabot Station is to install a fish lift at the dam that would put fish directly into the Turners Falls pool, thereby eliminating problems with the Cabot Station fishways, and the gatehouse fishway entrance and the variable passage efficiency of the gatehouse fishways. For this to be effective, attraction of shad to the Cabot Station discharge and associated delays would need to be overcome. It is possible that spillway flow releases coupled with behavioral measures at Cabot Station that dissuade shad from that tailrace could achieve this end. In order to assess the possibilities, we recommend the following study:

1. A literature search and desk-top assessment of the possible behavioral measures that could be effective in getting shad to pass Cabot Station tailrace and continue upstream to the dam.
2. Based on results of the desk-top assessment, possible evaluation of behavioral measures that are likely to be effective.
3. Field evaluation of the effect of different levels of spill at the dam that would induce fish to move past the Cabot Station into the bypass reach and up to the dam (as noted in Goals and Objectives).

In addition to passage success and delays at passage facilities, these studies would assess the impacts of project operations on migration passage delay, route, timing, injury, mortality, and passage structure attraction, retention, and success. Of particular interest will be fish behavior: during periods when project flow releases increase from the required minimum to peak generation flows, when they subside from peak generation to minimum flows, and in response to the operation of NMPS in pumping and generation modes.

Resource Management Goals

The Connecticut River Atlantic Salmon Commission (CRASC) developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following:

1. achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually;
2. achieve annual passage of 40 to 60 percent of the spawning run (based on a five-year running average) at each successive upstream barrier on the Connecticut River mainstem; and
3. maximize outmigrant survival for juvenile and spent adult shad.

The Atlantic States Marine Fisheries Commission, Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010, includes the following objective:

Maximize the number of juvenile recruits emigrating from freshwater stock complexes:

Upstream Passage –

1. American shad must be able to locate, enter, and pass the passage facility with little effort and without stress.
2. Where appropriate, improve upstream fish passage effectiveness through operational or structural modifications at impediments to migration.
3. Fish that have ascended the passage facility should be guided/routed to an appropriate area so that they can continue upstream migration, and avoid being swept back downstream below the obstruction.

Downstream Passage –

To enhance survival at dams during emigration, evaluate survival of post spawning and juvenile fish passed via each route (e.g., turbines,, spillage, bypass facilities, or a combination of the three) at any given facility, and implement measures to pass fish via the route with the least delay and best survival rate.

Based on the CRASC plan, the Service seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the projects. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the projects.

Specific to American shad movement and migration, the Service's goal is:

Minimize current and potential negative project operation effects such as migration delays, false attraction, turbine entrainment, survival of project passage routes, and trashrack impingement that could hinder management goals and objectives.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), the Silvio O. Conte National Fish and Wildlife Refuge Act (P.L. 102-212; H.R. 794), the Federal Power Act (16 U.S.C. §791a, *et seq.*), the Atlantic States Marine Fisheries Compact (P.L. 539, 77th Congress, as amended by P.L. 721, 81st Congress), and the Atlantic Coastal Fisheries Cooperative Management Act (16 U.S.C. 5107).

Public Interest

The requestor is a federal natural resource agency. Migratory species of fish are a trust resource for the Service due to their interjurisdictional movements. Protection and restoration of these fish is a key objective for the Service.

Existing Information

Passage of adult shad at the Turners Falls fishway complex has been the subject of intense study by the Conte Lab since before 1999. These studies have clearly demonstrated that passage through the existing fishways at the Cabot Station and spillway is poor (<10 percent in many years). Passage through the gatehouse fishway is better, but still rarely exceeds 80 percent, despite the short length of this ladder. In addition to poor passage for fish entering the ladders, shad that ascend the Cabot Station fishway experience extensive delays before entry into the gatehouse fishway. Shad that ascend spillway frequently fall back into the canal and are also subject to these upstream delays. A new entrance to the gatehouse fishway installed in 2007 led to dramatic improvements in passage out of the canal (from 5 percent to over 50 percent in 2011), but passage still falls well short of management goals. In addition, shad spend considerable time (up to several weeks) attempting to pass. These delays likely influence spawning success and survival. Adult shad, unable to pass the gatehouse fishway, experience similar delays in downstream passage, even after they have stopped trying to pass the gatehouse fishway. In addition, if there is no spill, all outmigrating shad that have passed upstream must enter the power canal and may be subject to delays exiting the canal.

During the course of these studies, a very large dataset has been compiled that could yield useful information for further improving passage of shad out of the canal in both the upstream and downstream directions. A unique feature of these data is a two-dimensional array covering the canal just downstream of the gatehouse fishway, documenting fine scale movements and occupancy of this zone. These data should be combined with computational fluid dynamics (CFD) and real-time hydraulic data to determine how canal hydraulics influence the ability of shad to locate and enter the fishway, and to identify modifications that are likely to lead to improvements in approach and entry rates. A separate CFD modeling study is requested that includes modeling of the gatehouse fishway entrance area at the head of the power canal.

In addition, whole-river shad telemetry studies performed in 2011 and 2012 will likely provide useful information and should be analyzed. These data should allow quantification of delay below Turners Falls, and could help guide studies requested above. Preliminary analyses of data through 2011 have been made available to FirstLight and the resource agencies (Castro-Santos and Haro 2005; Castro-Santos and Haro 2010).

The whole-river studies have also shown that, at least in 2011, most shad that pass Turners Falls rapidly progress upstream to Vernon Dam where extensive delays also occur. Data from the 2012 study are not available at this time, but Dr. Castro-Santos stated that similar patterns in upstream passage delay were noted in the data from both years (Dr. Theodore Castro-Santos, Conte Lab, personal communication). There are similar concerns relative to downstream passage delays of spent shad, with existing unpublished telemetry data sets suggesting this is an issue within the Turners Falls canal.

Since the first year of operation of the Turners Falls upstream fishways (1980), an average of only 3.6 percent of American shad that passed upstream of the Holyoke Dam have successfully passed the Turners Falls Dam. The highest values for this metric has not exceed 11 percent, and are well below the noted CRASC Management Plan target range for this objective, noted earlier as 40-60 percent on a five-year running average.

Since the first year of operation of the Vernon Dam upstream fish ladder (1981), the percent passage of American shad annually passed at the Vernon Project compared to the number passed upstream of Turners Falls Dam (gatehouse counts) has averaged 39.4 percent, ranging from 0.42 percent to 116.4 percent (>100 percent due to a counting error at one or both facilities, unknown).

Nexus to Project Operations and Effects

Existing project operations (peaking power generation) and limited bypass flows have a direct impact on instream flow and zones of passage (migration corridors). Project flow releases affect passage route selection, entry into fishways, and create delays to upstream migration. Inefficient downstream bypasses can result in migration delays and increased turbine passage. Mortality of adult shad passing through these turbines is expected to be high (Bell and Kynard 1985). In addition, stresses associated with passage and delay may cause mortality as shad are unable to return to salt water in a timely manner. The project's upstream and downstream passage facilities need to be designed and operated to provide timely and effective upstream and downstream fish passage to meet restoration goals of passage to upstream habitat and maximize post-spawn survival. These factors are all critically important to the success of restoration efforts.

Methodology Consistent with Accepted Practice

Use of radio, including passive-integrated transponder (PIT) telemetry, is widely accepted as the best method to assess fish migratory behavior and passage success, and has been used extensively to assess migration and passage issues at Turners Falls, as well as other Connecticut River projects. These studies include one conducted in 2011 and 2012 by the Service and the Conte Lab, which has provided substantial information related to some of the issues identified here. The requested study will build and expand on the information collected over the past two years.

The study design must specify sample sizes, tag configurations and receiver configurations, to ensure that rates of entry and exit to the tailraces, fishways, downstream bypasses, and the bypassed reach can be calculated with sufficient precision to determine effectiveness of flow and ensonification treatments (separate study request). For project assessments at Turners Falls (e.g., Cabot Station, spillway and gatehouse ladder attraction and entry, route selection, operational effects), double-tagged (radio and PIT) shad will be required for release from Holyoke Dam. Additional shad must be released directly into the Turners Falls canal to adequately assess the various project generation and fish passage operational and structural conditions likely to be encountered by shad.

A related request on CFD modeling in the Cabot Station tailrace, the upper power canal near the gatehouse fishway, and in the area around the entrance of the spillway ladder, will address related project operational effects that will also address identified objectives in this telemetry request. Shad captured at the Holyoke Project and tagged and released upstream of Turners Falls Dam, or tagged out of the gatehouse ladder, would help to ensure an adequate sample size to evaluate the impacts of the NMPS and Vernon projects on passage and delay.

Additional tagged shad are expected to be required for release upstream of the Vernon Dam to ensure adequate sample size to assess where shad spawn upstream of Vernon Dam (see separate study request), as well as to ensure that there is an adequate number of outmigrating spent adults to address downstream passage questions.

Existing information on captured, handled, tagged fish performance (e.g., percent that drop back, unsuitable for tracking) and factors such as timing of tagging and potentially transport, must all be carefully considered to ensure an adequate sample size of healthy (e.g., viable to characterize behavior, survival, etc.) tagged fish is available to address the many questions identified in this request (as supported by a statistical power analysis). Additionally, it will be important to ensure that an adequate number of tagged shad are available to address the downstream passage questions above, as expected losses of healthy tagged fish during upstream passage, natural mortality rates, and due to tagging-related effects are expected to reduce fish available for these assessments. The use of single PIT-tagged fish can help improve sample sizes, but will be of limited use to answer some of the passage questions we have identified.

Due to environmental variability, two years of study work will be necessary. A large array of stationary monitoring stations (radio and PIT) will be needed to address the issues identified among the project areas. A sufficient level of radio receiver and PIT reader coverage will be required, to provide an appropriate level of resolution, for data analyses, to answer these questions on project operational effects. The study will provide information on a variety of structural and operational aspects of fish migration, relative to route selection, timing, survival, and up- and downstream passage attraction, retention, delay, efficiency, survival as some examples at three projects (Turners Falls, NMPS, and Vernon). The use of video monitoring may also be utilized for specific study areas such as the spillway ladder to provide additional information on shad entrance activity, with the understanding of some data limitations associated with this approach (fish identification, water visibility).

In addition to the tagging studies, use of video monitoring of the spillway fishway would provide additional overall data on its efficiency as all shad attempting to pass could be monitored versus just those shad that have been tagged.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

The requested study is extensive and will require a substantial effort and cost to capture, PIT tag, and radio tag a sufficient number of shad at the Holyoke Project to release at upstream locations. We are not aware of any other study technique that would provide project-specific fish behavior and migration information to adequately assess existing project operations and provide insight in possible alternative operations and measures needed to address observed negative impacts to fish migration success. Cost for the entire multi-project tagging, tracking and data analysis are expected to range from $400,000 to $500,000, based on past Turners Falls studies and the 2011 and 2012 shad telemetry studies. Video monitoring of the spillway fishway would add a modest cost to this study.

Due to the fact that tagged shad will move throughout the larger five project area, to varying degrees, there will be expected cost savings (e.g., radio tags) to both owner/operators, provided cooperation in study planning and implementation occurs.

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FirstLight Study Request #7

Use of an Ultrasound Array to Create Avoidance of the Cabot Station Tailrace by Pre-spawned Adult American Shad and Facilitate Upstream Movement to the Turners Falls Dam

(Turners Falls, P-1889)

Goals and Objectives

The goal of this study is to determine if use of ultrasound is an effective behavioral mechanism to create avoidance of the Cabot tailrace area by upstream migrating adult shad. If not attracted to the Cabot Station discharge, shad may proceed upstream and pass the Turners Falls Dam via the fishway at the dam.

The objective of the study would be to establish a high frequency sound (ultrasound) array across the entire Cabot Station tailrace and determine the effect of the ensonified field on upstream and downstream migrating radio-tagged shad moving past Cabot Station. This would be accomplished by monitoring the movements and passage of shad, and the time shad spend in the tailrace area. If effective, this technology also may be applicable to the Turners Falls #1 Station discharge.

Resource Management Goals

In 1992, the Connecticut River Atlantic Salmon Commission (CRASC) developed a draft document titled: *A Management Plan for American Shad in the Connecticut River.* Management Objectives in the plan include the following:

1. achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually;
2. achieve annual passage of 40 to 60 percent of the spawning run (based on a five-year running average) at each successive upstream barrier on the Connecticut River mainstem; and
3. maximize outmigrant survival for juvenile and spent adult shad.

The Atlantic States Marine Fisheries Commission, Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010, includes the following objective:

Maximize the number of juvenile recruits emigrating from freshwater stock complexes:

Upstream Passage

1. American shad must be able to locate and enter the passage facility with little effort and without stress.
2. Where appropriate, improve upstream fish passage effectiveness through operational or structural modifications at impediments to migration.
3. Fish that have ascended the passage facility should be guided/routed to an appropriate area so that they can continue upstream migration, and avoid being swept back downstream below the obstruction.

Downstream Passage

To enhance survival at dams during emigration, evaluate survival of post spawning and juvenile fish passed via each route (e.g., turbines,, spillage, bypass facilities, or a combination of the three) at any given facility, and implement measures to pass fish via the route with the best survival rate.

Based on the CRASC plan, the U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the project.

Specific to American shad movement and migration, the Service's goal is:

Minimize current and potential negative project operation effects such as migration delays, false attraction, turbine entrainment, survival of project passage routes, and trashrack impingement, that could hinder management goals and objectives.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), the Federal Power Act (16 U.S.C. §791a, *et seq.*), the Atlantic States Marine Fisheries Compact (P.L. 539, 77th Congress, as amended by P.L. 721, 81st Congress), and the Atlantic Coastal Fisheries Cooperative Management Act (16 U.S.C. 5107).

Public Interest

The requestor is a federal natural resource agency.

Existing Information

The Turners Falls Project has two fish ladders that anadromous migrants must use to pass the project: one at the Cabot Station tailrace and one at the spillway. Both ladders have documented passage problems. Further, fish that are able to successfully swim up the Cabot Station ladder exit into the Cabot Station power canal and must successfully enter and ascend another fish ladder (gatehouse fishway) before entering the Turners Falls impoundment and continuing up the Connecticut River. Spillway ladder fish must also pass the gatehouse ladder to reach the impoundment. The gatehouse fishway also has well documented passage issues.

Many years of study and design changes at the gatehouse fishway have improved passage effectiveness of that facility, but overall passage through the Cabot and gatehouse fishways remains less effective than necessary to achieve management goals. A potential alternative to the current configuration of fishways at the project would be to cease using the Cabot ladder (thereby eliminating problems with that ladder and the need to pass the gatehouse ladder), and instead operate a single fish lift facility at the spillway. However, for this to be a viable option, one major issue would need to be resolved: false attraction to the Cabot Station tailrace discharge. Therefore, this study would attempt to determine if use of ultrasound technology would be an effective method to minimize false attraction to the tailrace discharge, while facilitating movement past the Cabot discharge and up to the spillway area without delay.

Much information exists about adult shad avoidance of ultrasound, and the adaptive significance seems related to avoidance of echolocation signals of predator bottlenose dolphins (Mann *et al.* 1997; 1998). These authors suggest shad can detect the echolocation clicks of dolphins up to 187 meters away. Further, in field trials in the early 1980s to develop a guidance system for downstream migrants in the first level canal of the Holyoke canal system, adult shad avoided, but were not well guided by an ultrasonic array. However, upstream migrants were guided well and even stopped entirely by the ensonified field (Kynard and Taylor 1984). Creating an ensonified field caused adult shad to leave their preferred location in the river upstream of trashracks at Holyoke Dam as long as the sound system was on.

Blueback herring also avoided the ultrasound field and behaved similarly to shad in the Holyoke Canal studies (Kynard and Taylor 1984). Acoustic barriers have been used for blueback herring on the Savannah River (Richard B. Russell Dam) and the Santee River (St. Stephen fish lift) in South Carolina, and on the Mohawk River in New York (Crescent Project, FERC No. 4678; Vischer Ferry, FERC No. 4679). Evidence from many studies that attempted to produce behavioral avoidance by adult shad strongly suggests that ultrasound is the most effective stimuli (Carlson and Popper 1997). Thus, the available evidence suggests that shad (and blueback herring) may be dissuaded from delaying at the tailrace of Cabot Station by installing and operating an ultrasound field.

In addition, one year of study on juvenile shad and blueback herring movements in the Holyoke canal (Buckley and Kynard 1985) and two years of study in an experimental flume (Kynard *et al.* 2003) found that juveniles did not exhibit an avoidance response to the same high frequency (162 kHz) that was avoided by adult shad and bluebacks at Holyoke.

Nexus to Project Operations and Effects

Given the poor performance of the upstream passage facilities at Turners Falls, studies to assess potential passage solutions are appropriate during relicensing proceedings. This study, coupled with the adult shad radio-telemetry study, can provide the information needed to select the best approach to resolve upstream shad passage at the project.

Methodology Consistent with Accepted Practices

Acoustic barriers have been used for blueback herring on the Savannah River (Richard B. Russell Dam) and Santee River (St. Stephen fish lift) in South Carolina, and on the Mohawk River in New York (Crescent Project, FERC No. 4678; Vischer Ferry, FERC No. 4679). This study would establish a high frequency sound (ultrasound) array across the entire Cabot Station tailrace and determine the effect of the ensonified field on upstream and downstream migrating shad moving through Cabot Station by monitoring shad behavior and the time that detected shad spend in the tailrace.

Shad tagged as part of the large-scale shad movement/migration telemetry study would be used to track shad movements through the Cabot Station area with the ultrasound system on versus off. Data would be analyzed to determine if ensonification is a successful deterrent mechanism (e.g., if shad spend less time in the tailrace when the area is ensonified relative to when it is not ensonified and whether shad move past Cabot Station to the spillway with limited delay).

