FEDERAL ENERGY REGULATORY COMMISSION
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OFFICE OF ENERGY PROJECTS

Project No. 2485-063 – Massachusetts
Project No. 1889-081 – Massachusetts
FirstLight Hydro Generating Company

Mr. John S. Howard
Director- FERC Hydro Compliance
FirstLight Hydro Generating Company
Northfield Mountain Station
99 Millers Falls Road
Northfield, MA 01360

Reference: Study Plan Determination for Aquatic Studies - Turners Falls Hydroelectric Project and the Northfield Mountain Pumped Storage Project

Dear Mr. Howard:

Pursuant to 18 C.F.R. § 5.13(c) of the Commission's regulations, this letter contains the study plan determination for the aquatic resource studies associated with the Turners Falls Hydroelectric Project (Turners Falls Project) and the Northfield Mountain Pumped Storage Project (Northfield Project). The determination is based on the study criteria set forth in section 5.9(b) of the Commission's regulations, applicable law, Commission policy and practice, and the record of information.

Background

On April 15, 2013, FirstLight Hydro Generating Company (FirstLight) filed its proposed plan for 36 studies covering geologic and soil resources, water quality, geomorphology, hydrology, instream flow, fish and aquatic resources, wildlife resources, botanical resources, recreation and aesthetic resources, and cultural and paleontological resources in support of its intent to relicense the projects.

FirstLight held its Study Plan Meeting on May 14, 2013, and subsequently held nine resource-specific study meetings on May 14, 15, 21, and 22, and on June 4, 5, 11, 12, and 14. In addition, FirstLight met with the Narragansett Tribe on June 6 to discuss proposed studies. On June 28, 2013, FirstLight filed an updated Proposed Study Plan for additional stakeholder review and comment. Following the conclusion of the study plan

meetings and after receiving of comments on its Proposed Study Plan and Updated Proposed Study Plan, FirstLight filed its Revised Study Plan on August 14, 2013. The Revised Study Plan included 38 proposed studies.

Comments on FirstLight's study plans were filed by: the U.S. Fish and Wildlife Service (FWS); the U.S Environmental Protection Agency (USEPA); the National Park Service (NPS); the National Marine Fisheries Service (NMFS); the Massachusetts Division of Fish and Wildlife (MADFW); the Massachusetts Department of Environmental Protection (MADEP); the Massachusetts Department of Conservation and Recreation (MADCR), the Massachusetts Historical Commission, the New Hampshire Department of Environmental Services (NHDES); the Vermont Agency of Natural Resources (VANR); the Vermont Division for Historic Preservation, the Nolumbeka Project; American Whitewater; The Nature Conservancy; the Appalachian Mountain Club; the Vermont River Conservancy; the Friends of the Connecticut River Paddlers' Trails; New England FLOW; Trout Unlimited; BK-Riverfish, LLC; Landowners and Concerned Citizens for License Compliance (Concerned Citizens); the Connecticut River Watershed Council (Watershed Council); the Franklin Conservation District; the Franklin Regional Council of Governments (Franklin Regional Council); the Town of Gill, Massachusetts; the Town of Northfield, Massachusetts; Turners Falls Fire Department; Karl Meyer; Donald Pugh; Warren Ondras and Lisa McLoughlin; Steven Alves; Philip F. Tomlinson Jr.; Peter Richardson; Katherine Putnam; Jane Whittlesey Winn; Glen Ayers; Elizabeth Austin; and Margo Jones.

On September 13, 2013, the study plan determination for the 20 proposed non-aquatic studies was issued. Of these studies, four were approved as filed by FirstLight, and16 were approved with staff-recommended modifications. However, as discussed below, decisions on the remaining 18 proposed aquatic resource studies and on an additional requested study for a hydraulic analysis of the power canal were deferred pursuant to section 5.29(f)(2) of the Commission's regulations.

