CONNECTICUT RIVER WATERSHED COUNCIL
The River Connects Us
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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. Section 3.2.1 (Page 3-8) and Section 3.3.1 (page 3-22) 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. Section 3.2.1 (Page 3-8) 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. Section 3.2.2 (page 3-10) 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

3.1 No action alternative. 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.

3.4.2.4 Turners Falls Project Licensees Proposals

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.

3.4.2.5 Northfield Mountain Project Licensees Proposals

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)

Aquatic Resources

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 Donlon
River Steward

Cc: John Howard, FirstLight
MassDEP
USFWS
NOAA
Don Pugh, Trout Unlimited
Katie Kennedy, The Nature Conservancy
Kimberly Noake MacPhee, FRCOG

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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 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 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.

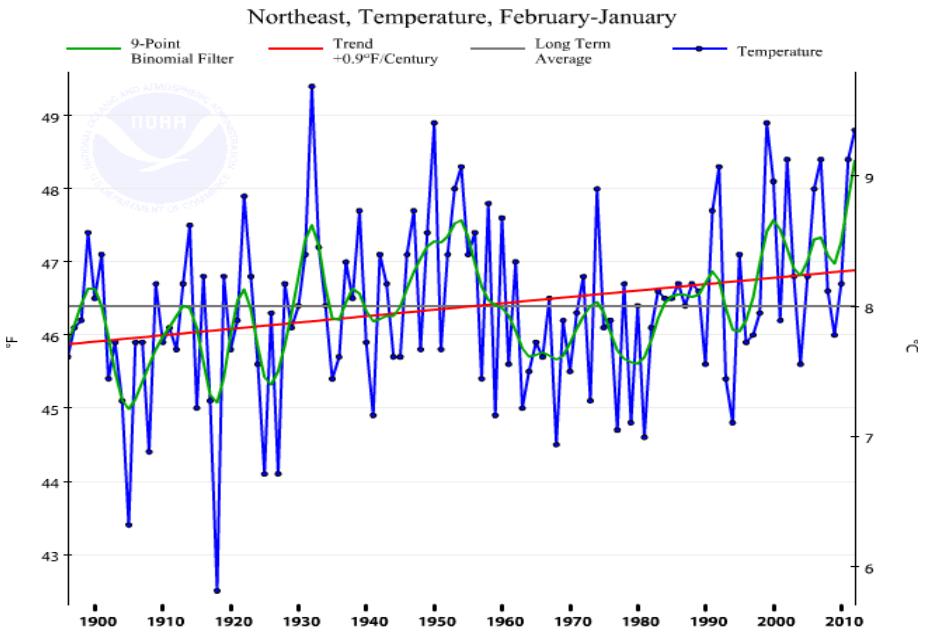

Figure 1. NOAA National Climate Data Center, Northeast 12-month average temperature for the period 1896 through 2012 (October).

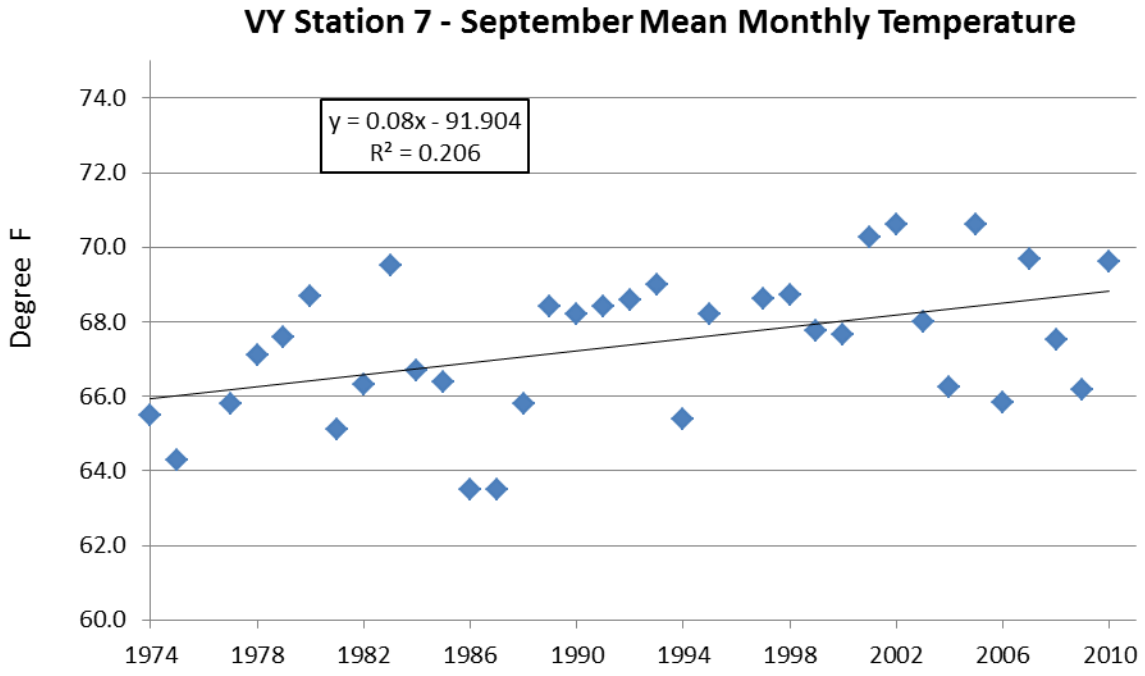

Figure 2. A plot of September's mean temperatures for Vermont Yankees' Station 7 (excludes outlier 1996 data point) for the period 1974 through 2011.

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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Lessard, J.L. and D.B. Hayes. 2003. Effects of elevated water temperature on fish and Macroinvertebrate communities below small dams. River Research and Applications.

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 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

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 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.

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 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).

[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.

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:

- 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.

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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.

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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.

References

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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.