Several businesses sell and operate ultrasound systems for fish avoidance. The use of these systems is world-wide at power production and water control facilities.

Level of Effort/Cost, and Why Alternatives Will Not Suffice

The level of effort/cost for the test will be low to moderate. Costs will be related to rental, installation, and operation of the ultrasound system, analysis of data, and production of a final report. The study could utilize the same test fish and monitoring equipment as the adult shad radiotelemetry study (although a few additional tracking stations may have to be installed in the Cabot Station tailrace).

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FirstLight Study Request #8

Three-Dimensional Computational Fluid Dynamics (CFD) Modeling in the Vicinity of Fishway Entrances and Powerhouse Forebays

(Turners Falls, P-1889)

Goals and Objectives

The goal of this study is to determine the flow field conditions that exist in and around the fishway entrances, and upstream of both Turners Falls powerhouses (Station 1 and Cabot). The information from this request is meant to be coupled with data from the telemetry study such that a comprehensive understanding of fish behavior is developed.

The objective of this study is to develop a series of color contour maps of velocity magnitude at select discharges agreed upon by the resource agencies and the licensee. With respect to upstream passage, the results will show approach velocities and flow fields that may create a response in fish. This information can be coupled with telemetry data (from the requested shad telemetry study) and passage counts to understand which conditions are optimal for guiding migrating fish to the fishway entrances and for stimulating fishway entry.

With respect to downstream migration, the results will show velocities and flow fields in front of each powerhouse. At Cabot Station, the results will indicate to what degree, if any, flow directs downstream migrating fish towards the surface bypass weir. At Station 1, we will have an improved understanding of the magnitude of velocity in front of the turbine intakes.

Resource Management Goals

The management goals of this study request are to obtain information that will help assist in designing effective upstream fishways for upstream migrating trust species and to reduce impingement, entrainment and delay for downstream migrating fish. CFD models are a relatively cost effective way to analyze existing and future conditions. As such, changes in the amount of attraction water, changes in which turbines are operating, and which spillway gates are releasing water can all be examined. As stated, the results from this study are meant to be used along with the data generated from the telemetry study. The combined analysis from these two data sources can help assess which flow conditions are most advantageous for migrating trust species to enter the fishway under current and proposed conditions.

As for downstream migration of adult and juvenile shad, and adult eel, the results from the models will reveal flow magnitude and direction in front of each powerhouse. Given the limited information that currently exists on survival through Cabot and Station 1, our management goal is to direct as many downstream migrating fish as possible towards the uniform acceleration weir and downstream bypass. With respect to upstream passage, we want to maximize the number of fish that find and enter the fishway entrances.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), and the Federal Power Act (16 U.S.C. §791a, *et seq.*).

Public Interest

The requestor is a resource agency.

Existing Information and the Need for Additional Information

To date, no CFD modeled data exist in front of either fish ladder, nor do they exist in front of either powerhouse. Some preliminary modeling has been done downstream of the gatehouse, but changes to the gatehouse entrances would require updated modeling. It is our understanding that the licensee has worked with the firm Alden Research Laboratory, Inc., to develop a CFD model of the upper end of the power canal and that elevation survey data from the power canal also are available. Detailed two-dimensional movement data on shad are available from observations made between 2003 to 2005 and 2010 to 2012. By coupling and analyzing these two data sets, flow and fish movement, we believe this will have substantial benefits to our management efforts.

Nexus to Project Operations and Effects

The Turners Fall Project has direct impacts to upstream and downstream migrating shad and eel. When designing upstream passage structures, a site assessment is critical. The development of these models will give resource agencies valuable information into the hydraulic cues which may elicit a response from upstream migrants. For downstream passage, the U.S. Fish and Wildlife Service has approach velocity guidelines; the output from these models would inform the resource agencies under what conditions appropriate approach velocities are being met and when they are being exceeded

With respect to upstream migration, the auxiliary water system (AWS) plays a critical role in determining whether or not fish are attracted to the entrance. The results from this study would allow us to assess how well the AWS is performing and under what conditions it attracts the most fish.

With respect to downstream migration, the development of a CFD model under existing conditions also informs the design of future modifications and improves the survivability of downstream migrating shad and eel.

The CFD models for the spillway fishway and gatehouse fishway should be developed as part of year one studies and it would be preferable to have them completed prior to year one field studies in spring 2014. It would be useful to have the gatehouse area CFD modeling completed as soon as possible to begin comparing hydraulic conditions to the two-dimensional shad location data from prior studies. This analysis may provide information on adjustments to canal operations or structures that can subsequently be analyzed.

Understanding the entrance conditions of the spillway fishway under a range of spill conditions would be informative as we evaluate the spillway fishway entrances. If developed prior to the year one upstream shad telemetry studies, it would provide information on spill gate settings that would likely best achieve entrance and ultimately passage. Further work with the model after year one studies could evaluate changes in ladder entrance or spill conditions that could improve passage and be tested with year two telemetry, video and/or count data.

CFD modeling of the flows leading to the canal via the gatehouse and the Cabot Station and Number 1 Station forebays would have value in interpretation of year one downstream passage telemetry results, but would not need to be completed prior to the year one telemetry, downstream juvenile shad and downstream eel passage studies, as those studies will provide the context for how and where shad and eels are passing the project and how successful passage is. The CFD modeling could then be focused on the locations indicated as important based on the field studies and could assess changes to structures or operations that could be evaluated in the model. Promising alternatives could then be tested in year two studies.

Methodology Consistent with Accepted Practice

A three-dimensional CFD model has become an increasing common standard of analysis at hydro-electric projects around the nation. Within the northeast region, we have seen these types of models developed at the Holyoke (P-2004), Brunswick (P-2284), Shawmut (P-2322), Milford (P-2534) and Orono (P-2710) projects. We would expect to engage with the licensee in terms of determining the appropriate area and flows to be modeled. We expect that the spatial extent of the model at each study site will vary. Given the large number of ways that output from these models can be presented and the near infinite number of flows that could potentially be modeled, we would expect to consult with the licensee to reach agreed upon modeling efforts and scenarios to be examined.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

The cost of developing, running and testing a CFD model can vary tremendously; one large variable in determining the cost is based on the amount of existing bathymetric data to which the Applicant currently has access. We roughly estimate that the cost of each CFD model could run as high as $50,000, assuming no bathymetric data currently exist. Proactive communication with resource agencies will reduce the cost and iterative effort. Given the level of effort that has occurred at other projects that have proposed to amend their license, we see the level of effort requested here as reasonable, given that the Applicant is seeking a renewal of its license.

FirstLight Study Request #9

Impact of Project Operations on Downstream Migration of Juvenile American Shad

(Turners Falls, P-1889; Northfield Mountain, P-2485)

Conduct a field study of juvenile American shad outmigration in the Turners Falls impoundment and the power canal and at Turners Falls Dam, Station #1, and Cabot Station to determine if project operations negatively impact juvenile American shad survival and production.

Goals and Objectives

Determine if project operations affect juvenile American shad outmigration survival, recruitment, and production. The following objectives will address this request:

1. assess project operations effects of the Northfield Mountain Pumped Storage Project (NMPS) and Turners Falls Dam on the timing, orientation, routes, migration rates, and survival of juvenile shad;
2. determine the proportion of juvenile shad that select the gatehouse into the power canal versus the dam spill gates as a downstream passage route, under varied operational conditions, including a range of spill conditions up to full spill;
3. determine if there are any delays with downstream movement related to either spill via dam gates or through the gatehouse and within the impoundment due to operations (i.e., NMPS pumping and generation);
4. determine survival rates for juvenile spilled over/through dam gates, under varied operation conditions, including up to full spill during the annual fall power canal outage period;
5. determine the juvenile downstream passage timing and route selection in the power canal to Station 1, Cabot Station, and the Cabot Station log sluice bypass, and assess delays associated with each of these locations and with project operations (e.g., stockpiling in the canal);
6. based upon year one study results on route selection, determine the survival rate for juvenile shad entrained into Station 1; and
7. determine the survival rates for juvenile shad entrained into Cabot Station units.

If it is determined that the project operations are adversely affecting juvenile shad survival, migration timing, or other deleterious population effects, identify operational solutions or other passage measures that will reduce and minimize these impacts within the project area. This study will require two years of field data to capture inter-annual variability of river discharge, water temperatures, and variability in the timing and abundance of juvenile production and their outmigration timing, which may relate to spring, summer, and fall conditions. This study will complement the NMPS fish entrainment study request, which includes assessment of impacts to juvenile shad.

Resource Management Goals

The Connecticut River Atlantic Salmon Commission (CRASC) developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management objectives in the plan include the following:

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.
2. Maximize outmigrant survival for juvenile and spent adult shad.

The Atlantic States Marine Fisheries Commission Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010, includes the following objective:

Maximize the number of juvenile recruits emigrating from freshwater stock complexes:

To enhance survival at dams during emigration, evaluate survival of post spawning and juvenile fish passed via each route (e.g., turbines, spillage, bypass facilities, or a combination of the three) at any given facility, and implement measures to pass fish via the route with the best survival rate.

The U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the projects. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the projects.

Specific to American shad, the Service's goal is:

Minimize current and potential negative project operation effects on juvenile American shad survival, production, and recruitment.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), the Silvio O. Conte National Fish and Wildlife Refuge Act (P.L. 102-212; H.R. 794), the Federal Power Act (16 U.S.C. §791a, *et seq.*), the Atlantic States Marine Fisheries Compact (P.L. 539, 77th Congress, as amended by P.L. 721, 81st Congress), and the Atlantic Coastal Fisheries Cooperative Management Act (16 U.S.C. 5107).

Public Interest

The requestor is a resource agency.

Existing Information

Since the construction of the Turners Falls Dam upstream fishways in 1980, American shad have had access to spawning and rearing habitat upstream of Turners Falls Dam. A number of modifications to the Turners Falls fishways have occurred since that time, with the numbers of adult shad passed at the gatehouse ladder (into Turners Falls Dam impoundment) reaching as much 60,089 in 1992, when a record 721,764 shad passed upstream of Holyoke Dam. However, since 1980, an average of only 3.6 percent of the adult shad passed upstream of Holyoke Dam subsequently have passed upstream of Turners Falls Dam, and this value has never exceeded 11 percent. This value is well below the CRASC 1992 Shad Plan objective of 40-60 percent passage from the previous dam. In addition, population number and passage numbers past Holyoke have declined substantially, with the average Holyoke passage number over the last 10 years being 211,850. Because historic data suggest that approximately half the returning adult shad to the Connecticut River pass the Holyoke Dam, recent adult returns are far below management goals. Effective upstream and downstream passage and successful in-river spawning and juvenile production are necessary to help achieve shad management restoration goals for the Connecticut River, which extends to the Bellows Falls Dam. In 1990, FirstLight's predecessor, Northeast Utilities, CRASC and its member agencies, signed a Memorandum of Agreement on downstream fish passage to address both juvenile and adults at the Turners Falls and NMPS projects.

American shad broadcast spawn, with the highest spawning activity occurring in runs and lowest activity in pools and riffle/pools (Ross *et al.* 1993). Field research by Ross *et al.* (1993) in the Delaware River further noted that a combination of physical characteristics that seem to be avoided by spawning adults is slow current and greater depth. American shad year-class strength has been shown to depend on parent stock size and environmental conditions during the larval life stages (Crecco and Savoy 1984). Delays in juvenile American shad outmigration may affect survival rates in the transition to the marine environment (Zydlewski *et al.* 2003). One published study on the Connecticut River identified that juvenile shad outmigration began when declining autumn temperatures reached 19°C and peaked at 16°C (O'Leary and Kynard 1986).

Juvenile American shad production has been monitored upstream of the Vernon Dam and immediately downstream of that dam by Vermont Yankee Nuclear as part of an annual monitoring program using both boat electrofishing (since 1991) and beach seining (since 2000). Sampling of juvenile shad was also conducted by a contractor hired by Northeast Utilities in the Turners Falls impoundment in 1992. O'Donnell and Letcher (2008) examined juvenile shad early life history and migration upstream and downstream of Turners Falls Dam. Their study results led to the decision by the agencies to require earlier operation of downstream fishways to protect early season juvenile shad out-migrants (1 September prior to 2010, 15 August in 2010, and since 2011, 1 August).

Downstream juvenile clupeid passage studies at Turners Falls were conducted in the fall of 1991 which included the objectives of determining the percentage of juvenile shad and herring that pass via the bypass log sluice or that were entrained in the Cabot Station turbines, and related data (e.g., catch rates) were compared. The 1991 Downstream Clupeid Study did not assess survival rates for juveniles for either of these passage routes. The 1991 study report documented a higher rate entrainment into the project turbines (23.0 fish per minute) versus through the bypass sluice (11.6 fish per minute). It was concluded that only an estimated 54 percent (average bypass rate, weighted by estimated number bypassed) of the juvenile American shad approaching Cabot Station were bypassed via the log sluice. The range of the percent bypassed varied widely by date, between nearly 0 and 83 percent, with 'no clear explanation as to why." The report did not identify the percentage entrained into the turbines, but it can be reasoned to be substantial based on the data presented in the report, or assumed as the remaining balance (46 percent), as there were no spill events reported during this study, and therefore nowhere else for them to pass. It was further noted that entrainment rates for juveniles were consistently greatest for units 1 and 6 (ends), not uniform across all units. Although no concurrent bypass sampling occurred during the first entrainment sampling events, it was noted that "entrainment rates were relatively high during the end of September." Additional modifications have occurred over time without quantitative evaluation to improve downstream passage attraction and use to the bypass sluice, including lighting systems.

The 1994 Downstream Juvenile Shad Study report assessed juvenile shad survival from passage via the log sluice, reported to be 98 percent, based on tagged and recaptured fish (held for up to 48 hours). Scale loss (<20 percent) (22 of treatment fish) compared with scale loss of >20 percent (five of treatment fish) was examined and determined to occur in an overall total of 10 percent of study fish (adjusted by control fish data).

Nexus to Project Operations and Effects

Adult American shad passed upstream of Turners Falls Dam utilize upstream spawning habitat. Juvenile American shad production occurs in these habitats upstream of Turners Falls Dam on an annual basis. Juvenile American shad require safe and timely downstream passage measures to have the opportunity to contribute to the fishery agencies' target restoration population size.

The Service is not aware of any studies being conducted specifically designed to determine:

1. When are spill gates open at the Turners Falls Dam?
2. What proportion of juvenile outmigrant shad take that route of passage?
3. What is the rate of survival under a range of spill and gate configurations?
4. What is the timing, duration, and magnitude of juvenile shad outmigrants in summer and fall to the Turners Falls Dam and gatehouse?
5. Are there delays in migration/movement at the dam, gatehouse, Cabot Station, or Station 1?
6. For juveniles that enter the power canal, what proportion subsequently enter the Station 1 power canal?
7. As there are no downstream passage facilities at Station #1, and trash rack spacing is 2.6 inches, what is the survival rate of juvenile shad entrained at Station #1?

8. What is the rate of movement through the Turners Falls power canal, and what is the delay to juvenile shad outmigration, and the potential accumulation of juveniles in the canal (e.g., prior to the canal drawdown in September)?
9. What proportion of juvenile shad use the downstream sluice bypass versus the Cabot Station turbines under varied operational conditions, given that project operations may change (PAD notes possible increase in turbine capacity at Cabot)?
10. Based upon earlier facility studies (1991 Downstream Clupeid), a large proportion and number of juvenile shad are entrained into Cabot Station turbines. What are the associated impacts in terms of short-term and longer term survival and injury (i.e., scale loss)?

The Service is concerned that project operations may impact juvenile shad outmigration survival and is contributing to the failure of the Connecticut River shad population to meet management targets. In the PAD, proposed modifications include: Station 1 may be upgraded with new turbines; Station 1 may be closed; and/or the turbine capacity at Cabot may be increased. It is unclear how these scenarios will affect the questions identified in this request.

Methodology Consistent with Accepted Practice

The impact to juvenile shad outmigrants by project operations would be best studied by a combination of approaches, including hydroacoustic, radio telemetry, and turbine balloon tags. Project discharge over a full range of existing and, to the extent possible, potential future operational conditions at Station 1 and Cabot, at the dam (likely increased bypass reach flows in new license), and in relation to the gatehouse, should be examined relative to timing, duration, and magnitude of juvenile shad migration to and through these areas, with hydroacoustic equipment for natural/wild fish evaluation. In addition, study fish should be collected and tagged (PIT, radio, other mark, balloon) to also empirically determine rates of survival for fish passed over or through the dam's gates, under varied operations, including up to full spill condition that occurs annually in the fall with the canal outage period. The understanding of the timing, magnitude, and duration of the wild fish outmigration will help inform the design, data/results, and assessment of tagged fish study. The release of tagged or marked fish (radio, PIT) upstream of the gatehouse induction into the power canal will provide data on concerns of delay and route selection to Station 1, Cabot Station downstream bypass, Cabot Station spill gates, and Cabot Station turbines. Additional hydroacoustic assessment at the Cabot Station forebay will provide information on wild/natural juvenile fish timing, magnitude, and duration to and through this area. Based upon year one study findings relative to the frequency, magnitude, and timing of juvenile American shad that end up in the forebay of Station 1, the determination of whether an entrainment survival study at that site is necessary will be made. Release sites for tagged fish will be determined based upon further consultation among the parties.

Radio-tagged juvenile shad will be released in areas upstream of the NMPS facility at multiple release locations, to determine operation effects on migration rates, route, orientation, entrainment, and survival, over a full range of permitted and operational conditions.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

FirstLight does not propose any studies to meet this need. Estimated costs for the study are expected to be high, between $200,000 and $300,000, with the majority of costs associated with equipment (hydroacoustic gear, radio tags, radio receivers, and PIT readers) and related field work labor.