Deferred Studies

On August 27, 2013, Entergy announced plans to decommission its Vermont Yankee Nuclear Power Plant (Vermont Yankee) during the fourth quarter of 2014. Vermont Yankee uses the upstream Vernon Project's (FERC No. 1904) reservoir for its cooling water supply and discharge. Operation of Vermont Yankee has influenced water temperatures in the Connecticut River downstream through the Turners Falls Project since the plant went into operation in 1972. Because the baseline environmental condition will change after 2014, FirstLight's proposed aquatic studies may have produced invalid data if conducted while Vermont Yankee was still operating. Because of this unusual circumstance, staff hosted a technical meeting on November 25, 2013 to:

(1) identify aquatic resource studies not affected by operations of Vermont Yankee, that could be implemented in 2014; (2) identify aquatic resource studies likely affected by operation of Vermont Yankee; and (3) identify aquatic resource studies that may need modification due to the decommissioning of Vermont Yankee.

General Comments

A number of the comments received do not address study plan issues. This determination does not address these comments, but only addresses comments specific to the merits of the proposed studies submitted pursuant to section 5.13 of the Commission's regulations and comments received thereon.

Study Plan Determination

Of the 18 aquatic studies proposed by FirstLight and addressed in this study determination, four are approved as filed by FirstLight, and 14 are approved with staff-recommended modifications (see Appendix A). An additional study requested by other entities and not proposed by FirstLight, *Hydraulic Study of the Turners Falls Power Canal* is not being required at this time. Finally, we are amending the proposed schedules for 11 of these studies, as indicated in Appendix A and specified in Appendix C, since they are potentially affected by the closure of Vermont Yankee.

The specific modifications to the study plan and the basis for modifying FirstLight's study plan are discussed in Appendix B. Although Commission staff considered all study plan criteria in section 5.9 of the Commission's regulations, only the specific study criteria that are particularly relevant to the determination are referenced in Appendix B.

As discussed in Appendix B, FirstLight must modify 6 of its proposed study plans after consultation with stakeholders, and for Commission approval. Five of these modified study plans[1] must be filed when FirstLight files its Initial Study Report in September 2014 and the 6th study plan[2] is due with the Updated Study Report in September 2015. FirstLight must include in its filing, copies of any comments, a discussion of how comments are addressed, and reasons for not adopting any recommendations.

Nothing in this study plan determination is intended in any way to limit any agency's proper exercise of its independent statutory authority to require additional

[1] Studies 3.2.1, 3.3.1, 3.3.5, 3.3.6, and 3.3.11
[2] Study 3.3.19

studies. In addition, FirstLight may choose to conduct any study not specifically required herein that it feels would add pertinent information to the record.

If you have any questions, please contact Ken Hogan at (202) 502-8434.

Sincerely,

Jeff C. Wright
Director
Office of Energy Projects

Enclosures: Appendix A – Summary of determinations on proposed studies, requested study modifications, and the additional study requested
Appendix B – Staff's recommendations on proposed studies, requested studies, and the additional study requested
Appendix C – Studies effected by the closure of Vermont Yankee and associated study schedule amendments
Appendix D – Recommended Locations of Radio Telemetry Receivers in the Turners Falls Power Canal

cc: Mailing List
Public Files

APPENDIX A

SUMMARY OF DETERMINATIONS ON PROPOSED STUDIES, REQUESTED STUDY MODIFICATIONS, AND THE ADDITIONAL STUDY REQUESTED

Study	Recommending Entity*	Approved	Approved with Modifications	Not Required
3.2.1 -- Water Quality Monitoring Study	FirstLight		X[1]	
3.3.1 -- Conduct Instream Flow Habitat Assessments in the Bypass Reach and below Cabot Station	FirstLight		X	
3.3.2 -- Evaluate Upstream and Downstream Passage of Adult American Shad	FirstLight		X[1]	
3.3.3 -- Evaluate Downstream Passage of Juvenile American Shad	FirstLight		X[1]	
3.3.4 -- Evaluate Upstream Passage of American Eel at the Turners Falls Project	FirstLight	X		
3.3.5 -- Evaluate Downstream Passage of American Eel	FirstLight		X[1]	
3.3.6 -- Impact of Project Operation on Shad Spawning, Spawning Habitat and Egg Deposition in the Area of the Northfield Mountain and Turners Falls Projects	FirstLight		X[1]	
3.3.7 -- Fish Entrainment and Turbine Passage Mortality Study	FirstLight		X[1]	
3.3.10 -- Assess Operational Impacts on Emergence of State-Listed Odonates in the Connecticut River	FirstLight		X[1]	