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FirstLight Study Request #10

Shad Population Model for the Connecticut River

(Turners Falls, P-1889; Northfield Mountain, P-2485; Bellows Falls, P-1855; Vernon, P-1904)

Develop an American shad annual step, mathematical simulation population model for the Connecticut River to quantify how project operations and potential restoration/mitigation measures impact the population of shad in the Connecticut River.

Goals and Objectives

The goal of the model is to assess impacts of both upstream and downstream passage at each of the Connecticut River projects and potential management options for increasing returns to the river.

Specific objectives include:

1. annual projections of returns to the Connecticut River;
2. a deterministic and stochastic option for model runs;
3. life history inputs of Connecticut River shad;
4. understanding the effect of upstream and downstream passage delay at projects;
5. calibration of the model with existing data;
6. analysis of the sensitivity of model inputs;
7. analysis of sensitivity to different levels of up- and downstream passage efficiencies at all projects; and
8. multiple output formats including a spreadsheet with yearly outputs for each input and output parameter.

Resource Management Goals

The Connecticut River Atlantic Salmon Commission (CRASC) developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management objectives in the plan include the following:

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.
2. Achieve annual passage of 40 to 60 percent of the spawning run (based on a five-year running average) at each successive upstream barrier on the Connecticut River mainstem.
3. Maximize outmigrant survival for juvenile and spent adult shad.

The U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the projects. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the projects.

Specific to American shad, the Service's goal is:

Minimize current and potential negative project operation effects on American shad spawning and recruitment.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), and the Federal Power Act (16 U.S.C. §791a, *et seq.*).

Public Interest

The requestor is a natural resource agency.

Existing Information

Since the construction of the first fish lift facility at Holyoke Dam in 1967, American shad have had access to spawning and rearing habitat upstream from Holyoke Dam. A number of improvements to the Holyoke fishway have occurred since that time, but while the numbers of shad lifted at Holyoke have reached as much as 721,764 and the overall shad population to the river exceeded 1.6 million shad in 1992 (CRASC 1992), total shad populations, and numbers of shad passing Holyoke, Turners Falls and Vernon Dam have not met CRASC management goals.

Population and passage numbers past Holyoke have declined substantially from those totals in recent years, with average Holyoke passage numbers since 2000 of 229,876. Whole river population estimates have shown that approximately half of the returning population of shad pass upstream of Holyoke. Recent returns to Holyoke are far below management goals. Average passage efficiency of shad at Turners Falls (gatehouse counts) and Vernon since 2000 has been 3.1 and 20.4 percent, respectively. These too are well below the CRASC management goals.

Safe, timely and effective up- and downstream passage, along with successful spawning and juvenile production, are necessary to help achieve shad management goals for the Connecticut River.

Nexus to Project Operations and Effects

Existing project operations and fish ladder efficiencies have a direct effect on shad populations in the Connecticut River. Poor upstream passage efficiencies and delays restrict river access to returning shad. Fish unable to reach upriver spawning grounds may not spawn or have reduced fitness or survival of young. Poor downstream passage survival and downstream passage delays affect outmigration and consequently repeat spawning, an important ecological aspect of the iteroparous Connecticut River shad population (Limberg *et al.* 2003).

The Service is concerned that poor passage efficiencies and delays at projects may be limiting access to upstream reaches of the river, altering spawning behavior, decreasing outmigration survival and contributing to the failure of the Connecticut River shad population to meet management targets (Castro-Santos and Letcher 2010).

Development of a population model will allow an assessment of individual project impacts on the population as well as the cumulative impacts of multiple projects. The model will allow managers to direct their efforts in the most efficient manner toward remedying the conditions that most impact the shad population.

Methodology Consistent with Accepted Practice

Population models are commonly used to assess anthropomorphic and natural impacts and are consistent with accepted practice. A model similar to this request was constructed for the Susquehanna River by Exelon (FERC No. 405). The model is constructed in Microsoft Access.

Specific parameters that would be included in the model:

1. upstream passage efficiency at Holyoke, Turners Falls (Cabot, gatehouse and spillway
2. ladders), Vernon fishways, and any impacts associated with Northfield Mountain Pumped Storage;
3. distribution of shad approaching the Turners Falls Project between the Cabot ladder and the spillway at the dam;
4. downstream passage efficiencies at Vernon, Northfield Mountain Pumped Storage, Turners Falls, and Holyoke projects for juveniles and adults;
5. entrainment at Mount Tom Power Plant and Vermont Yankee Nuclear Power Plant;
6. sex ratio of returning adults;
7. the proportion of virgin female adults returning at 4, 5, 6, and 7 years;
8. the proportion of repeat spawning females at 5, 6 and 7 years;
9. spawning success of females in each reach;
10. fecundity;
11. percent egg deposition;
12. fertilization success;
13. larval and juvenile in-river survival;
14. calibration factor to account for unknown parameters such as at sea survival;
15. options for fry stocking and trucking as enhancement measures;
16. start year and model run years;
17. start population;
18. rates of movement to and between barriers; and
19. temperature, river discharge, and other variables of influence to migration and other life history events.

The model should be adaptable to allow the input of new data and other inputs.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

Neither FirstLight nor TransCanada have proposed any study to meet this need. Estimated cost for the study is expected to be low to moderate. As the model describes the impacts of multiple projects and two owners, both project owners would share the cost of model development.

REFERENCES

CRASC (Connecticut River Atlantic Salmon Commission). 1992. A management plan for American shad in the Connecticut River basin. Sunderland, MA.

Castro-Santos, T. and B. H. Letcher. 2010. Modeling migratory bioenergetics of Connecticut River American shad (*Alosa sapidissima*): implications for the conservation of an iteroparous anadromous fish. Can.J.Fish.Aquat.Sci. 67: 806-830.

Limberg, K. E., K. A. Hattala and A. Kahne. 2003. American shad in its native range. Pages 125-140 in K. E. Limberg and J. R. Waldman, editors. Biodiversity, status and conservation of the world's shads. American Fisheries Society, Symposium 35, Bethesda, Maryland.

FirstLight Study Request #11

Impacts of Turners Falls Canal Drawdown on Fish Migration and Aquatic Organisms

(Turners Falls, P-1889)

Conduct a study to quantify impacts of the annual Turners Falls Canal drawdown on emigrating and resident fishes, freshwater mussels and mudpuppies in the canal.

Goals and Objectives

Quantitatively assess the effects of the Turners Falls Canal drawdown on diadromous fishes and other aquatic organisms known to be present in the canal during the annual drawdown. Objectives of this study request include:

1. Determine whether juvenile shad and American eel abundance in the canal increases leading up to the time of its closure, due to delays in downstream passage (e.g., are fish accumulating in the canal?).
2. Determine level of mortality for juvenile sea lamprey from exposure of burrow habitats.
3. Conduct surveys to determine aquatic organisms (fishes, freshwater mussels, and mudpuppies) present in the canal during the drawdown, their densities, status (stranded, dead, alive), and mapping to document habitat, substrate type, and wetted area at complete drawdown.
4. Evaluate measures to minimize aquatic organism population impacts of the canal drawdown.

Other submitted study requests complement or directly relate to this project activity and assessment of project effects, including the resultant effects of all river flow being passed over the Turners Falls Dam as spill (e.g., downstream juvenile shad study request and American eel movement and survival request).

Resource Management Goals

The Connecticut River Atlantic Salmon Commission (CRASC) developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following:

1. achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually; and
2. maximize outmigrant survival for juvenile and spent adult shad.

The Atlantic States Marine Fisheries Commission Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010, has the stated goal of "Protect, enhance, and restore Atlantic coast migratory stocks and critical habitat of American shad in order to achieve levels of spawning stock biomass that are sustainable, can produce a harvestable surplus, and are robust enough to withstand unforeseen threats," and includes the following objective:

Maximize the number of juvenile recruits emigrating from freshwater stock complexes:

To enhance survival at dams during emigration, evaluate survival of post spawning and juvenile fish passed via each route (e.g., turbines, spillage, bypass facilities, or a combination of the three) at any given facility, and implement measures to pass fish via the route with the best survival rate.

The U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the project.

Specific to diadromous fishes, the Service's goal is:

Minimize current and potential negative project operation effects on diadromous fishes, including juvenile shad, adult silver eels, and sea lamprey ammocetes.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Silvio O. Conte National Fish and Wildlife Refuge Act (P.L. 102-212; H.R. 794), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), and the Federal Power Act (16 U.S.C. §791a, *et seq.*).

Public Interest

The requestor is a resource agency.

Existing Information

Existing information in the PAD does not provide data on the population size or survival rates of juvenile American shad, American eels, or juvenile sea lamprey located in the power canal during the dewatering process. The power canal is dewatered in early September of each year for over a one week period to perform facility maintenance, inspections, and repairs, including substantial silt removal and bank repairs. Historically, the canal drawdown occurred in July, but approximately five years ago, it was moved to September, where it has occurred annually since then, with the exception of 2010. The agencies were informed in a letter by FirstLight that the shift to September was at the request of the Independent System Operator–New England (ISO-NE) to avoid peak load months of June through August. Studies conducted by the previous operator, Northeast Utilities Service Company (NUSCO), to assess downstream clupeid survival and use (1991 and 1994 studies at Cabot Station) support the contention that juvenile shad out-migration is occurring within the current drawdown time frame. There are no data to suggest that out-migration would occur earlier than 1 August, but likely does begin in the month of August (O'Donnell and Letcher 2008). Based on these data, CRASC altered its Fish Passage Notification Letter for Downstream Passage Operations for juvenile shad and herring to require the Cabot Station downstream bypass to begin operating on 15 August in 2010, and then moved the date to 1 August in 2011.

It is unknown whether the power canal may, through potential mechanism(s) of delay due to its configuration or operation, cause out-migrating juvenile shad to accumulate in the canal. This information gap leads to concerns that migrant numbers may be elevated beyond simple extrapolations of surface area comparison in the canal to main stem habitat. In the PAD, FirstLight indicates that the Cabot Station forebay in the vicinity of the intake has a maximum depth of 60 feet, while the existing near-surface downstream bypass structure at the Cabot Station is designed to operate only within a depth of 6 feet of the surface. As a result, the downstream bypass only operates effectively for a short period during the drawdown period (timing of this is unknown). The only points of egress, once the fish bypass becomes unavailable, are through the turbines at Cabot Station and Station 1, and eventually at the Keith Street gate located well upstream from the Cabot Station intakes. It is unknown what the survival rates are for these passage routes, what proportion of fish are using each route, what number may become stranded and their survival rates, and how many fish are subjected to this situation. The related study requests on downstream juvenile shad outmigration and American eel outmigration outline objectives that would address some of these information gaps.

There is also a paucity of information relative to the disposition of fish moving downstream in the impoundment during the canal drawdown. Once the Turners Falls gatehouse closes its gates, all inflow passes over the dam, a situation unique to this brief one-week annual time period. Survival rates for outmigrating juvenile American shad and adult American eel moving past the project during the period of spill are not known.

Lastly, there exists an information gap regarding the fate of juvenile sea-lamprey (known as ammocetes) that reside in the soft substrate materials located in much of the lower or downstream end of the canal (Boyd Kynard, BK Riverfish, LLC, personal communication). In previous drawdowns, thousands to tens of thousands of dessicated ammocetes have been observed (Matt O'Donnell, USGS Conte Lab, personal communication). However, the distribution and abundance of ammocetes in the canal, as well as mortality rates for ammocetes during the drawdown period, have not been quantitatively determined.

Nexus to Project Operations and Effects

Previous studies at Cabot Station have documented that juvenile American shad and American eel migrate through the project area during the canal drawdown period. During normal operations (where canal water level elevations are stable), downstream migrants are able to utilize the Cabot bypass facility; however, as the canal water level is drawn down, the bypass is no longer available, and the only routes of egress are through the turbines at Cabot Station and Station 1, unless the Cabot Station spill gates are utilized (the spill gates have a canal depth limitation of approximately 16 feet). Turbine entrainment at hydropower projects has been shown to cause injury and mortality to fishes.

The annual canal drawdown was formerly conducted in July. In response to ISO-NE's request that FirstLight conduct the drawdown outside of the June through August period, FirstLight moved the drawdown to a period of time when diadromous fishes are known to be moving through the project area.

Once the canal has been drawn down, isolated shallow pools are left standing until the canal is refilled. During this period, fish (including lamprey ammocetes), amphibians, and benthic invertebrates are prone to dessication, predation or other sources of mortality or impact.

Methodology Consistent with Accepted Practice

The methods presented here are consistent with the study requests addressing downstream juvenile American shad passage and downstream American eel passage, with an emphasis on addressing survival and movement immediately prior to and during the canal drawdown. Hydroacoustic monitoring immediately upstream of the Turners Falls gatehouse, as well as upstream of opened dam gates for spill, will provide data on the timing, frequency and magnitude of natural wild juvenile shad movement into these areas, particularly the power canal. The abundance of juvenile shad moving into the canal can be derived and compared with similar data obtained with hydroacoustic equipment monitoring upstream of the Cabot Station intake and bypass, for comparisons. Juvenile shad will be PIT-tagged, released, and monitored in the canal, for movements, timing and location, including the Station 1 canal and forebay. PIT-tagged fish will be detected at the Cabot bypass sluice sampler. Juvenile fish should be specifically targeted for release immediately prior to drawdown to assess survival and movement in and through the canal. Surveys of sea lamprey ammocetes should be conducted by a stratified sampling design based upon substrate.

Lamprey density surveys, immediately after drawdown and in a subsequent later survey, may derive rates of change in observed densities and their status (live, moribund, dead); appropriate methods would need to be discussed. Surveys of remaining ponded water should be conducted immediately following drawdown and at later intervals (mid-week and end of week) to compare species occurrence and densities (relative abundance) which will be used to develop catch-curve analyses that can inform rates of mortality to the observed populations.

Assessments of freshwater mussels should also be conducted to quantify drawdown impacts. As with lamprey, the assessment can be based on sampling identified habitats in a stratified, random design, over the three time periods noted (initial drawdown, mid-week, and end of week), tracking changes in densities and status of observed individuals among areas. Sub-sampling, with sufficient repeated measures to determine variability and acceptable level of precision of data, will inform the required sampling intensity that will be needed. This sampling intensity will be determined as the study occurs and may vary among identified species. Comparisons among the three time periods for measures of density and status will inform the evaluation of project effects for juvenile shad, sea lamprey ammocetes, freshwater mussels and mudpuppies.

The canal drawdown mitigation assessment involves evaluating alternative drawdown protocols to minimize impacts to resident and migratory fish, mussels and amphibians inhabiting the canal. Alternatives should include: (1) moving the drawdown to a time of year outside of migration seasons; (2) keeping or moving the timing of the drawdown, but utilizing technologies to keep the majority of the canal wetted during the drawdown (e.g., portadams in the forebay immediately upstream of the trashracks and at other canal intakes in need of maintenance); and (3) in combination with alternative #2, assessing whether other existing infrastructure within the forebay could be used to pass fish safely out of the canal (e.g., low level outlets, deep gates, side spillway boards, etc.). The assessment should compare the merits and drawbacks of each alternative and provide an order of magnitude cost estimate for implementation.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

This study request has many elements that overlap directly with a larger-scale downstream juvenile American shad passage and downstream American eel passage study requests. With equipment costs principally covered in those requests, many components of what has already been proposed will be used in this study. However, this request does include some specific elements not specified in the other two larger requests. The study cost and effort are expected to be low to moderate. Some additional radio tags and balloon tags with additive days of field work to accurately assess impacts specific to the drawdown period will be required. Surveys for identified aquatic organisms will take several days during the drawdown period as well.

The canal drawdown mitigation assessment should require a low to moderate level of effort and cost. One staff person would evaluate alternative drawdown protocols. This should take less than one week to complete.

The Applicant did not propose any studies to meet this need in the PAD.

REFERENCES

O'Donnell, M and B. H. Letcher. 2008. Size and age distributions of juvenile Connecticut River American shad above Hadley Falls: influence on outmigration representation and timing. River Research Applications #24: 929-940.

FirstLight Study Request #12

Entrainment of Migratory and Riverine Fish from the Connecticut River into the Northfield Mountain Pumped Storage Project

(Northfield Mountain, P-2485)

Goals and Objectives

The goal of the study is to determine the impact of Northfield Mountain Pumped Storage Project (NMPS) during the pumping cycle on entrainment of juvenile American shad, adult shad, adult American eel, and riverine fish, including early life stages.

The objective of the study is to quantify the number of resident and migratory fishes entrained at the NMPS intake on an annual basis in order to evaluate potential impacts to riverine fish populations in the Turners Falls pool and diadromous fish migrants moving through the project area. This will be accomplished through a combination of hydroacoustic monitoring and netting using various gear types to quantify and identify species of different life stages.

Resource Management Goals

The Connecticut River Atlantic Salmon Commission (CRASC) developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management objectives in the plan include the following:

1. achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually;
2. achieve annual passage of 40 to 60 percent of the spawning run (based on a five-year running average) at each successive upstream barrier on the Connecticut River mainstem; and
3. maximize outmigrant survival for juvenile and spent adult shad.

Based on the CRASC plan, the U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the project.

The Atlantic States Marine Fisheries Commission (ASMFC) has developed two documents related to the management of American eel:

1. Interstate Fishery Management Plan for American Eel. April 2000. Atlantic States Marine Fisheries Commission.
2. Addendum II to the Fishery Management Plan for American Eel. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

Objectives of the management plan include: (1) protect and enhance American eel abundance in all watersheds where eel now occur; and (2) where practical, restore American eel to those waters where they had historical abundance, but may now be absent, by providing access to inland waters for glass eel, elvers, and yellow eel, and adequate escapement to the ocean for pre-spawning adult eel.

Addendum II contains specific recommendations for improving upstream and downstream passage of American eel, including requesting that member states and jurisdictions seek special consideration for American eel in the Federal Energy Regulatory Commission relicensing process.