Study	Recommending Entity*	Approved	Approved with Modifications	Not Required
3.3.11 -- Fish Assemblage Assessment	FirstLight		X[1]	
3.3.12 -- Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream from Cabot Station	FirstLight	X		
3.3.13 -- Impacts of the Turners Falls Project and Northfield Mountain Project on Littoral Zone Fish Habitat and Spawning Habitat	FirstLight		X[1]	
3.3.14 -- Aquatic Habitat Mapping of Turners Falls Impoundment	FirstLight	X		
3.3.15 -- Assessment of Adult Sea Lamprey Spawning within the Turners Falls Project and Northfield Mountain Project Areas	FirstLight		X[1]	
3.3.16 -- Habitat Assessment, Surveys and Modeling of Suitable Habitat for State-listed Mussel Species in the CT River below Cabot Station	FirstLight		X	
3.3.17 -- Assess the Impacts of Project Operations of the Turners Falls Project and Northfield Mountain Project on Tributary and Backwater Area Access and Habitat	FirstLight	X		

Study	Recommending Entity*	Approved	Approved with Modifications	Not Required
3.3.18 -- Impacts of the Turners Falls Canal Drawdown on Fish Migration and Aquatic Organisms	FirstLight		X	
3.3.19 -- Evaluate the Use of an Ultrasound Array to Facilitate Upstream Movement to Turners Falls Dam by Avoiding Cabot Station Tailrace	FirstLight		X[1]	
4.2.3 -- Hydraulic Study of Turners Falls Power Canal	Karl Meyer			X

[1]Study schedule adjusted due to the timing of the decommissioning of the Vermont Yankee Nuclear Power Plant. See Appendix C for more detail.

APPENDIX B

STAFF'S RECOMMENDATIONS ON PROPOSED STUDIES, REQUESTED STUDY MODIFICATIONS, AND THE ADDITIONAL STUDY REQUESTED

The following discusses staff's recommendations on studies proposed by FirstLight and requests for study modifications and an additional study. We base our recommendations on the study criteria outlined in the Commission's regulations [18 C.F.R. section 5.9(b)(1)-(7)].

I. Requests for Study Modifications

Prelude

Shortnose Sturgeon

The shortnose sturgeon is a federally listed endangered species under the Endangered Species Act (ESA). There is a population of shortnose sturgeon residing between the Holyoke dam and the upstream Turners Falls dam.[1] Spawning habitat for these fish occurs between a natural rock formation locally known as "Rock dam" (within the Turners Falls bypassed reach) and a point approximately 650 feet downstream of the Cabot Station tailrace. Sturgeon spawning in this area typically occurs from April to mid-May and the egg incubation period is about two weeks when water temperatures are between 8 and 12 degrees Celsius. Upon hatching, larval shortnose sturgeon hide under available cover at the spawning site while absorbing the yolk-sac for about 12 days and before migrating downstream to deeper water between the confluence of the Deerfield River and Holyoke dam.[2] As such, shortnose sturgeon (spawning adults or larvae) may be concentrated within the spawning reach of the river from April through June and may be present in the deeper waters of the Connecticut River between Holyoke dam and the Deerfield River year-round.

FirstLight proposed several studies downstream of Turners Falls dam. Therefore, in the study-specific discussions below and where appropriate, we recommend modifications to certain studies to avoid adverse effects to shortnose sturgeon.

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[1] Retrieved from: http://www.fws.gov/r5crc/fish/zf_acbr.html on January 27, 2014.

[2] National Marine Fisheries Service. 1998. Final Recovery Plan for the shortnose sturgeon (*Acipenser brevirostrum*). Prepared by the Shortnose Sturgeon Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland. December 1998.

Comments on Study Report Content

Multiple commenters made detailed requests regarding the specific content of the study reports. In general, we find most commenters' requests reasonable. However, we do not individually evaluate each request and do not make a recommendation for each herein. Instead, we recommend that FirstLight address the requests when preparing its respective study reports. A provision for stakeholder comments on the adequacy of the study reports and their content is provided in section 5.15 of the Commission's regulations. After the Initial Study Report meeting in September 2014, Commission staff will evaluate each report to determine if the report content is adequate with respect to the goals and objectives of the study.

3.2.1 - Water Quality Monitoring Study

Operation of the Turners Falls and Northfield Mountain projects may affect water quality within the Turners Falls reservoir, the bypassed reach, power canal, and in the Connecticut River below Cabot station. Therefore, from spring through fall, FirstLight proposes to conduct a water quality study to: (1) characterize water temperature and dissolved oxygen (DO) within the Turners Falls reservoir bypassed reach,[3] power canal, and below Cabot Station; (2) determine the potential impacts of project operation on water temperature and DO; and (3) compare collected data with applicable state water quality standards.

Sediment Analysis

Applicant's Proposal

FirstLight analyzed sediment samples for metals, organics, and polychlorinated biphenyls (PCBs) in the Turners Falls reservoir in August 2010 and detected no PCBs or pesticides in any of the samples. For the current study, FirstLight is not proposing to conduct sediment sampling, but has offered to make previous sediment data available upon request.

Comments

The Massachusetts Department of Environmental Protection (MADEP) requests sampling of the sediments behind the Turners Falls dam. The Connecticut River Watershed Council (Watershed Council) suggests that water level fluctuations within Turners Falls reservoir may increase the bio-accumulation of mercury in fish. Therefore,

[3] The Turners Falls bypassed reach is 2.1 miles long and is located immediately below the Turners Falls Dam downstream to the Cabot Station tailrace where a majority of the flow is returned to the Connecticut River.

it requests that FirstLight analyze sediments for metals, especially mercury and PCBs, in Barton's Cove, the first cove upstream of the Turners Falls dam. Both MADEP and the Watershed Council believe that PCB contamination originates in the Millers River, a tributary to the Connecticut River within the Turners Falls reservoir.

Although FirstLight proposes to provide existing sediment data, the Watershed Council believes that samples collected upstream by FirstLight in August 2010 at the Northfield Mountain tailrace (in the Turners Falls reservoir) would not be representative of PCB contamination at Bartons Cove because the Millers River drains into the Connecticut River downstream of the Northfield tailrace.

Discussion and Staff Recommendation

Natural and anthropogenic sources of mercury can be widely dispersed in the atmosphere and can accumulate in soil, including reservoir sediments. There is little evidence that routine short-term water level fluctuations, such as those practiced by FirstLight, have the ability to increase mercury bioavailability, and there is no indication that FirstLight is proposing to alter this operational scenario.

A 2003 study shows that PCB contamination in the Millers River originates from point sources on the Otter River near Baldwinville, 35 miles upstream of where the Millers River joins the Connecticut River.[4] The study indicates that PCB concentrations in fish tissue and in the water column decline by a factor of four and five respectively, between their source near Baldwinville and the confluence of the Millers and Connecticut Rivers. The study concludes that there are no other sources of PCB's other than those near Baldwinville.

While we agree that FirstLight's existing sediment sampling upstream of the known source of PCB's would not characterize any PCB's in sediment in Barton's Cove, it is evident that FirstLight's hydropower projects are not the source of PCB contamination in the Connecticut River and there is no nexus between project operation and the movement of PCB's from the Millers River into the Connecticut River (section 5.9(b)(5)). Therefore, we do not recommend additional sediment sampling for mercury or PCBs.

[4] Taggart, B.E., Colman, J.A., Cooke, M.G. 2003. Tracking polychlorinated biphenyls in the Millers River Basin, Massachusetts: U.S. Geological Survey Fact sheet FS 093-03.

Nutrient Analysis

Applicant's Proposal

FirstLight does not propose to collect nutrient data at any water quality monitoring sites.