In addition, CRASC developed A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin in 2005. The goal of the plan is "to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem…" Management objectives in the plan include the following:

1. protect and enhance eel populations where they currently exist;
2. where practical, restore populations to waters where they had historical abundance;
3. provide effective upstream and downstream fish passage around dams and other barriers within the species' range in the basin; and
4. comply with all requirements of the Fishery Management Plan of the ASMFC.

Specific to resident riverine and migratory fish entrainment, the Service's goals are:

1. Minimize current and potential negative project operation effects such as turbine entrainment that could hinder management goals and objectives.
2. Minimize project-related sources of mortality to resident and migratory fishes in order to restore natural food web interactions and ecosystem functions and values.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), and the Federal Power Act (16 U.S.C. §791a, *et seq.*).

Public Interest

The requestor is a resource agency.

Existing Information

Limited project-specific information exists regarding entrainment of fish and aquatic organisms at the NMPS. As part of a 1990 Memorandum of Agreement between then-owner Northeast Utilities Service Company (NUSCO) and regulatory agencies (including the Service), NUSCO conducted studies to determine the impact of NMPS on anadromous fishes, including Atlantic salmon, American shad, and blueback herring. Results of a pilot study conducted in the fall of 1990 indicated that trap netting at the intake was ineffective at collecting fish. Gill netting and boat-shocking did result in collection of some juvenile shad, but further refinement in both methods was recommended to improve effectiveness. A total of 78 fish were collected at the intake (77 of which were American shad) by gill netting and 11 shad were collected by boat electrofishing. Hydoacoustic monitoring was deemed an effective method for monitoring entrained fish during pumpback operation. Hydroacoustic sampling over a two-week period (September 12-27, 1990) produced hourly entrainment estimates that cumulatively equaled 14,816 fish.

Based on the results of the pilot study, NUSCO developed a two-year plan to quantitatively determine the number of shad and salmon entrained at NMPS station. In 1992, an entrainment study targeting juvenile American shad life stages was conducted in the lower (mainstem river) and upper reservoirs of NMPS. The study used several gear types to quantify egg through juvenile shad densities in different areas. Entrained juveniles were sampled using an upper reservoir net. Pumping operations were modified to only run three (77 percent of sample time) and sometimes two (23 percent of sample time) of the station's four units during the study, and effort was limited to a total of 80 hours over a period spanning 9 August through 27 October (80 days). An estimated total of 1,175,900 shad eggs, 2,744,000 yolk-sac larvae, 10,525,600 post yolk-sac larvae, and 37,260 juveniles were reported entrained.

There are no reliable data on the timing, magnitude and duration of entrainment of larval riverine fishes in the NMPS area. Unlike anadromous shad and river herring, riverine species occurrence and susceptibility relative to space and time exposure windows to NMPS pumping are undocumented. The complete lack of any long-term fish population monitoring data for riverine species in the Turners Falls impoundment leaves questions unanswered on the types and extent of impacts to these populations that may be linked to the near daily cycling of river water up and down through the NMPS operations system. As a starting point, it is necessary to obtain baseline data on project operation impacts for all species potentially impacted by NMPS. An additional study request seeks to obtain a more accurate documentation of all fish species inhabiting or utilizing the Turners Falls impoundment.

Nexus to Project Operations and Effects

Entrainment of fish and aquatic organisms associated with water withdrawal and hydroelectric operations has been documented to result in injury or death of entrained organisms. Migratory and resident fish pass through the project area directly in front of the pump intakes. These organisms may be entrained and thus exposed to passage through the project pumps and reservoir supply tubes. How far from the intake these species and life stages may be drawn into the intake on a pumping cycle or how susceptible they are to the repeated daily cycles of pumping and discharge, and how these factors vary in relation to habitat and river conditions, are unknown. Survival of fish subjected to entrainment on the pumping cycle is unknown, but regardless of whether fish survive the pumping process, they are lost to the Connecticut River system. Depending on the species, life stages, and numbers entrained, this loss could impact the ecosystem productivity of the Turners Falls pool and may hinder restoration goals for diadromous fishes.

Previous entrainment studies have been conducted at the project. Those studies, which were done 20 years ago, documented entrainment of American shad and Atlantic salmon at the project, including over 13 million yolk sac and post-yolk sac larvae of American shad. This level of entrainment is cause for concern, not only due to the resultant loss of potential adult returns, but for the important role early life history phases and juveniles play in their ecological contributions to the river system (e.g., trophic interactions).

No entrainment studies for other species of fish have been conducted at the project and require evaluation. Studies conducted in 1969 and 1970 at the Muddy Run Pumped Storage Station documented significant entrainment of eggs and larval fish. In June and July of 1970, 5.3 million eggs and 56.6 million larvae were entrained (Snyder 1975). Muddy Run and NMPS are of a similar size and both use a river as the lower reservoir. It is anticipated that a considerable number of eggs and larvae will be entrained by the NMPS.

Since the previous studies were conducted, operations at the NMPS facility have changed (e.g., the project increased the efficiency of its turbines, and raised the pumping capacity from 12,000 cfs up to 15,000 cfs), as have river conditions (e.g., Vermont Yankee has increased its thermal discharge and the Vernon Project has increased its station capacity). Further, the PAD indicates that FirstLight will evaluate the feasibility of utilizing an additional 3,009-acre feet of storage capacity to generate an additional 1,990 MWhs (this represents a 23 percent increase over existing storage and stored generation levels). While not specified in the PAD, increasing storage and generation would mean longer periods of both pumping and generation at NMPS. In addition, anticipated improvements in fish passage at the Turners Falls Project will result in increased juvenile production above the NMPS. These factors, individually or cumulatively, could increase the potential for entrainment at NMPS station.

Methodology Consistent with Accepted Practice

Previous studies used varying methodologies for determining entrainment. The 1990 study concluded that hydroacoustic monitoring at the intake was a viable method for determining entrainment of later life stages, but does not allow for identification of the species being entrained. While trap netting was ineffective at collecting fish near the intake, gill netting and boat shocking did capture some fish. Both may prove to be viable sampling methods; however, it is likely that additional testing and gear refinement will be necessary.

The 1992 study used nets at the pump discharge location into the upper reservoir to collect entrained fish. Testing showed that this method was only 10 percent efficient. Plankton netting in the nearfield area of intake was used to estimate entrainment of ichthyofauna. It is likely that a combination of methods would provide the most reliable results (e.g., hydroacoustic monitoring at the racks during pumpback operations, variable gear sampling in the vicinity of the intake immediately prior to initiation of pumpback operations to determine species composition, and plankton netting in the nearfield area of the intake to obtain information on entrainment of ichthyofauna). As these methodologies have previously been utilized at the site, they are consistent with accepted practice (Harza Engineering Company 1991).

Although a previous entrainment study was conducted, the Service believes it should be repeated, using a modified study design. The 1992 study only collected a total of 330 juvenile shad over a three-month period (resulting in an overall estimate of 37,260 juveniles entrained, after accounting for poor net efficiency), whereas the hydroacoustic study conducted in 1990 estimated nearly 15,000 fish in 15 days (while these fish were not identified, 77 of the 78 fish collected at the intake during the study were juvenile shad). It also should be noted that in the 1992 study, juvenile shad were collected on the first day of sampling, indicating that the sampling did not begin early enough, which would mean the results are an underestimate of the number of juvenile shad that were actually entrained. In 1990, 27,908 adult shad passed the Turners Falls gatehouse, while in 1992 over 60,000 shad passed the gatehouse. The fact that the numbers entrained were so variable between study years argues for repeating the study, using a combination of previously-used methodologies (Lawler, Matusky and Skelly Engineers 1993).

The study will require deployment of at least five hydroacoustic transducers (one per rack face and one offshore). These transducers would be operated during every pumping cycle from April 15 through May 14 to assess riverine fish entrainment, from May 15 through July 15 for spent adult shad, and from July 16 through November 30 for entrainment of adult silver eels, juvenile American shad, and riverine fishes. Concurrent field sub-sampling at the intake to determine species composition would need to occur.

Sampling for planktonic fish larvae should capture early spring spawning species (white suckers) through later season centrarchid species (bass and sunfish). Active plankton trawl surveys should utilize a sampling design that adequately captures temporal and spatial changes in water pumping cycle (i.e., early start-up is local water, later cycle pumping is drawn in from both upstream and downstream habitat areas).

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

We know of no other tool that will provide for this type of assessment for all fish species and organisms that may pass through the project. Cost and effort are expected to be high.

The Applicant did not propose any studies to meet this need in the PAD.

REFERENCES

CRASC. 1992. A Management Plan for American Shad in the Connecticut River.

Harza Engineering Company. 1991. Draft Northfield Mountain Pumped Storage Project 1990 Field Sampling Program. February 1991. Northeast Utilities Service Company, Berlin, CT.

Lawler, Matusky and Skelly Engineers (LMS). 1993. Northfield Mountain Pumped-Storage Facility – 1992 American Shad Studies. February 1993. Northeast Utilities Service Company, Berlin, CT.

Memorandum of Agreement. NUSCO. July 1990.

Snyder, D.E. 1975. Passage of fish eggs and young through a pumped storage generation station. J. Fish Res. Board Canada. 32: 1259-1266.

FirstLight Study Request #13

Model Flows in the Northfield Mountain Pumped Storage Project Intake/Tailrace Channeland Connecticut River Upstream and Downstream of the Discharge Using Computational Fluid Dynamics (CFD) Modeling

(Northfield Mountain, P-2485)

Goals and Objectives

The goal of this study is to determine the potential impacts of the Northfield Mountain Pumped Storage Project (NMPS) operations (pumping and generating) on: (1) the zone of passage for migratory fish near the turbine discharge/pump intake; (2) natural flow regimes in the area of the Connecticut River immediately upstream and downstream of the project; and (3) the potential for fish entrainment during pumping operations.

Specific objectives of the study include:

1. Develop a CFD model of the NMPS intake and tailrace channel, along with the full width of the Connecticut River upstream and downstream of the discharge.

2. Model flow characteristics upstream and downstream of the project under existing project operations (pumping and generating) and at several representative river flow levels, as well as proposed operations such as those proposed in section 3.4.4 of the PAD, and any other modifications under consideration, to assess potential impacts to fish and wildlife resources.

3. Assess velocities and flow fields at and in proximity to the NMPS intake/discharge structure when pumping or generating, and their potential to interfere with fish migration, create undesirable attraction flows, and result in fish entrainment.

4. Assess the potential for velocity barriers in the mainstem river resulting from pumping and generation flows at the project, alone or in combination with generation flows from the upstream Vernon Project and operations at the Turners Falls Project.

5. Assess the potential of a mainstem instream local flow reversal associated with pumping operations to impact migrating fish.

6. Model and then evaluate flow characteristics under alternative project operations with potential measures to avoid, minimize, or mitigate impacts to fish and wildlife resources.

Resource Management Goals

The mission of the U.S. Fish and Wildlife Service (Service) is to work with others to protect, conserve and enhance fish, wildlife, plants and their habitats for the continuing benefit of the American public. Service trust resources include wetlands, endangered species, and migratory species, all of which have been documented to occur in the project area. The Service also is working with a number of federal, state, local, non-governmental organizations, and the public to restore and enhance trust resources in the Connecticut River Basin through comprehensive management plans and cooperative agreements. Instream flow is an important riverine habitat characteristic that can have a great impact on aquatic habitat for fish, wildlife, and plants. Flow is an important directional guidance cue for instream navigation and attraction to fishway entrances for migratory fish.

Public Interest

The requestor is a natural resource agency.

Existing Information

No project-specific information exists that will allow for a comprehensive assessment of existing project operations (pumping and generating flows) on Connecticut River flows and on fish and aquatic organisms in the project area upstream and downstream of the project. Preliminary results from an ongoing study of radio-tagged American shad by the Service and the USGS Silvio O. Conte Anadromous Fish Research Center indicate that shad are exposed to the intakes and some individuals spend substantial amounts of time in the vicinity of the intakes. The PAD does not contain any information or tool that will allow for predictions of impacts of alternative project operations, or potential mitigation measures to protect or enhance aquatic fish and wildlife resources.

Nexus to Project Operations and Effects

Existing project operations have a direct impact on instream flow and aquatic habitat in the pump/discharge area of the Connecticut River. The PAD (section 3.2.2) says that the discharge at the trash racks when operating at full capacity is 20,000 cfs and maximum pumping conditions are 15,200 cfs. Annual flow duration curves shown for below the Vernon Dam submitted in the PAD (section 4.3.1.2) (for years 1944-1973; recent and near project flows are not available; see p. 459) indicate that river flows are ≤ 20,000 cfs more than 85 percent of the time. Flows released from the project must therefore influence flow patterns and velocities in the Connecticut River, particularly at flows below some unknown threshold level.

Recreational users of the Connecticut River in the Turners Falls impoundment have anecdotally described flow reversals in the mainstem river. Discharges from the project could potentially be larger than river flows or at least act like a major tributary to the Connecticut River. Project flows may influence the availability and extent of upstream and downstream migration zones, or may confuse fish and delay migration.

Methodology Consistent with Accepted Practice

CFD modeling is consistent with generally accepted practice, and has been used to assess proposed modifications to the Holyoke Project (FERC No. 2004) fish passage facilities, upstream of the intakes and downstream of the dam, as well as at hydroelectric projects on the Susquehanna River to assess existing and proposed project operations, and develop mitigation measures for fish and wildlife resources.

A study plan that describes the specific modeling tools to be used, the amount of bathymetric data to be gathered, the geographic scope of the assessment and the flow conditions to be modeled will need to be developed in consultation with the Service and other parties.

Level of Effort/Cost, and Why Alternative Studies will Not Suffice

This study will require a detailed elevation map of the study area upstream and downstream of the NMPS intake structure. Some information already exists in historic construction files for the project and past hydraulic analyses. Additional bathymetric data likely will need to be collected in the field using standard survey techniques. The CFD computer program will need to simulate existing project operations, as well as accommodate all potential variations of pumping and generating, and static operation.

No project-specific instream flow analysis tool has been developed for the NMPS that will allow for assessment of existing operations and alternative operational impacts on instream flow and aquatic habitat for fish and wildlife resources. The computer model, once built, can be used to simulate flow conditions in the vicinity of the project during migratory fish passage and can be used together with behavior studies (i.e., telemetry studies and entrainment studies requested herein) to assess the impacts of varying project operations or potential mitigation operations and measures on fish migration and aquatic habitat. We know of no other tool that will provide for these types of assessments. Cost is expected to be moderate to high.

FirstLight Study Request #14

Upstream American Eel Passage Assessment at Turners Falls
(Turners Falls, P-1889; Northfield Mountain, P-2485)

Goals and Objectives

This study has two objectives:

1. Conduct systematic surveys of eel presence/abundance at the Cabot Station discharge, Station #1 discharge, canal discharges, and Turners Falls Dam to identify areas of concentration of eels staging in pools or attempting to ascend wetted structures that would potentially establish the most effective locations to place upstream eel passage facilities.

2. Collect eels with temporary trap/pass devices at areas identified from surveys as potential locations of eel concentration to assess whether eels can be collected/passed in substantial numbers, and whether locations are viable sites for permanent eel trap/pass structures.

Resource Management Goals

The Atlantic States Marine Fisheries Commission (ASMFC) has developed two documents related to the management of American eel:

1. Interstate Fishery Management Plan for American Eel. April 2000. Atlantic States Marine Fisheries Commission.
2. Addendum II to the Fishery Management Plan for American Eel. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

In addition, the Connecticut River Atlantic Salmon Commission (CRASC) developed A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin in 2005. The goal of the plan is "to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem…" Management objectives in the plan include the following:

1. protect and enhance eel populations where they currently exist;
2. where practical, restore populations to waters where they had historical abundance;
3. provide effective upstream and downstream fish passage around dams and other barriers within the species' range in the basin; and
4. comply with all requirements of the Fishery Management Plan of the ASMFC.

Based on these plans, the U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.

2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the project.

Specific to upstream passage of American eel, the Service's goals are:

1. Minimize current and potential negative project operational effects that could hinder management goals and objectives.
2. Minimize project-related sources of upstream passage delay, injury, and stress in order to facilitate access to historical rearing habitat.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), and the Federal Power Act (16 U.S.C. §791a, *et seq.*).

Public Interest

The requester is a resource agency.

Existing Information

The PAD contains no information relative to areas where eels seeking to move upstream concentrate downstream of the dam, or annual numbers of eels attempting to ascend past Turners Falls Dam. While eels have been known to ascend the Cabot Station ladder (A. Haro, U.S. Geological Survey, personal communication), its efficiency is unknown, and it is only operated during the American shad passage season (from April 1 through July 15). Eels are currently able to pass the Turners Falls Dam complex (as evidenced by documented presence of eels upstream), but the total number of eels attempting to pass Turners Falls and the proportion successfully passing the project is unknown (but suspected to be low). The downstream Holyoke Project has operated upstream eel passage facilities since 2004. Last year, these facilities passed over 40,000 juvenile eels. While there is rearing habitat in between the Holyoke and Turners Falls dams, some eels will attempt to continue upstream, and passage needs to be provided so these fish can access historical habitat.

These information gaps need to be filled so resource agencies can determine the best locations to site upstream eel passage facilities and assess whether operating the existing anadromous ladders would be an effective mechanism to move juvenile eels upstream past the project.

We also note that within the past seven years, the Service has received two petitions to list the American eel under the Endangered Species Act. The first petition was received on November 18, 2004. On July 6, 2005, the Service issued a substantial 90-day finding on the petition and initiated a 12-month status review that concluded on February 2, 2007 with a finding that listing was not warranted. The second petition was filed on April 30, 2010 by the Council for Endangered Species Act Reliability (CESAR). On September 29, 2011, the Service issued a substantial 90-day finding and initiated a 12-month status review. The Service is still accepting new American eel information for the ongoing status review. The Service also is currently in settlement negotiations with CESAR on their legal complaint that the Service failed to complete the 12-month finding within the statutory timeframe. Although the date for completion of the Service's 12-month finding on the latest petition is uncertain, it is likely that it will be made before any new licenses are issued for the project.

Nexus to Project Operations and Effects

The project generates hydropower on the head created by the Turners Falls Dam. This dam creates a barrier to upstream migrating eels. While some eels are able to pass dams, some are not, and the passability of a given dam depends on factors such as its height, hydraulics, presence of climbable surfaces, presence of predators, risk of exposure to heat or drying while climbing a dam, etc. The Turners Falls Dam is high (35 feet above bedrock), and the majority of the dam face is dry during most of the upstream eel passage season. Design of the dam is not currently amenable to passage of eels by climbing. While flow is released to the bypass reach via a bascule gate (typically the one closest to the gatehouse), this would not facilitate eel passage, as bascule gates open outward and downward (i.e., requiring the eels to essentially swim nearly upside down to get over the gate). As mentioned earlier, the existing anadromous passage facilities are not designed to pass eels, and even if some eels are able to ascend the ladders, they may incur delays (in attraction or passage rates), be size-selective (e.g., velocity barrier for small eels presented by ~8 ft/sec flow through weirs and orifices), present a potential predation risk (predators in or near the fishways), and are not operated throughout the upstream eel passage season.

Methodology Consistent with Accepted Practice

1. Objective 1: Systematic Surveys

   Surveys of eel presence and relative abundance should be conducted at regular intervals throughout the eel upstream migratory season (~1 May to ~15 October, or when river temperatures exceed 10°C). Surveys should consist of visual inspection and trapping in likely areas where eels may concentrate as they attempt to climb structures wetted by significant spill or leakage flow in the Turners Falls Dam complex area. These locations include: Cabot Station downstream bypass outfall, Cabot Station spillway (including attraction water stilling basin), Cabot fishway (dewatered state), USGS Conte Lab flume outfall, Number One Station outfall, various small turbine and process water outfalls from the Cabot Canal, spillway fishway attraction water stilling basin, and leakage points along the downstream face of the Turners Falls Dam (bascule and taintor gates). Methods should include visual surveys (on foot, from a boat, or snorkeling) and trapping using small mesh (< 1/8"-clear opening) baited eel pots. Visual surveys should be performed once per week, at night, preferentially during precipitation events. Trap sets should be performed once per week, with an overnight soak time. Recorded data should include location, observation of eels (presence, absence, relative numbers, relative sizes, behaviors, time/date of observation), and survey method.

2. Objective 2: Trap/Pass Collections

   Areas identified from Systematic Surveys as having a significant number of eels present should be targeted as potential areas for permanent eel trap/passes, and should be initially assessed using temporary/portable trap passes. At a minimum (regardless of survey results), temporary trap passes should be installed at the following locations: Cabot fishway attraction flow stilling basin (during dewatered fishway period), Number One Station outfall, and spillway fishway attraction flow stilling basin (during watered and dewatered fishway period), as these locations may be supplemented with additional attraction flow and have high potential for being concentration points for upstream migrant eels. Temporary trap/passes should be purpose-designed and built for each location, and operated throughout the eel upstream migratory season (~1 May to ~15 October, or when river temperatures exceed 10°C). Ramp-type traps with supplementary attraction flow are preferred temporary trap/pass designs. Traps should operate daily, with catches quantified every two to three days. Recorded data should include location, trapping interval, absolute numbers of eels trapped, relative eel sizes, and hydraulic and environmental conditions during the trapping period.

All collected eels from surveys should be released at their point of capture; those eels collected from trap/pass collections should be transported to and released above the dam in the Turners Falls pool.

These methodologies are consistent with accepted practice.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

The level of cost and effort for the survey component of the study would be low; a minimal number of personnel may be able to conduct the weekly surveys. The trap/pass component would require low to moderate cost (estimated at $40,000) and effort.

In the PAD, the Applicant has identified the need to assess issues related to upstream passage for American eels at the project, but indicates that it intends to rely on information from previously conducted studies and ongoing studies. The Service is not aware of any previously conducted or ongoing studies related to upstream eel passage.

FirstLight Study Request #15

Evaluation of Timing of Downstream Migratory Movements of American Eels on the Mainstem Connecticut River

(Turners Falls, P-1889; Northfield Mountain, P-2485; Bellows Falls, P-1855; Wilder, P-1892; Vernon, P-1904)

Goals and Objectives

The goal of this study is to better understand migration timing of adult, silver-phase American eels in relationship to environmental factors and operations of mainstem hydropower projects on the Connecticut River.

The objective of this study is:

Quantify and characterize the general migratory timing and presence of adult, silver-phase American eels in the Connecticut River relative to environmental factors and operations of mainstem river hydroelectric projects.

Resource Management Goals

The Atlantic States Marine Fisheries Commission (ASMFC) has developed two documents related to the management of American eel:

1. Interstate Fishery Management Plan for American Eel. April 2000. Atlantic States Marine Fisheries Commission.
2. Addendum II to the Fishery Management Plan for American Eel. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

Objectives of the management plan include: (1) protect and enhance American eel abundance in all watersheds where eel now occur; and (2) where practical, restore American eel to those waters where they had historical abundance, but may now be absent, by providing access to inland waters for glass eel, elvers, and yellow eel, and adequate escapement to the ocean for pre-spawning adult eel.

Addendum II contains specific recommendations for improving upstream and downstream passage of American eel, including requesting that member states and jurisdictions seek special consideration for American eel in the Federal Energy Regulatory Commission relicensing process.

In addition, the Connecticut River Atlantic Salmon Commission (CRASC) developed A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin in 2005. The goal of the plan is "to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem…" Management objectives in the plan include the following:

1. protect and enhance eel populations where they currently exist;
2. where practical, restore populations to waters where they had historical abundance;
3. provide effective upstream and downstream fish passage around dams and other barriers within the species' range in the basin; and
4. comply with all requirements of the Fishery Management Plan of the ASMFC.

Based on these plans, the U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the projects. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the projects.

Specific to downstream passage of American eel, the Service's goals are:

1. Minimize current and potential negative project operation effects that could hinder management goals and objectives.
2. Minimize project-related sources of downstream passage delay, injury, stress, and mortality in order to maximize the number of silver eels migrating to the spawning grounds.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), and the Federal Power Act (16 U.S.C. §791a, *et seq.*).

Public Interest

The requester is a resource agency.

Existing Information

Data on timing of downstream migratory movements and rates of American eels in the mainstem Connecticut River are sparse and relatively incomplete. Preliminary data on the presence of "eel-sized" acoustic targets have been collected (Haro *et al.* 1999) within the Turners Falls Project's Cabot Station forebay that were somewhat confirmed by video monitoring at the Cabot Station downstream fish bypass; however, these were short-term studies, with acoustic monitoring only performed from 17 September to 5 October and video monitoring only conducted between 18 September to 22 October.

Some daily monitoring of the downstream bypass at the Holyoke Dam (canal louver array) was performed in 2004 and 2005 (Kleinschmidt, Inc. 2005, 2006, Normandeau Associates 2007); these studies also were of relatively short duration (spanning from October 5 to November 10 in 2004 and September 9 to November 11 in 2005) and the sampler was only operated at night.

To date, no other directed studies of eel migratory movements have been conducted at any location on the Connecticut River mainstem. This information gap needs to be filled, as it relates directly to when downstream passage and protection measures need to be operated.

We also note that within the past seven years, the Service has received two petitions to list the American eel under the Endangered Species Act. The first petition was received on November 18, 2004. On July 6, 2005, the Service issued a substantial 90-day finding on the petition and initiated a 12-month status review that concluded on February 2, 2007 with a finding that listing was not warranted. The second petition was filed on April 30, 2010 by the Council for Endangered Species Act Reliability (CESAR). On September 29, 2011, the Service issued a substantial 90-day finding and initiated a 12-month status review. The Service is still accepting new American eel information for the ongoing status review. The Service also is currently in settlement negotiations with CESAR on their legal complaint that the Service failed to complete the 12-month finding within the statutory timeframe. Although the date for completion of the Service's 12-month finding on the latest petition is uncertain, it is likely that it will be made before any new licenses are issued for the projects.

Nexus to Project Operations and Effects

The timing of downstream migration of adult eels is poorly defined for the Connecticut River; therefore, the general effects of hydroelectric project operations on eel survival to the ocean are unknown. Although separate study requests have been submitted to address project-specific downstream passage route selection, delays, and mortality of eels, general characteristics of river flow and environmental conditions may have significant relationships with project operation and eel migratory success and survival. For example, eels may tend to move immediately before or during periods of significant precipitation (or consequently river flow), times at which projects may be generating at maximum capacity or spilling, which may (or may not) present a higher passage risk to eels. Conversely, periods of low flow may be associated with a significant proportion of total river flow passing through turbine units, which present additional (or different) passage risk to eels. If discrete conditions which promote eel downstream migration are known, it may be possible to take actions with respect to project operations which reduce or minimize passage risk; i.e., operation of a bypass, reduction of intake approach velocities, directed spillage through a "safe" route, etc. These studies should provide baseline information on river-specific downstream migration to predict when silver-phase eels are expected to be migrating in the mainstem Connecticut River, from which project operations could be modified to minimize passage risks.

The studies are proposed for a single or multiple sites; the results will be relevant to all sites on the Connecticut River mainstem.

Methodology Consistent with Accepted Practice

Quantification of downstream movements of American eels in river systems requires systematic sampling of migrants throughout the migratory season. This can be accomplished with traditional active trapping methods; i.e., fyke or stow net sampling, weirs, or eel racks, but these methods are technically challenging on larger mainstem rivers, due to the scale of flows that need to be sampled, difficulties in operation throughout all flow conditions, and high debris loading during fall flows. Passive monitoring of migrant eels using hydroacoustic methods offers an alternative to active trapping. However, this form of passive monitoring requires verification of potential acoustic targets with some level of active (collection) or visual (traditional optical or acoustic video) sampling.

Two potential locations offer opportunities to conduct simultaneous passive and active sampling: the Cabot Station (Turners Falls Project) canal/forebay and the Holyoke Dam forebay and canal louver/bypass system. Each location possesses a route of downstream passage which conducts a significant proportion of river flow (Cabot canal and Holyoke forebay or canal), and each has a proximal bypass equipped with a sampler so that fish can be concentrated/collected from the passage route and identified to species. Project operations do influence the relative proportion of flow (and thus numbers of downstream migrant eels) in each passage route, so numbers of eels sampled in each route represent only a proportion of the total number of eels migrating downstream within the entire river. Because the absolute proportion of eels using a specific route at any one time is unknown, numbers of eels quantified within a route must serve as a relative index of the degree of migratory movement.

This study shall quantify eel movements in either one, or preferably both, locations for two consecutive years (since environmental conditions strongly influence migratory timing of eels, which can vary significantly from year to year) (Haro 2003). Eels will be quantified using methods similar to Haro *et al.* (1999), by continuously monitoring a fixed location at the projects with hydroacoustics. Because eels tend to concentrate in areas of dominant flow (Brown *et al.* 2009; EPRI 2001), the zone to be monitored should pass a dominant proportion of project flow throughout most periods of operation (i.e., forebay intake area). Hydroacoustic monitoring shall encompass the entire potential migratory season, beginning in mid-August and ending in mid-December, and shall operate 24 hours per day. Data will be recorded for later processing and archiving.

Systematic active quantification of eels at downstream bypass samplers shall be performed simultaneously with passive hydroacoustic monitoring, to verify presence of eels and relative abundance of eel-sized hydroacoustic targets from the hydroacoustic data. Although daily operation of the bypass sampler could be performed, a more comprehensive technique is to monitor eels entering the bypass with an acoustic camera (i.e., DIDSON, BlueView, etc.). The acoustic camera will afford positive visual identification of eels as they enter the bypass, which is a concentration point for migrating eels. Acoustic camera monitoring will also allow monitoring to be performed 24 hours a day, and will be relatively unaffected by water turbidity (which influences effectiveness of traditional optical video monitoring). The acoustic camera system will be operated during the same time period as acoustic monitoring, and images will be recorded for later processing and archiving.

Data analyses of hydroacoustic, acoustic camera, bypass sampling, and environmental/ operational data will follow standard methodology.

Project operation (flows, levels, gate openings, number of units operating and operation level) and environmental conditions (river flow, temperature, turbidity, air temperature, precipitation) will be monitored regularly (hourly measurements if possible) throughout the duration of the studies.

These methodologies are consistent with accepted practice.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

The level of cost and effort for the downstream migrant eel migratory timing study would be moderate, given the level of cost for instrumentation, deployment, and data review/analysis. Cost is estimated at $50,000 per year for the study.

The Applicant did not propose any studies to meet this need in the PAD.

REFERENCES

Brown, L., A. Haro, and T. Castro-Santos. 2009. Three-dimensional movement of silver-phase American eels in the forebay of a small hydroelectric facility. Pages 277-291in: J. Casselman et al. editors. Eels at the Edge: Science, Status, and Conservation Concerns. American Fisheries Society, Bethesda, MD.

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Haro, A. 2003. Downstream migration of silver-phase anguillid eels. Pages 215-222 in: Aida, K., K. Tsukamoto, and K. Yamauchi, eds. Eel Biology. Springer, Tokyo.

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Kleinschmidt, Inc. 2005. Factors influencing the timing of emigration of silver-phase American Eels, *Anguilla rostrata*, in the Connecticut River at Holyoke MA. Submitted to the City of Holyoke Gas and Electric Department. 27 pp.

Kleinschmidt, Inc. 2006. Holyoke Project (FERC No. 2004) silver-phased American eel flow priority plan. Submitted to the City of Holyoke Gas and Electric Department. 51 pp.

Normandeau Associates, Inc. 2007. American eel emigration approach and downstream passage routes at the Holyoke Project, 2006. Submitted to the City of Holyoke Gas and Electric Department. Final report. Normandeau Associates, Inc., Westmoreland, New Hampshire. 81 pp.

FirstLight Study Request #16

Downstream American Eel Passage Assessment at Turners Falls and Northfield Mountain Pumped Storage

(Turners Falls, P-1889; Northfield Mountain, P-2485)

Goals and Objectives

The goal of this study is to determine the impact of two hydroelectric projects on the outmigration of silver eels in the Connecticut River. Entrainment of eels at the Northfield Mountain Pumped Storage (NMPS) Station removes eels from the river, effectively extirpating them from the population. Entrainment at the conventional turbines at Station 1 and Cabot Station of the Turners Falls Project can result in mortality or injury. It is important to understand the passage routes at each project and the potential for mortality to assess alternative management options to increase survival.

The objectives of this study are:

1. Quantify the movement rates (including delays) and relative proportion of eels passing via various routes at the projects; i.e., for NMPS, the proportion entrained into the intake; for Turners Falls Dam, the proportion entrained into the power canal and spilled via bascule and taintor gates; for the Cabot Canal, proportion of fish passing via spillways, turbines, and the downstream bypass.

2. Evaluate instantaneous and latent mortality and injury of eels passed via the Turners Falls Dam routes, including bascule and taintor gates, spillways, turbines, and the downstream bypass.

Resource Management Goals

The Atlantic States Marine Fisheries Commission (ASMFC) has developed two documents related to the management of American eel:

1. Interstate Fishery Management Plan for American Eel. April 2000. Atlantic States Marine Fisheries Commission.
2. Addendum II to the Fishery Management Plan for American Eel. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

Objectives of the management plan include: (1) protect and enhance American eel abundance in all watersheds where eel now occur; and (2) where practical, restore American eel to those waters where they had historical abundance, but may now be absent, by providing access to inland waters for glass eel, elvers, and yellow eel, and adequate escapement to the ocean for pre-spawning adult eel.

Addendum II contains specific recommendations for improving upstream and downstream passage of American eel, including requesting that member states and jurisdictions seek special consideration for American eel in the Federal Energy Regulatory Commission relicensing process.

In addition, the Connecticut River Atlantic Salmon Commission (CRASC) developed A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin in 2005. The goal of the plan is "to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem…" Management objectives in the plan include the following:

1. protect and enhance eel populations where they currently exist;
2. where practical, restore populations to waters where they had historical abundance;
3. provide effective upstream and downstream fish passage around dams and other barriers within the species' range in the basin; and
4. comply with all requirements of the Fishery Management Plan of the ASMFC.

Based on these plans, the U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the projects. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the projects.

Specific to downstream passage of American eel, the Service's goals are:

1. Minimize current and potential negative project operation effects that could hinder management goals and objectives.
2. Minimize project-related sources of downstream passage delay, injury, stress, and mortality in order to maximize the number of silver eels migrating to the spawning grounds.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), and the Federal Power Act (16 U.S.C. §791a, *et seq.*).

Public Interest

The requester is a resource agency.

Existing Information

The PAD contains information on the biology, life history, and regulatory status of American eel. It also discusses 2-D and 3-D telemetry studies that were conducted at Cabot Station in 1996, 1997, 2002 and 2003. Results of those studies indicate that a significant proportion of eels entering the Cabot forebay become entrained (90 percent in 2002, 100 percent in 2003) (Brown 2005; Brown *et al.* 2009). The PAD notes that the study done in 2003 determined that 15 of the 29 test eels were detected at the Hadley Falls Station. However, that study was not designed to assess turbine mortality.

To date, no directed studies of eel mortality at Cabot Station or eel entrainment or mortality at either Station 1 or the NMPS facility have been conducted. These information gaps need to be filled so resource agencies can assess the relative and cumulative impact of project operations on outmigrating eels and develop adequate passage and protection measures to meet management goals and objectives.