Comments

The New Hampshire Department of Environmental Services (NHDES) recommends that FirstLight's water quality study include collection of weekly nutrient data (total phosphorus, nitrite/nitrate, Kjeldahl nitrogen, and chlorophyll-a) in the Connecticut River upstream of the Massachusetts' border to assess if the waters support designated uses such as the maintenance of aquatic life and recreation.

The Watershed Council also recommends that FirstLight collect weekly water samples in the forebay of the Turners Falls dam for nutrients to make comparisons with other river sites, identify trends, and investigate the potential cumulative effect of nutrient loading from sediment transport.

Discussion and Staff Recommendation

Nutrient concentrations in the Connecticut River in general and in the upper portion of the Turners Falls pool are the result of point and non-point source loadings upstream of the project and are beyond the control of FirstLight. Adding nutrient sampling to the baseline water quality study will not provide data that is directly connected to project operation (section 5.9 (b)(5)). Further, existing information data on nutrient loading in the Connecticut River basin appears to be extensive, and there does not appear to be the need for any additional information on this subject (section 5.9(b)(4).

Therefore, we do not recommend that FirstLight modify the study plan to add nutrient sampling at their proposed water quality monitoring location in the reach upstream of the Massachusetts border within New Hampshire.

Peaking Effects on Water Temperature

Applicant's Proposal

To evaluate the effects of peaking flows on water quality, FirstLight would examine the relationship between continuous temperature data and hourly operational data from Northfield Mountain and Turners Falls. FirstLight proposes to continuously monitor temperature at nine locations in the project-affected area including two locations in the bypassed reach downstream of Turners Falls dam and one location between Cabot

Station and the mouth of the Deerfield River. FirstLight does not propose to monitor temperature downstream of the Deerfield River.

Comments

The Massachusetts Division of Fish and Wildlife (MADFW) indicates that water temperature during low flows and the rate of temperature change caused by peaking operation is a concern throughout the study area. Specifically, MADFW is concerned that project operation may alter water temperature and negatively impact state-listed mussels downstream of Cabot Station. MADFW requests modeling of water temperature in relation to various flows and project operation.[5]

Following the Vermont Yankee Technical Meeting, MADFW recommends that FirstLight delay temperature data collection until after the Vermont Yankee decommissioning in December 2014 to ensure the accuracy of temperature data. Alternatively, MADFW suggests FirstLight could collect temperature data both before and after Vermont Yankee decommissioning. At a minimum, MADFW suggests FirstLight deploy digital temperature recording devices to assess the rate, magnitude, and seasonality of temperature change that occurs during project peaking cycles.

Discussion and Staff Recommendation

Although MADFW's request is focused on state-listed mussels, water temperature and its potential effects on all aquatic species is a concern because project-induced changes in water temperature may affect the quality and quantity of habitat or directly affect species behavior (section 5.9(b)(5)).

Continuous water quality monitoring in Turners Falls reservoir and hourly operation data from Northfield Mountain should be sufficient to analyze effects in the reservoir as proposed. Similarly, two monitoring stations in the bypassed reach should provide sufficient information to analyze project effects there. However, a single monitoring location immediately downstream of Cabot Station would not fully describe the effect of peaking operations or minimum flow releases on water temperature because there are not enough monitoring locations downstream of the project(section 5.9(b)(7)). Typically, river water temperatures respond to ambient air temperature conditions as the water travels downstream, and the rate of change is related to flow volume (section 5.9(b)(5)). Turners Falls project operation affects flow volume in the Connecticut River from Cabot Station to Holyoke dam downstream of the Deerfield River. Therefore, FirstLight should collect data to evaluate project effects on water temperature and temperature rate of change in this area (section 5.9(b)(5)). This data is necessary to

[5] We address MADFW's request for temperature modeling under study 3.3.1.

assess potential project effects on aquatic species in the Connecticut River downstream of Cabot Station (section 5.9(b)(7)).