We also note that within the past seven years, the Service has received two petitions to list the American eel under the Endangered Species Act. The first petition was received on November 18, 2004. On July 6, 2005, the Service issued a substantial 90-day finding on the petition and initiated a 12-month status review that concluded on February 2, 2007 with a finding that listing was not warranted. The second petition was filed on April 30, 2010 by the Council for Endangered Species Act Reliability (CESAR). On September 29, 2011, the Service issued a substantial 90-day finding and initiated a 12-month status review. The Service is still accepting new American eel information for the ongoing status review. The Service also is currently in settlement negotiations with CESAR on their legal complaint that the Service failed to complete the 12-month finding within the statutory timeframe. Although the date for completion of the Service's 12-month finding on the latest petition is uncertain, it is likely that it will be made prior to any new licenses being issued for the projects.

Nexus to Project Operations and Effects

The Turners Falls Project operates as a peaking facility, except during periods when inflow exceeds the hydraulic capacity of Cabot Station and Station 1. Silver eels outmigrate during the mid-summer through late fall, a time of year when flows are generally near the maximum operating capacity of the stations. Therefore, the project would be expected to spill infrequently during the silver eel outmigration beyond the nominal amount required in the bypass reach.

Racks at Cabot Station, Station 1, and the NMPS facility are not designed to protect eels from entrainment. At Cabot, the racks have one-inch-clear spacing on the top 11 feet, with five-inch-clear spacing on the bottom 20 feet of racks. The approach velocity at the racks is approximately 2.0 feet per second at maximum hydraulic capacity. At Station 1, the racks have 2.6-inch-clear spacing and an approach velocity of 1.2 feet per second. Eels can readily pass through a 2.6-inch-clear space. NMPS has 48-foot-deep trashracks with 6-inch-clear spacing over the intake and an approach velocity of 3.5 feet per second at full pumping capacity (15,000 cfs).

As mentioned above, previous studies conducted at Cabot Station documented eel entrainment. Cabot Station has existing downstream passage facilities designed for anadromous species, but studies have documented few eels utilizing the surface bypass (likely because Cabot has a relatively deep, wide intake area). Station 1 has no passage and protection facilities. NMPS has a seasonally deployed barrier net to minimize entrainment of Atlantic salmon smolts, but it is only operated from April through June 15 annually. While no studies have been conducted at Station 1 or the NMPS facility, the rack spacing is wide enough to allow for entrainment.

Methodology Consistent with Accepted Practice

In order to understand the movements of outmigrating silver eels as they relate to operations at the NMPS facility, Station 1, and Cabot Station, radio telemetry technology should be utilized. Radio telemetry is an accepted technology that has been used for a number of studies associated with hydropower projects, including at the Muddy Run Project (FERC No. 2355).

Studies should be designed to investigate route selection (i.e., entrainment vs. spill) independently from estimation of mortality/injury, because these metrics require different telemetric methodologies. Studies also will likely benefit from data from several seasons (especially route selection studies, which may be more significantly affected by environmental conditions during a given season than mortality/injury studies). It is also envisioned that results from route selection studies can guide design of turbine mortality studies. Therefore, it is proposed, at a minimum, that route selection studies be conducted in multiple years, but mortality/injury studies may be conducted after the first year of route selection studies have been completed.

1. Objective 1: Route Selection

   This study will involve systematic releases of radio-tagged silver phase eels at strategic points above areas of interest, to assess general routes of passage (i.e., via spill, bypass, or turbines). Active downstream migrants should be collected within-basin if possible (i.e., Cabot or Holyoke bypass samplers), but fish sourced from out of basin may be acceptable to meet sample size demands. Experimental fish must meet morphometric (e.g., eye diameter relative to body size) criteria to ensure they are migrant silver phase. Collections should be made within the migratory season (late August to mid-October), and eels should be tagged and released within seven days of collection.

   NMPS Route Selection Study:

   A minimum number of 50 telemetered eels (e.g., five separate groups of approximately 10 eels each) will be required to maximize the data return. Eels will be released at least 5 km upstream of the NMPS project; releases should be timed so that there is a significant probability that migrating eels will encounter NMPS during the pumping stage. Radio telemetry antennas will be strategically placed to determine times eels are present within the river reach in the vicinity of the NMPS intakes, within the intakes themselves, and whether they are entrained into the upper reservoir.

Turners Falls Dam Route Selection Study:

A minimum number of 50 telemetered eels (e.g., five separate groups of approximately 10 eels each) will be required to maximize the data return. Groups of eels should be released during spill and non-spill periods, if possible. Tagged eels will be released at least 3 km upstream of the Turners Falls Dam, but several km below the intake to NMPS. Telemetry receivers and antennas will be located above and below the dam to assess passage via the following potential routes: entrainment into power canal; passage via spill over the bascule gates; passage via spill through the taintor gates.

Eels from the NMPS route study not entrained into the NMPS intake and migrating to the Turners Falls Dam may be used to supplement (but not serve in lieu of) these release groups.

Turners Falls Project – Canal Route Selection Study:

A minimum number of 50 telemetered eels (e.g., five separate groups of approximately 10 eels each) will be required to maximize the data return. Groups of eels should be released during periods of low, moderate, and high generation conditions, if possible. Eels will be released in the upper canal (ideally just downstream of the gatehouse), and allowed to volitionally descend through the canal. Telemetry receivers and antennas will be located within the canal, bypass, channel, and mainstem below Cabot Station to assess passage via the following potential routes: spillway fishway attraction water intake (if operational); Station 1 turbines; Cabot Station spillway; Cabot Station bypass; Cabot Station turbines.

Eels from the NMPS and Turners Falls Dam route studies not entrained into the NMPS intake and migrating into the Turners Falls Canal may be used to supplement (but not serve in lieu of) these release groups.

Mobile tracking (i.e., via boat) in river reaches between release sites and several km downstream of Cabot Station will be performed at regular intervals during and after releases to confirm routes and fates of passed fish, or fish lost to follow-up.

Movement rates (time between release and passage) of eels passing the projects by various routes will also be quantified.

The route selection portion of this study should occur in both study years.

2. Objective 2: Spill, Bypass, and Turbine Mortality/Injury Studies

Spill, bypass, and turbine mortality will be assessed using a radio-telemetric balloon tag method. A minimum number of 50 tagged eels (e.g., five separate groups of approximately 10 eels each) will be required at each location (dam bascule gate, dam taintor gate, Cabot Station spillway, Cabot Station bypass, Station 1 and Cabot Station) to maximize the data return. Turbine mortality studies are not required at NMPS because it is assumed that all entrained fish (including eels) are lost to the Connecticut River system.

For spill mortality sites (dam bascule gate, dam taintor gate, Cabot Station spillway, Cabot Station bypass), tagged eels will be injected or released into spill flow at points where water velocity exceeds 10 ft/sec, to minimize the possibility of eels swimming upstream into the headpond or canal. Passed balloon-tagged eels will be recovered below areas of spill and held for 48 hours in isolated tanks for observation of injury and latent mortality; unrecovered balloon-tagged eels will be censored from the data.

For turbine mortality sites (Station 1 and Cabot Station), tagged eels will be injected into intakes of units operating at or near full generation at points where intake water velocity exceeds 10 ft/sec, to minimize the possibility of eels swimming back upstream through the intakes. Passed balloon-tagged eels will be recovered in the tailrace and held for 48 hours in isolated tanks for observation of injury and latent mortality; unrecovered balloon-tagged eels will be censored from the data.

Mobile tracking (i.e., via boat) in river reaches between release sites and several km downstream of Cabot Station will be performed at regular intervals after releases to confirm routes and fates of passed fish, or fish lost to follow-up.

The turbine mortality component of the study should occur in study year two.

Data analyses of route selection and turbine mortality (instantaneous and latent) will follow standard methodology.

Project operation (flows, levels, gate openings, number of units operating and operation level) and environmental conditions (river flow, temperature, turbidity, air temperature, precipitation) will be monitored regularly (hourly measurements if possible) throughout the duration of the studies.

These methodologies are consistent with accepted practice.

Level of Effort/Cost, and Why Alternative Studies will Not Suffice

The level of cost and effort for the downstream eel passage study would be moderate to high; silver eels would need to be collected, tagged, and released in several locations over the course of the migration season. Antennas and receivers would need to be installed at the intakes to all stations, as well as at the Turners Falls Dam spillway and Cabot Station bypass, and monitored regularly. Data would need to be retrieved periodically, then analyzed. A multi-site route selection study conducted by the USGS Conte Lab on the Shetucket River in Connecticut cost approximately $75,000 for the first year of study. Costs are estimated at $100,000 per year for the route selection studies and $75,000 per year for the spill, bypass, and turbine mortality/injury studies.

In the PAD, the Applicant has identified the need to assess issues related to downstream passage for American eels at the project, but indicates that they intend to rely on information from previously conducted studies and ongoing studies. The Service is not aware of any previously conducted or ongoing studies related to downstream eel passage.

REFERENCES

Brown, L.S. 2005. Characterizing the downstream passage behavior of silver phase American eels at a small hydroelectric facility. M.Sc. Thesis, Department of Natural Resource Conservation, University of Massachusetts, Amherst, Massachusetts. 110 pp.

Brown, L., A. Haro and T. Castro-Santos. 2009. Three-dimensional movement of silver-phase American eels in the forebay of a small hydroelectric facility. Pages 277-291 in: J. Casselman et al. editors. Eels at the Edge: Science, Status, and Conservation Concerns. American Fisheries Society, Bethesda, MD.

FirstLight Study Request #17

Determine the Fish Assemblage in the Turners Falls and Northfield Mountain Pumped Storage Project-Affected Areas

(Turners Falls, P-1889; Northfield Mountain, P-2485)

Goals and Objectives

The goal of this request is to determine the occurrence, distribution, and relative abundance of fish species present in the project-affected areas of the Turners Falls and Northfield Mountain Pumped Storage (NMPS) project areas, which potentially includes Species of Greatest Conservation Need (SGCN) for Massachusetts, New Hampshire, and Vermont.

Specific objectives include:

1. Document fish species occurrence, distribution and abundance within the project-affected areas along spatial and temporal gradients.

2. Compare historical records of fish species occurrence in the project affected areas to results of this study.

Resource Management Goals

The Massachusetts Division of Fisheries and Wildlife, the New Hampshire Fish and Game Department and the Vermont Fish and Wildlife Department each have as a mission the protection and conservation of fish and their habitats. Riverine fish species are an important component of the river's ecology and are the basis for the sport fishery. Furthermore, several of the states' SGCN have been documented in the project-affected areas.

Determining species occurrence, distribution, and abundance will better clarify what species occur in the project area both spatially and temporally, relative to habitats which may be affected by project operations of the Turners Falls or NMPS projects. This information will better inform other results from other study requests that will be examining project operation effects on various aquatic habitats, water quality and other related concerns such as entrainment concerns at NMPS. This information will be used to make recommendations and provide full consideration for all species, including those that might not otherwise be known to occur in the project-affected area and impacts that may affect their population status through direct or indirect effects of the projects.

Public Interest

The requestor is a natural resource agency.

Existing Information

A thorough and comprehensive assessment of the fish assemblage present in the project-affected areas of the Turners Falls and NMPS projects is lacking. The PAD for these project sites notes resident fish surveys conducted by the State of Massachusetts in the early to mid-1970s and a limited 2008 sampling effort by Midwest Biodiversity Institute (contracted by EPA). The PAD identifies a total of 22 fish species in the project area which omits, as an example of its limited information basis, northern pike, tessellated darter, burbot, eastern silvery minnow, and channel catfish (Ken Sprankle, USFWS, and Jessie Leddick, MADFW, personal communication). It is unknown how many other species may inhabit or utilize aquatic habitats in the project areas, potentially including species of greatest conservation need.

The most relevant recent fish survey study related to the project-affected areas is a Connecticut River electrofishing survey conducted in 2008 (Yoder *et al.* 2009). While some sampling was conducted in both project areas during the 2008 survey, this survey did not have the same goals and objectives as those outlined above. Due to the design of the study limitations in geographic/habitat type coverage both spatially and temporally, and the use of a single gear type, these data may not be a full representation of species occurrence in the project affected areas. It follows that since information is limited regarding the composition of the fish community and their use of habitats in the project-affected area, project impacts on fish species are also unknown.

Nexus to Project Operations and Effects

Project operations have the potential to directly impact fish species life history requirements, biological interactions, and habitat quantity and quality. For example, headpond and tailwater water level fluctuations could dewater important spawning areas, or affect habitat availability, thus limiting productivity of fish species by direct impacts to their spawning success or indirectly by limiting the spawning success of forage fish species. Accordingly, a thorough understanding of the current fish assemblage structure and associated metrics is needed in order to examine any potential project-related impacts. A study request to examine project effects on aquatic habitats, as well as impacts to spawning habitats (e.g., sea lamprey and black bass) has been submitted and will compliment this request.

Methodology Consistent with Accepted Practice

An accepted and robust field sampling design (e.g., as described in Pollock *et al.* 2002 or MacKenzie *et al.* 2006) and accepted methods for collecting fish species likely to be present in the project-affected areas (Bonar *et al.* 2009) should be used to conduct field surveys. Randomly sampling multiple habitat types using a multi-gear approach will be required to ensure that all fish species present are sampled. The spatial scope of the study will be from the headwaters of the Turners Falls pool downstream to Sunderland, Massachusetts, and will omit the upper reservoir of NMPS. Sampling should occur at each selected site across multiple seasons (spring, summer, and fall). Digital photographs should be taken to avoid misidentification of certain species such as Cyprinids.

The sampling design should include replicate samples for estimation of species detection probability. Sample replicates may be gathered temporally, using different methods, by independent observers, or by randomly sampled spatial replicates (MacKenzie *et al.* 2006). For each replicate sample, data that may be important for describing variation in species occurrence and presence/absence should be collected and recorded, such as gear type, mesohabitat type, depth, velocity, flow, water temperature, substrate, time of day, day of year, presence of cover, proportion of vegetation cover, size of individuals collected (juveniles may select different habitat), and/or other factors as determined by a qualified biologist. Species detection, occurrence, and/or abundance and related habitat measures on these parameters should be estimated using methods as described by Kery *et al.* (2005), MacKenzie *et al.* (2006), Wenger and Freeman (2008), or Zipkin *et al.* (2010).

This will be a one-year study, provided river discharge conditions fall within the 25-75th percentile for weekly averages. Based upon this study's results, and the information obtained from studies to survey aquatic habitats and littoral zone fish spawning, additional studies may be required if there is evidence of effects of the projects on populations or habitat of identified species.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

The cost of the study will be moderate to high as seasonal sampling with several types of gear will be required. However, cost will also be partially dependent on the number of sites sampled, the number of sample replicates, and the extent of the covariate data that are measured, all of which may be flexible. Based on first-year study results, a second year of sampling or specific studies examining impacts of project operations on specific fish species may be needed and requested. Provided the collected data are of high quality, analysis and synthesis should take approximately 10-20 days. FirstLight did not propose any studies specifically addressing this issue.

REFERENCES

Bonar, S.A., W.A Hubert and D.W. Willis, editors. 2009. Standard methods for sampling North American freshwater fishes. American Fisheries Society, Bethesda, Maryland.

Kery, M., J.A. Royle and H. Schmid. 2005. Modeling avian abundance from replicated counts using binomial mixture models. Ecological Applications 15:1450-1461.

MacKenzie, D.I., J.D. Nichols, J.A. Royle, K.H. Pollock, L.L. Bailey and J.E. Hines. 2006. Occupancy estimation and modeling: inferring patterns and dynamics of species occurrence. Elsevier: San Diego, California.

Pollock, K.H., J.D. Nichols, T.R. Simons, G.L. Farnsworth, L.L. Bailey and J.R. Sauer. 2002. Large scale wildlife monitoring studies: statistical methods for design and analysis. Environmetrics 13:105-119.

Wenger, S.J. and M.C. Freeman. 2008. Estimating species occurrence, abundance, and detection probability using zero-inflated distributions. Ecology 89:2953-2959.

Yoder, C.O., L.E. Hersha and B. Appel. 2009. Fish assemblage and habitat assessment of the Upper Connecticut River: preliminary results and data presentation. Final Project Report to: U.S. EPA, Region 1, Boston, MA. Center for Applied Bioassessment & Biocriteria. Midwest Biodiversity Institute. Columbus, OH.

Zipkin, E.F., J.A. Royle, D.K. Dawson and S. Bates. 2010. Multi-species occurrence models to evaluate the effects of conservation and management actions. Biological Conservation 134:479-484.

FirstLight Study Request #18

Impacts of the Turners Falls and Northfield Mountain Pumped Storage Projects on Littoral Zone Fish Habitat and Spawning

(Turners Falls, P-1889; Northfield Mountain, P-2485)

Goals and Objectives

The goal of this study is to determine if project operations and water level fluctuations in the Turners Falls Project impoundment negatively impact anadromous and resident fish. This study complements a separate study request specific to American shad spawning and also on habitats affected by water level manipulations.

Specific objectives include:

1. delineate, quantitatively describe (e.g., substrate composition, vegetation type and abundance), and map shallow water aquatic habitat types subject to inundation and exposure due to project operations, noting and describing additional areas where water depths at lowest operational range are wetted to a depth less than one foot (flats, near shore areas, gravel bars, etc. with very slight bathymetric change);
2. conduct analyses of the impacts of normal operations and the maximum permitted reservoir fluctuation range on the suitability of littoral zone habitats for all life stages of target species likely to inhabit these areas;
3. conduct field studies to assess timing and location of fish spawning;
4. conduct field studies to evaluate potential impacts of impoundment fluctuations on nest abandonment, spawning fish displacement, and egg dewatering; and
5. evaluate potential impoundment fluctuation ranges and how implementation of such changes would mitigate for identified impacts.

Resource Management Goals

The U.S. Fish and Wildlife Service (Service) has identified its mission as: working with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people. The Service has identified the following Northeast Regional goals to support the Service's mission and vision, the national Fisheries Program mission, and Service priorities: 1) conservation, and management of aquatic species: maintain, restore, and recover populations of species of conservation and management concern to self-sustaining levels; and 2) conservation and management of aquatic ecosystems: maintain and restore the ecological composition, structure, and function of natural and modified ecosystems to ensure the long-term sustainability of populations of species of conservation and management concern.

areas subject to dewatering and mapped relative to observations of fish nests, spawning fish, and egg deposits. During identified spawning periods for the target species, suitable spawning habitats subjected to daily project operational fluctuations will be surveyed to document the type and extent of project effects on nests or spawning habitat (e.g., nests of fallfish, lamprey, bass and sunfish) and observable eggs or larvae, relative to water level and other environmental conditions, including water temperature and water velocity in noted areas.

At least one year of data collection is necessary. A second year of study may be required should environmental (e.g., river discharge, air/water temperature) or operational conditions in the first year prove to be atypical during the study period (end of March through August).

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

FirstLight Power does not propose any studies to meet this need. Estimated cost for the study is moderate.

FirstLight Study Request #19

Impacts of the Turners Falls and Northfield Mountain Pumped Storage Project Operations on Tributary and Backwater Area Access and Habitats

(Turners Falls, P-1889; Northfield Mountain, P-2485)

Goals and Objectives

One goal of this study is to determine if water level fluctuations from the Turners Falls and Northfield Mountain Pumped Storage projects result in a barrier(s) to fish movement in and out of tributaries and backwaters to the impoundments and riverine reaches below dams.

A second goal is to determine if water level fluctuations in the Turners Falls and Northfield Mountain Pumped Storage project impoundments impact water levels, available fish habitat and water quality in tributaries and backwaters to the impoundments and riverine reaches below dams, and if impacts are found, to ascertain how spatially far reaching they are and develop mitigation measures.

Results of this study may also be used to help determine the adequacy of existing downstream minimum flow requirements.

Specific objectives include:

1. Conduct a field study of tributaries and backwaters, including water velocity and habitat data where appropriate, to evaluate potential impacts of impoundment fluctuation on fish access to tributaries and backwater areas. The study should also evaluate if changes in impoundment fluctuation range would mitigate for any identified impacts and if other mitigative measures would improve access.

2. Conduct a field study to examine potential impacts of impoundment fluctuations on water levels, available habitat and water quality in tributaries and backwaters. The evaluation should also evaluate if changes in impoundment fluctuation range would mitigate for identified impacts and if other mitigative measures would lessen these impacts.

Resource Management Goals

The U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the projects. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the projects.

Specific to aquatic resources, the Service's goals are:

1. Protect, enhance, or restore diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
2. Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the areas impacted by project operations.
3. Minimize current and potential negative project operation effects on water quality and aquatic habitat.

This requested study will facilitate the collection of information necessary to conduct effects analysis and to develop conservation measures to protect and enhance tributary and backwater access and valuable fish habitat. Maintaining connectivity between the mainstem of the Connecticut River and tributaries and backwaters is vital to the fish populations in these systems, as many fish species utilize these areas for spawning, rearing, refuge, and feeding.

Public Interest

The requestor is a natural resource agency.

Existing Information

To our knowledge, limited information exists related to this requested study.

Nexus to Project Operations and Effects

Project operations have the potential to impact fish species life history requirements, biological interactions, and habitat quantity and quality. For example, water level changes due to project operations could create conditions that could impede free movement of fish between tributaries/backwaters and the mainstem of the Connecticut River, thus limiting access to spawning habitat and/or growth opportunities. Additionally, water level changes could also alter tributary and backwater fish habitat quality, quantity, and also water quality, thus decreasing productivity and available habitat.

Methodology Consistent with Accepted Practice

Common tools to evaluate water level impacts would be used, including bathymetric mapping, substrate, depth and velocity measurements, and water quality information (dissolved oxygen, temperature, turbidity, and pH). Studies should be conducted throughout the year.

The study area for tributary and backwater fish sampling should cover all tributaries and backwaters within the project-affected areas of the Turners Falls and Northfield Mountain Pumped Storage projects. A second year of study may be required if first year data collection is limited due to environmental or other conditions, or if river discharge in the first year proves to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

FirstLight does not propose any studies to meet this need. Estimated cost for the study is moderate.

FirstLight Study Request #20

Impacts of Water Level Fluctuations on Riparian and Aquatic Vegetation Including Invasive Species and their Associated Habitats in the Turners Falls Dam Project Impoundment

(Turners Falls, P-1889; Northfield Mountain, P-2485)

Conduct a study to quantify impacts of reservoir fluctuation on riparian, wetland, emergent aquatic vegetation (EAV), submerged aquatic vegetation (SAV), littoral zone and shallow water aquatic habitats in the Turners Falls Dam impoundment.

Goals and Objectives

The goal of this study is to obtain baseline information on riparian, wetland, emergent and submerged aquatic vegetation, and associated shallow water aquatic habitats (subject to operational inundation and exposure to near exposure) known to occur in the project area. Information would be used to determine whether riparian, wetland, EAV and SAV, littoral, and shallow water (e.g., mid-river bars and shoals) habitats are impacted by current water level fluctuations permitted under the Turners Falls and Northfield Mountain Pumped Storage (NMPS) projects' licenses and whether these vegetation types and shallow water habitats can be protected and restored by modifications to project operations or other mitigation measures. This analysis needs to take into account existing and potential future limits on pond level fluctuations intended to limit recreation impacts, and the interactions of any changes in pond level fluctuation range or frequency and discharge changes under the new licenses of the Turners Falls and upstream projects. This information is needed to determine whether the project operations affect plants, habitat, and wildlife in the project area, whether aquatic vegetation and its habitats can be enhanced by modifications to project operations or other mitigative measures, and whether there is any unique or important shoreline or aquatic habitats that should be protected.

The specific objectives of the field study, at a minimum, include:

1. quantitatively describe and map wetland types within 200 feet of the shoreline, and describe associated wildlife;
2. delineate, quantitatively describe, and map all wetland types, including invasive species and wildlife observed (e.g., bald eagle nesting, water fowl nesting) within 200 feet of the shoreline, and the extent of this habitat if it extends beyond 200 feet; and
3. quantitatively describe (e.g., substrate composition, vegetation type and abundance) and map shallow water aquatic habitat types subject to project operation inundation and exposure, noting and describing additional areas where water depths at lowest operational range are wetted to a depth less than one foot (flats, near shore areas, gravel bars, with very slight bathymetric change).

A second year of study may be required should river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period.

The field study should produce a habitat inventory report that includes:

1. the results of the field study in the form of maps and descriptions;
2. an assessment of project effects on wetland, riparian, littoral zone vegetation and shallow water habitats, invasive plant species, and wildlife habitat at the project;
3. recommendations for any necessary plant, habitat type, or wildlife, protection and/or invasive species control measures; and
4. recommendations for plant, habitat type, or wildlife protection and/or invasive species control measures, including riparian buffer restoration and protection and protection of key nest and roost trees for bald eagles.

Resource Management Goals

The U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the projects. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the projects.

Specific to aquatic resources, the Service's goals are:

1. Protect, enhance, or restore diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
2. Minimize current and potential negative project operation effects on water quality and aquatic habitat.

Public Interest

The requestor is a resource agency.

Existing Information

Existing information in the PAD does not quantify EAV and SAV in this area, or other shallow aquatic habitat types and physical features (e.g., depths, substrates, wood structure) that are the environment for aquatic biota in the project area. The PAD does provide some limited monitoring data for 2012 (two locations) on water surface elevations that showed daily fluctuations, in the upper third of this impoundment, that varied over 4 feet on a daily cycling frequency, with fluctuations generally in the 2-foot range in low flow months for the data provided in the PAD. The current license does permit a greater pool elevation operational fluctuation, up to a 9-foot change in elevation, based on the Turners Falls Dam water elevation. In the PAD, it is noted that these operational fluctuations under most circumstances at the Turners Falls Dam are within 3.5 feet.

In the PAD it is noted that FirstLight would like to expand its NMPS upper reservoir capacity (by up to 24 percent); how this may affect project operations and the habitats noted in this request is unknown. It is also noted that water is typically pumped to the upper reservoir in the evening and generation back to the river occurs once to twice daily, in daytime hours, based upon power needs and power value. Under current license conditions, provided set thresholds for minimum flow and Turners Falls Dam current license elevations are met, the NMPS may operate with no restriction in timing, frequency, or magnitude for pumping or generation. No data were provided on the operation of the NMPS plant over time relative to data on pumping and generation on an hourly basis averaged values were provided over monthly periods. It is unclear what the actual timing, frequency and magnitude of these NMPS operations are over the course of a year and how that relates to aquatic plant species establishment, growth, survival, littoral zone or other shallow water habitat fish spawning periods and their effects on these fishes (reproduction success and subsequent recruitment, e.g., bass and fall fish nests) in available and utilized habitat, and how the quantity and quality of these shallow water habitats are effected by project operational manipulation/alteration, as currently permitted or proposed.

The PAD provides lists of plant and wildlife species whose native ranges overlap with the project area, but it does not provide any baseline information on known occurrences of these species in the wetlands, riparian, littoral and shallow water habitats, within or adjacent to the project area. Plant and wildlife occurring in these habitats may benefit from protection, mitigation, and enhancement (PMEs) measures, given the potential effects of continuing the current semiautomatic peaking operating regime. In addition, a large-scale sediment discharge from NMPS resulted in regulatory actions by FERC, the EPA and MADEP in 2010. Continuing and as yet unresolved management plan measures relative to sediment and NMPS project operations are further concerns for shallow water, littoral zone, and wetland habitats.

The Atlantic States Marine Fisheries Commission, Atlantic Coast Diadromous Fish Habitat: A Review of utilization, threats, recommendations for conservation, and research needs (ASMFC 2009), contains a review of habitat information for these species. Recommendations in this report include: Maintain water quality and suitable habitat for all life stages of diadromous species in all rivers with populations of diadromous species.

Nexus to Project Operations and Effects

Water level fluctuations due to project operations could affect EAV and SAV habitat as well as the quantity and quality of littoral and shallow water habitat. These operational water level fluctuation effects are expected to impact fish species use of these habitats and may affect spawning fishes reproductive success and subsequent population recruitment including but not limited to American shad, blueback herring, sea lamprey, fall fish, and bluegill, which spawn in mid-to-late spring through early summer in areas subject to daily or more frequent water level fluctuations.

The current operating mode, as well as the unknowns with proposed upper reservoir expansion, may affect wetland riparian, littoral and other shallow water habitats, and promote the introduction and expansion of invasive plant species through fluctuating water levels. A study that explains the relationship between the proposed mode of operation and the type and quantity of wetland, riparian, littoral, shallow water habitats, and invasive species affected would help inform a decision on the need for protection and/or control of these resources in the license.

Riparian buffers provide for river bank stability, reduction in nutrient and sediment from runoff, shading and reduced solar heating of river waters and wildlife habitat (including eagle nesting and roosting habitat) and movement corridors. Management of the project's shorelines are within the scope of project review and a Shoreline Management Plan is likely to be required. Incorporation of riparian resource protection and enhancement into this plan will require baseline information on existing conditions.

Methodology Consistent with Accepted Practice

The PAD currently contains maps portraying general wetland types from the Cabot Station tailrace upstream to the Vernon Dam. In addition, the Service understands that detailed bathymetry exists for the Turners Falls impoundment. The proposed study should utilize this existing information in conjunction with field surveys designed to describe the characteristics of each mapped wetland, riparian, littoral and shallow water habitat, including plant species composition, relative abundance/density, habitat quality, and land use. These surveys should be conducted to describe these habitats at the lowest water level operational range permitted on a daily operation schedule, under low flow conditions. Information collected should include:

1. plant species composition, and their relative abundance/density and condition/structure (e.g., seedlings);
2. structured data, including estimates of average heights and aerial cover of each vegetation layer (specifically denoting invasive species);
3. aquatic habitat substrate composition, quantity (i.e., percent types and area), wood structure (relative abundance measure applied by area), water depths (inundated, exposed, and water less than one foot);
4. predominate land use(s) associated with each cover type;
5. wildlife sightings should be noted; and
6. field-verified wetland, riparian, and littoral and shallow water habitats and invasive species occurrences should be geo-referenced as polygons and overlain on orthophoto at a suitable scale.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

In the PAD, FirstLight identified impacts of the project operations on wetlands, riparian and littoral zone habitat as a potential issue to be addressed in relicensing. FirstLight proposed wetland vegetation mapping, but additional analysis as described above is needed to understand the impacts of the project on these resources and habitats.

A wetlands, riparian, littoral/shallow water, invasive species inventory, of the scope envisioned, would likely require six to eight months to complete and cost $40,000 to $50,000.

REFERENCES

Atlantic States Marine Fisheries Commission. 2009. Atlantic coast diadromous fish habitat: A review of utilization, threats, recommendations, for conservation, and research needs. Habitat Management Series #9. Washington, D.C.

FirstLight Study Request #21

Water Quality Monitoring
(Turners Falls, P-1889; Northfield Mountain, P-2485)

Goals and Objectives

Determine the current water quality of the Connecticut River within the project area.

The specific objectives of this study are as follows:

1. Characterize water quality in the Turners Falls impoundment, bypass reach, canal and below the confluence of the bypass reach and canal discharge.
2. Evaluate the potential effects of project operation on water quality parameters such as temperature and dissolved oxygen (DO) in conjunction with various other water uses.

Resource Management Goals

The U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the project.

Specific to water quality within the Turners Falls Project area, the Service's goals are:

1. Protect, enhance, or restore diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
2. Minimize current and potential negative project operation effects on water quality and aquatic habitat.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), and the Federal Power Act (16 U.S.C. §791a, *et seq*.).

Public Interest

The requestor is a natural resource agency.

upstream of the confluence with the Deerfield River. In order to ensure that data are collected during a time of important biological thresholds and anticipated "worst case" conditions for DO (low flow, high temperature, antecedent of any significant rainfall event), we recommend deploying continuous data loggers at all six locations, with biweekly vertical profiles taken at the deep impoundment location from April 1 through November 15. Results should include date, time of sampling, sunrise time, GPS location, generation status (estimated flow through canal and bypass reach), precipitation data, water temperature, DO concentration and percent saturation.

If river flow and temperature conditions are representative of an "average" or "low" water year, one year of data collection should be sufficient to perform the study. If conditions are not representative (i.e., a "wet" or cool year), a second year of data collection may be necessary.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

Cost would depend on the specific methodology chosen. If continuous data loggers are installed at all six locations and biweekly vertical profiles taken at the deep impoundment location from April 1 through November 15, the estimated cost of the water quality study is moderate. It is expected to take two technicians approximately one day to deploy the loggers, twelve days to collect the vertical profiles, one day to remove the loggers, one day to download the data, and five days to write the report.

In the PAD, the Applicant proposes to assess the effects of the Turners Falls and the Northfield Mountain Pumped Storage (NMPS) project operations on DO and temperature by continuously monitoring DO and temperature at locations within the project areas and gathering vertical profiles within the Turners Falls impoundment and NMPS upper reservoir.

FirstLight Study Request #22

Climate Change as it Relates to Continued Operation of the Vernon, Bellows Falls, Wilder, Northfield Mountain Pumped Storage, and Turners Falls Projects

(Turners Falls, P-1889; Northfield Mountain, P-2485; Bellows Falls, P-1855; Wilder, P-1892; Vernon, P-1904)

Goals and Objectives

The goal of this study is to determine how climate change relates to the continued operation of the Vernon, Bellows Falls, Wilder, Northfield Mountain Pumped Storage (NMPS), and Turners Falls projects.

The objectives of this study are:

1. Quantify the amount of thermal loading contributed by each respective impoundment (including the NMPS upper reservoir).
2. Using climate change prediction models, calculate how much warmer the project impoundments are projected to get in the next 30-50 years.
3. Model the effect of various project modifications on river temperature under current conditions and climate change predictions (e.g., converting to run-of-river, deep-water releases, dam removal, large-scale riparian revegetation, etc.).
4. Using climate change prediction models, determine if the projects actually provide an environmental benefit with respect to mitigating against climate change impacts (vis a vis warming of air and water temperatures) by producing low greenhouse gas emitting energy. The NMPS assessment must be based on net energy production (i.e., NMPS generates 1,143,038 MWh annually, but consumes 1,567,506 in its pumping operations, for a net consumption of 424,468 MWh annually).
5. Determine how climate change predictions will impact management of high flow events at the three projects and evaluate if changes to dam structures would mitigate adverse impacts of the existing flood management protocols.

Resource Management Goals

The U.S. Fish and Wildlife Service (Service) seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the projects. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the projects.

Specific to climate change, the Service's goals are:

1. Minimize current and potential negative project operation effects that could hinder management goals and objectives.
2. Minimize deep headpond drawdowns associated with the loss of stanchion logs during high flow events, which are predicted to increase due to climate change.
3. Minimize project-related sources of thermal increases to Connecticut River waters to mitigate against predicted climate change impacts.

The Service, along with the National Oceanic and Atmospheric Administration (NOAA) and the Association of Fish and Wildlife Agencies, developed a draft *National Fish, Wildlife and Plants Climate Adaptation Strategy* (Strategy) in 2012. The public comment period closed on March 5, 2012, and the agencies are working to finalize the document. Goal #7 of the Strategy calls for reducing non-climate stressors to help fish, wildlife, plants, and ecosystems adapt to a changing climate. The Strategy notes that some stressors (such as habitat loss and fragmentation and pollution) "are not only some of the things decision makers can control, they are also likely to interact with climate change to magnify negative impacts on fish, wildlife, and plants."