We recommend FirstLight develop a temperature monitoring study plan for the reach between Cabot Station and the Holyoke dam to describe temperature and temperature rate of change associated with peaking operations. The plan should be developed in consultation with interested stakeholders and file for Commission approval with the Initial Study Report in September 2014. We note that effects of peaking operations may attenuate downstream due to tributary inflow and the backwatering effect of the Holyoke dam. These effects should be accounted for in the study's design. Once the study plan is filed, stakeholders would be provided an opportunity to comment pursuant to section 5.15(c) of the Commission's regulations. We expect the cost of developing and implementing a temperature monitoring study between Cabot Station and the Holyoke dam to be approximately $25,000.

Study 3.3.1 – Conduct Instream Flow Habitat Assessments in the Bypass Reach and below Cabot Station

Project operation alters river flows and affects aquatic habitat in the bypassed reach and the Connecticut River downstream of Cabot Station. FirstLight proposes to conduct an Instream Flow Incremental Methodology (IFIM) habitat study and use a Physical Habitat Simulation model (PHABSIM) and a HEC-RAS model (Hydrologic Engineering Center River Analysis System) to quantify the relationship between project flow releases and aquatic habitat. FirstLight proposes 5 study reaches extending from the upper bypassed reach downstream to the Dinosaur Footprints Reservation[6] in the downstream Holyoke Project's (FERC Project No. 2004) reservoir.

HSI Development for Sea Lamprey

Applicant's Proposal

FirstLight proposes to form a study team comprised of licensee representatives and technical experts to develop habitat model input parameters and review model outputs. The team would collaboratively design Habitat Suitability Indices (HSI) for applicable species and life stages.[7] Regarding sea lamprey, FirstLight proposes to

[6] Dinosaur Footprints Reservation is an eight-acre park approximately 3 miles north of Holyoke, MA.

[7] HSI criteria describe suitable and unsuitable habitat conditions for fish and other aquatic organisms and are often used in conjunction with hydraulic models to determine the location and quantity of suitable habitat under different flow regimes.

evaluate spawning habitat suitability or include sea lamprey in a "shallow-fast" guild in reaches 1-4.

Comments

The National Marine Fisheries Service (NMFS) requests that FirstLight add sea lamprey incubation criteria to reaches 1 and 2. Both NMFS and Donald Pugh suggests FirstLight add sea lamprey zone of passage criteria to reaches 1 and 2.

Discussion and Staff Recommendation

Designation of specific HSI criteria for IFIM studies is typically completed collaboratively by a group of resource experts familiar with the study site, flow conditions, and species of interest (section 5.9(b)(6)). As such, requests for specific HSI criteria and application of these criteria in specific reaches at this time are premature because each stakeholder or study team member should have the opportunity to comment on or adjust the HSI criteria dependent on site-specific knowledge such as the preferred spawning depth of a fish in a particular river. Therefore, we do not recommend any specific changes to the HSI criteria or HSI application at this time.

If the technical study team cannot reach consensus on specific HSI criteria for sea lamprey or other species, FirstLight should proceed with the study as described in the study plan and file the Initial Study Report as required by section 5.15(c) of the Commission's regulations. After comments and responses to comments on the Initial Study Report are received, we would make a determination regarding any outstanding issues including the need for additional data analysis based on alternative HSI criteria.

Transects at Shad Spawning Sites

Applicant's Proposal

FirstLight proposes to locate IFIM transects in collaboration with a study team composed of qualified technical experts. Specific to shad spawning sites, FirstLight proposes to place transects within representative spawning habitat in reaches 3 and 4. FirstLight would identify these spawning sites through review of known shad spawning sites[8] and the shad spawning surveys (in 2015) conducted in river reaches 3 and 4 pursuant to study 3.3.6. FirstLight would then utilize a 2-dimensional (2-D) model to

[8] Layzer, J.B. 1974. Spawning Sites and Behavior of American Shad, *Alosa sapidissima* (Wilson), in the Connecticut River between Holyoke and Turners Falls, Massachusetts, 1972. Master of Science Thesis. University of Massachusetts, Amherst, Massachusetts.

evaluate project effects on spawning sites in reach 3 and a one-dimensional (1-D) model in reach 4.

Comments

Due to study timing, shad spawning locations in reaches 3 and 4 from the shad spawning survey in study 3.3.6 would not be available at the time when transect locations are identified for this study in 2014. Therefore, NMFS requests that FirstLight add transects upon identifying shad spawning sites, should the nearest existing transects not adequately represent the depth and velocity of shad spawning habitat. In addition, MADFW and Donald Pugh request that FirstLight locate transects at all previously identified shad spawning locations in reaches 4 and 5 and at each additional spawning location in reaches 3 and 4 FirstLight identified during study 3.3.6.

Discussion and Staff Recommendation

FirstLight would initiate this study and establish transects in reaches 1-3 during 2014. In 2015, FirstLight would complete transect selections for reach 4 in order to use the results of the mussel survey (study 3.3.16) and the shad spawning survey (study 3.3.6) to inform transect locations. As such, spawning survey data for reach 3 will not be available when FirstLight proposes to select transects for this reach in 2014. However, we note that in reach 3, FirstLight proposes to utilize a 2-D model that would examine potential project effects on spawning habitat. Unlike a 1-D model which is limited by transects and defined transect boundaries, a 2-D model is continuous and can model habitat conditions for target species throughout an entire reach, regardless of exact transect locations. Given the application of a 2-D model in reach 3, data collection along transects that correlate to specific spawning sites observed during the shad spawning surveys is not needed provided that transects are located within representative spawning habitats, as FirstLight proposes. Regarding reach 4, where FirstLight is proposing to implement a 1-D model, we note that transect selection in reach 4 would occur during the 2015 field season when spawning survey results should be available from study 3.3.6.

FirstLight does not propose to include any transects at known shad spawning habitat in reach 5. Although water level fluctuations due to project operation attenuate in reach 5, effects on shad spawning may still occur.[9] Therefore, inclusion of transects within representative shad spawning habitat in reach 5 is appropriate (section 5.9(b)(5)). However, establishing a transect at every known and newly identified spawning site within reaches 4 and 5, as requested by MADFW and Donald Pugh, would be costly and excessive (section 5.9(b)(7)). The intent of locating transects in "representative habitat" is to provide data from a limited sample size that would be representative of the whole

[9] Water surface elevation data provided in the study plan from the Rainbow Beach area in reach 5.

and is a standard practice within the scientific community (section 5.9(b)(6)). Therefore, placing a transect at every shad spawning site is not justified.

For the reasons discussed above, we recommend FirstLight, in consultation with the technical study team, place transects in representative spawning habitat within the project-affected areas of reach 5 utilizing existing shad spawning data.[10]

We estimate that the additional cost of including transects in reach 5 would be approximately $6,000. If consensus is not reached regarding the number or placement of transects, we recommend FirstLight follow the process described in *HSI Development for Sea Lamprey* above.

Host Fish Habitat Modeling

Applicant's Proposal

FirstLight proposes to evaluate habitat suitability for Massachusetts state-listed mussels[11] documented to occur in the study area. FirstLight also proposes to model habitat for tessellated darter, the primary host fish for dwarf wedgemussel.

Comments

MADFW states that in addition to modeling of mussel habitat, the modeling of individual host fish habitat would yield important information regarding the presence and availability of host fish habitat and whether host fish habitat availability is a limiting factor for mussel distribution. MADFW suggests that FirstLight model persistent habitat[12] for all confirmed host fish species of the three state-listed mussels potentially

[10] Layzer, J.B. 1974. Spawning Sites and Behavior of American Shad, *Alosa sapidissima* (Wilson), in the Connecticut River between Holyoke and Turners Falls, Massachusetts, 1972. Master of Science Thesis. University of Massachusetts, Amherst, Massachusetts.

[11] In this document, Massachusetts state-listed mussels include yellow lampmussel (*Lampsilis cariosa*), dwarf wedgemussel (*Alasmidonta heterodon*), and eastern pondmussel (*Ligumia nasuta*). Dwarf wedgemussel is also listed as endangered under the federal Endangered Species Act.

[12] Persistent habitats are areas that are suitable for a given species throughout a defined range of river flows.

present.[13] MADFW also supports an evaluation of persistent habitat for every potential host fish if confirmed hosts are unknown.