Goal #7 contains a number of strategies and associated actions, including:

Strategy 7.1: Slow and reverse habitat loss and fragmentation

Actions:

1. Consider application of offsite habitat banking linked to climate change habitat priorities as a tool to compensate for unavoidable onsite impacts and to promote habitat conservation or restoration in desirable locations.
2. Identify options for redesign and removal of existing structures/barriers where there is the greatest potential to restore natural processes.

Strategy 7.2: Slow, mitigate, and reverse where feasible ecosystem degradation from anthropogenic sources through…water resource planning, pollution abatement…

Actions:

1. Work with….water resource…planners to identify potentially conflicting needs and opportunities to minimize ecosystem degradation resulting from development and land and water use.
2. Reduce existing pollution and contaminants and increase monitoring of air and water pollution.
3. Increase restoration, enhancement, and conservation of riparian zones and buffers in agricultural and urban areas to minimize non-point source pollution.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq.*), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq.*), and the Federal Power Act (16 U.S.C. §791a, *et seq.*).

Public Interest

The requester is a resource agency.

Existing Information

The PAD contains no information relative to climate change and how climate change predictions may impact future operation of the hydroelectric plants, nor of how the projects either mitigate for or exacerbate predicted climate change impacts to freshwater ecosystems.

TransCanada's PAD provides a summary of water quality data collected in 2012. Table 1 below is a synthesis of the temperature data collected by TransCanada. It should be noted that the upper and mid-impoundment stations at each project represent the average of temperature readings taken over the entire water column, while the continuous loggers (Lower Cont. and TR) were located near the water surface. These data indicate that from the upstream end of the Wilder headpond to the Vernon tailrace, water temperature increased approximately 6°C.

Table 1. Median water temperature at monitoring stations located within the impoundments and tailraces of the three hydropower projects.

	Median Water Temperature °C			
Project	Upper Imp.	Mid-Imp.	Lower Cont.	TR
Wilder	20.86	21.83	24.08	23.59
Bellows Falls	22.43	23.67	24.86	24.38
Vernon	23.81	24.49	26.73	26.35

Relative to existing flood management protocols at each station, TransCanada's PAD identifies that all three dams utilize stanchion bays (two at Vernon, three at Bellows Falls, and four at Wilder). When inflows to each dam reach certain levels, the stanchion bays are removed, and cannot be replaced until inflows subside. The depth of these bays and the flows at which they are removed are outlined in Table 2 below.

Table 2. Summary of pertinent stanchion bay information for the Vernon, Bellows Falls, and Wilder projects.

Project	Stanchion Height (feet)	Flow Complete Removal	Triggering Stanchion
Wilder	17	145,000 cfs	
Bellow Falls	13	50,000 cfs	
Vernon	10	105,000 cfs	

The PAD provides no information on the history of stanchion removal at any of the projects (frequency, duration, timing), nor a discussion of how predicted climate change might alter management of the stanchion bays in the future (with respect to the frequency and seasonality of occurrence). There also is no discussion of potential impacts to headpond resources that occur as a result of stanchion bay removal. These information gaps need to be filled so resource agencies can assess the relative and cumulative impact of project operations with respect to the Service's management goals and objectives, including those identified in the Strategy.

Data provided by NOAA, Climate Data Center, illustrates long-term increasing air temperatures in the Northeast (Figure 1). Long-term, monthly mean water temperature data for the Vernon Dam impoundment, monitored by Vermont Yankee, has shown significant differences over time (ANOVA analyses, $P < 0.05$) that when plotted and further analyzed by linear regression, show a significant increasing trend for the period 1974–2010 for the months of January, September, and October (Figure 2). These analyses were performed with data from Vermont Yankee, analyzed by the Massachusetts Department of Environmental Protection.

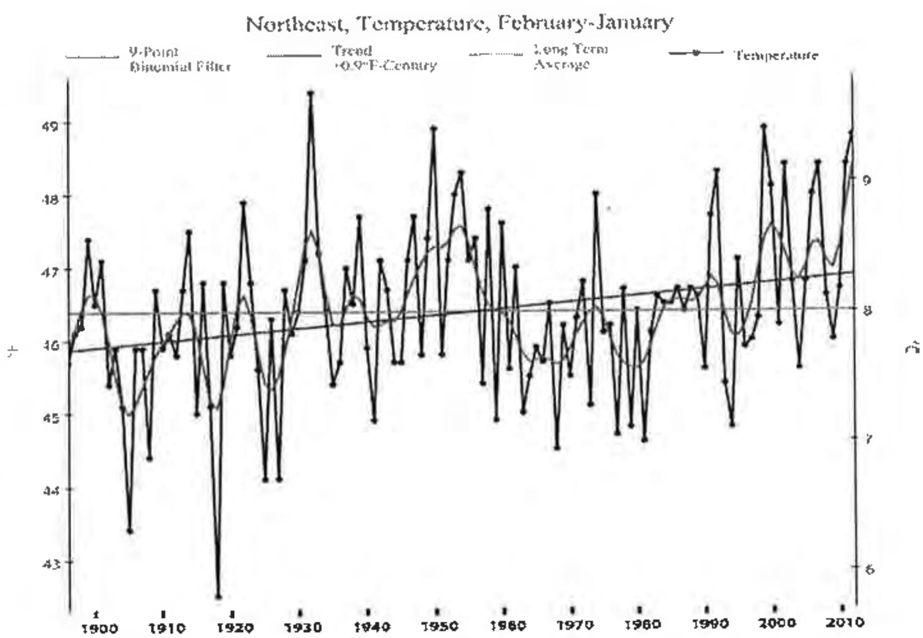

Figure 1. NOAA National Climate Data Center, Northeast 12-month average temperature for the period 1896 through 2012.

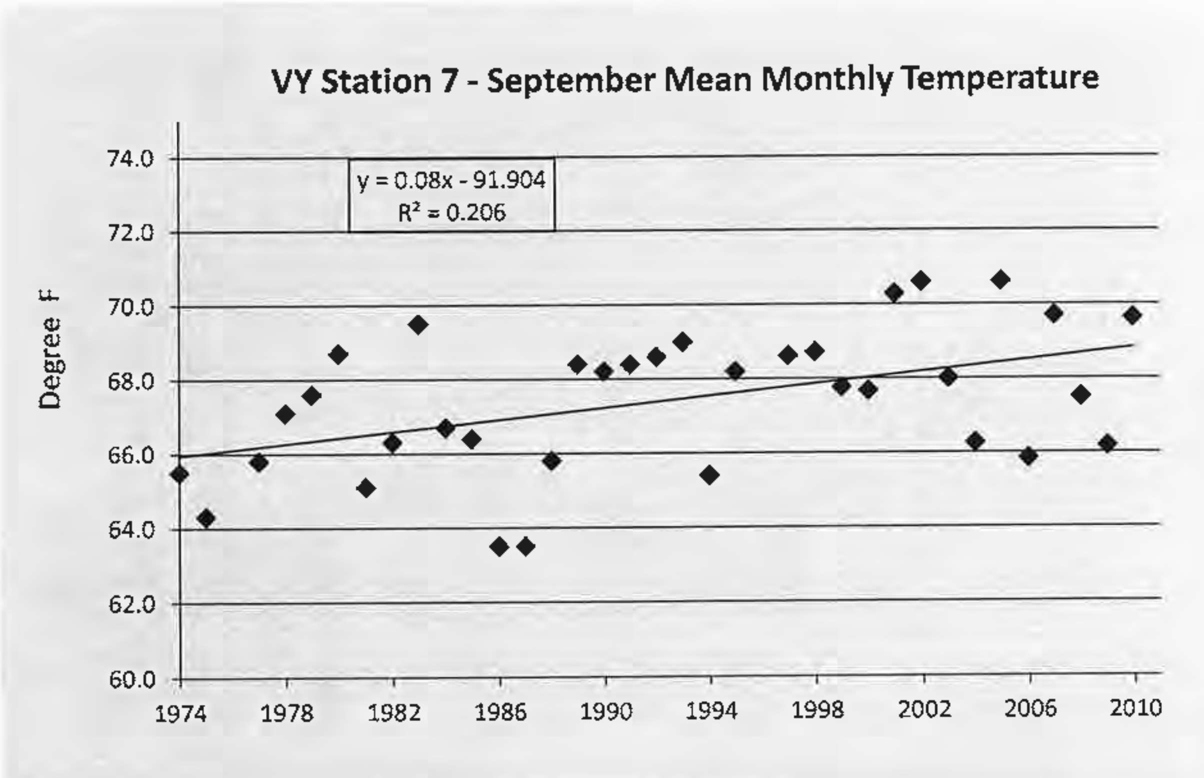

Figure 2. A plot of September's mean temperatures for Vermont Yankee's Station 7 (excludes outlier 1996 data point) for the period 1974 through 2010.

The PAD for the Turners Falls and NMPS projects provides a summary of existing water quality data compiled by FirstLight, including water temperature data obtained from the Service. The PAD also notes a 1991 study by the former licensee that modeled thermal effects of pumping to the upper reservoir. That model reported a maximum temperature difference attributable to NMPS operation of 0.21°C in the Turners Falls reach of the Connecticut River in low flow (4,000 CFS) simulation.

Nexus to Project Operations and Effects

The four mainstem projects have very long impoundments capable of storing large volumes of water (Table 3 below). These impoundments effectively have converted large portions of the Connecticut River into a series of in-river "lakes." Because water velocities slow in these impounded sections of the river, it allows for increased thermal loading and resultant higher water surface temperatures than in free-flowing sections of the river.

Table 3. Relevant characteristics of the reservoirs behind the Wilder, Bellows Falls, Vernon, Turners Falls dams and NMPS.

Project	Headpond Length (miles)	Gross Storage Volume (acre-ft.)	Average Depth (ft.)	Surface Area (acres)	Flushing Rate (days)
Wilder	45	34,350	11	3,100	3
Bellows Falls	26	26,900	10	2,804	<2
Vernon	26	40,000	16	2,550	2
Turners	20	21,500		2,110	
NMPS	n.a.	17,,050		246	n.a.

Depending on where the hydropower intakes withdraw water, these warmer surface waters may be discharged downstream, raising the temperature of those waters as well (the data in Table 1 above suggest that the projects do draw water from the upper levels of the reservoirs). This effect may be felt for miles downstream. If there are a series of impoundments (like on the Connecticut River), the cumulative impact is an overall warming of the river. Even small run-of-river dams have been shown to elevate downstream water temperature (Lessard and Hayes 2003; Saila *et al.* 2005). The most recent climate change prediction models specific to the Northeast forecast warmer air temperatures, more frequent high precipitation events, more heat waves, and an increase in the incidence of short-term droughts (Karl *et al.* 2009).

Resource concerns related to this project effect include the potential impacts to populations (reductions in abundance, structure, condition) or loss of species not tolerant of increases in temperature and other effects related to physiology such as energetic costs with warmer temperatures (Leggett 2004). As one example, American shad restoration target numbers for fish passage at mainstem dams into upstream historic habitat could be negatively impacted from artificially increased water temperatures. Water temperature has been identified as a factor in the timing (i.e., duration) of this species migration, as well as its role in gonad development and spawning (Glebe and Leggett 1981; Leggett 2004). These factors can be logically reasoned to result in accelerated rates of energy reserve use and a reduced migration window, possibly reducing the ability of fish to reach up-river habitats and further reducing the ability to survive downstream outmigration.

With respect to project operations during high flow events, all TransCanada projects have stanchion bays that are used to manage water during high flow events. Each time these stanchion bays are removed, the headponds are lowered substantially (from 10 to 17 feet, depending on the project) and must remain lowered until inflows subside. Depending on the timing and duration of these deep drawdowns, headpond resources could be negatively impacted.

All of the dams also contain other mechanisms for managing flows, such as tainter gates, sluice gates, roller gates, skimmer gates and hydraulic flood gates. All of these gates have an advantage over stanchion bays in that they do not require flows to subside significantly before they can be closed to return impoundment levels back to normal. One climate change prediction for the

Northeast is that we will see more frequent high precipitation events which will result in high flow conditions on rivers. Therefore, it is likely that the stanchion bay removal protocol will have to be employed more frequently in the future.

Methodology Consistent with Accepted Practice

1. In order to quantify the amount of thermal loading contributed by each respective impoundment, detailed bathymetry will need to be collected. This bathymetry, combined with storage volume, tributary hydrology, and project operations, should be used to calculate the thermal loading of each headpond. The individual and cumulative increase in surface water temperature due to the impoundments should then be used to predict future warming based on climate change models.

2. Analyze different mitigation strategies to understand which have the greatest benefit in terms of building resilience against the impacts of climate change on water temperature. Potential scenarios to analyze include converting the projects to run-of-river, implementing deep-water releases, removing one or more dams, conducting large-scale riparian revegetation, etc.).

3. Input to climate change models the amount of GHG emissions that would be generated if fossil fuel plants were producing the equivalent amount of net energy as the five hydropower projects to determine the impact on air and surface water temperatures.

4. Climate change prediction model output should be assessed to determine if the frequency and timing of high flow events are likely to change in the future. If high flow events that necessitate initiating the stanchion bay removal protocol are predicted to increase in frequency and/or shift in timing, the Applicant should evaluate structural and/or operational alternatives that would mitigate adverse impacts of the existing flood management protocols.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice

The level of cost and effort for the thermal loading analysis would be low to moderate. Collecting bathymetry in the three TransCanada headponds would take two staff members less than one week to collect (it took the Kansas Biological Survey two days to collect bathymetry at a 3,500-acre lake; Jakubauskas *et al.* 2011). Bathymetry for the Turners Falls pool and NMPS upper reservoir already exist. The remaining work would be desk-based, loading relevant information into an appropriate thermal loading model to compute the estimated thermal loading of each headpond and then comparing this information to surface water data from climate change prediction models.

The high flow flood protocol study is a desktop analysis that should require low cost and effort. Climate change models already exist and that output would be downloaded and analyzed. The remaining analysis requires a review of alternative means of managing flows without the use of stanchion bays.

The Applicant did not propose any studies to meet this need in the PAD.

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Joanne McGee, Northfield, MA.

Although I am a member of the Northfield Open Space Committee, I am writing this letter as an individual and as a kayaker.

The number of canoe and kayak paddlers is really increasing in Northfield, but the conditions on our very own Connecticut River don't help us to get on the river. Currently we share access with power boats at the Pauchaug Boat Ramp, an area which is frequently silted in with mud. Paddlers must drag kayaks to the river across an expanse of sand and mud which is often occupied by illegal vehicles.

I would like to propose a new access spot restricted to canoes and kayaks at the Bennett Brook Wildlife Management Area on the west side of the river. Silt does not build up here, and there is ample parking. Canoes and kayaks will not disturb the wildlife in the area.

If Bennett Brook is not feasible, I would be interested in working with First Light to find an additional location on the Connecticut River in Northfield.

Kurt Heidinger, Westhampton, MA.
Dear FERC,

As concerns the relicensing process for FERC No.1889, I am writing to request studies be undertaken and reported for Aesthetic Resources and Socioeconomic Resources.

I write as Director of the non-profit Biocitizen School of Environmental Philosophy and Practice (biocitizen.org) which provides educational services within the field of environmental philosophy, including operating a school that teaches this subject in both traditional indoor classroom settings and outdoors at local, national and international sites. To ensure its educational services are of the highest quality, and reach as large an audience as possible, Biocitizen conducts scholarly research, develops curricula and syllabi, trains teachers, and performs public outreach through a website, the giving of lectures and presentations, and through the creation and dissemination of educational materials in print and other media.

Biocitizen uses the CT River from Turners Falls to Rainbow Beach, Northampton to teach environmental philosophy and practice.

Last year, two things occurred as a result of the operation of FERC No.1889 that impacted our operations in June and July 2012. 1st, we encountered a population of homeless people who made it impossible for us to teach; we posted a blog that details what happened: http://biocitizen.org/the-homeless-men-living-by-the-side-of-the-river . Firstlight removed these people, and encouraged us to return to use the area between Poet's Tower and the Rt. 2a bridge as an educational resource. Firstlight acknowledges the CT River as an educational resource and the public record, and relicensing studies, reports and analyses, should reflect this fact.

A good report would collect data on how from Turners Falls to Rainbow Beach, Northampton is a valuable educational resource, used by many schools and nonprofits, for many years.

Use of the Ct River from Turners Falls to Rainbow Beach, Northampton as an educational resource should be reported on too in terms of the positive economic value of using it as such.

The second thing that occurred as a result of the operation of FERC No.1889 that impacted our operations was the amount of dead fish floating in the river and dessicating on the river banks.

The impact was educational, because students were depressed to see so many dead fish and wanted to know why the fish ladders were not performing well, as the attendants at the dam said they were. It left our instructors having to explain why so many fish were dying. Just at that time the EPA announced it was giving up on the Atlantic Salmon recovery program, which really hit students hard because they had to try to understand how the charismatic species which symbolizes the life of the river itself was now extinct. The presentations they witnessed at the Holyoke Dam and the Turners Falls dam made them believe the Salmon and other anadromous species were on their way to recovery, and when they realized that wasn't happening, they felt taken advantage of, even cynically lied to.

A good study of the impact that FERC No.1889 has upon the Ct River must discuss how the educational resource is negatively impacted when fish recovery plans fail.

Moreover, since the anadromous fish and birds that feed upon them are considered beautiful by reseachers, teachers and students, the mass death and extinction of the fish must be assessed as an impact upon the river's aesthetic resources. The sight of hundreds of dead shad upriver of the 2a bridge (from Greenfield to Turners Falls) is very ugly and depressing.

The ugliness that is caused by the failure of the fish ladder system and the recovery program to care for anadromous fish has educational, aesthetic and economic impacts that are real. Because of this, I am writing to request studies be undertaken and reported for Aesthetic Resources and Socioeconomic Resources.

thank you,
Kurt Heidinger