Discussion and Staff Recommendation

Host fish species are necessary to complete the mussel life cycle and ensure population survival. Specifically, an adult mussel releases glochidia (a mussel lifestage) that must attach to a particular host fish or fishes to develop into a juvenile mussel. Project operation may affect host fish and their habitat and, in turn, indirectly affect mussel populations. First Light's proposal would evaluate the host fish for the dwarf wedgemussel, but would not evaluate host fish habitat suitability for yellow lampmussel or eastern pondmussel and, therefore, would not provide information to adequately evaluate project effects on state-listed mussels (section 5.9(b)(5)).

Therefore, we recommend FirstLight evaluate project effects on the primary host fish of all state-listed mussels present in the project-affected area in addition to the proposed evaluation of tessellated darter. Previous mussel surveys and proposed surveys in study 3.3.16 - *Habitat Assessment, Surveys and Modeling of Suitable Habitat for State-listed Mussel Species* would determine which state-listed mussel species are present in the project-affected area. FirstLight should develop HSI curves for these host fishes in a collaborative manner as described above.

Velocity Profiles for Mussels

Applicant's Proposal

To model persistent mussel habitat, FirstLight would develop a HEC-RAS model from Turners Falls dam to Holyoke dam using previous transect data from flood insurance studies and a U.S. Army Corps of Engineers' (Corps) HEC-RAS model as well as new transect data from this study. Then, FirstLight would use HSI criteria developed in study 3.3.16, including criteria for shear stress and other hydraulic parameters, to determine if project-related flow conditions are suitable or unsuitable for mussels.

In reach 4, FirstLight would use the mussel survey from study 3.3.16 to inform transect placement. At each transect, FirstLight would collect water surface elevation data at three calibration flows and collect mean column velocity at a single calibration flow. In mussel habitat, determined in consultation with MADFW, FirstLight would also collect benthic (i.e., near-substrate) velocity along the transects or simulate benthic velocity using the IFG4 program in PHABSIM.

[13] We respond to MADFW's request to conduct laboratory studies in order to confirm host fish species for state-listed mussels under study 3.3.11 – *Fish Assemblage Assessment* below.

In reach 5, FirstLight would use transect data from flood insurance studies and the Corps' HEC-RAS data to model hydraulic conditions for mussels.

Comments

MADFW expresses concern regarding the validity of simulated benthic velocity data and other hydraulic parameters, such as shear stress, which FirstLight would calculate from benthic velocity. MADFW indicates that benthic velocity data, collected at different flows, are particularly critical to analyze effects of flow regime on mussel behavior and mussel habitat. In order to accurately calculate and model shear stress, an important parameter for persistent mussel habitat, MADFW requests full velocity profiles including velocity measurements at near-substrate depths within all potentially suitable state-listed mussel habitats.

Discussion and Staff Recommendation

Benthic velocities describe flow conditions relevant to mussels that inhabit the river bottom and allow the calculation and modeling of shear stress, a key hydraulic parameter useful in describing suitable mussel habitat. In this study, FirstLight would collect or simulate benthic velocity, but does not describe when it would utilize direct collection efforts over simulations. In reach 5, FirstLight only intends to use previously collected transect data, which likely does not include benthic velocity measurements, thus requiring FirstLight to use the IFG4 program to simulate benthic velocities.

The use of simulated benthic velocities from mean column velocities, direct measurements of benthic velocities during multiple test flows, or some combination of the two (e.g. simulated data validated by field measurements) are generally acceptable scientific methods (section 5.9 (b)(6)). However, MADFW raises a significant validation concern regarding the collection of mean column velocity data at a single test flow. Although velocity can be calculated once depth along a transect and river discharge are known, variability and measurement error could affect calculated velocities and other hydraulic variables (e.g., benthic velocity, shear stress). In order to ensure the reliability of benthic velocities and dependent hydraulic parameters, some validation of velocity data should occur at multiple test flows (section 5.9(b)(6)). Collecting benthic velocity data within all potential state-listed mussel habitat at all calibration flows, as suggested by MADFW, would ensure more accurate data but would substantially increase study costs (section 5.9(b)(7)).

Therefore, we recommend that FirstLight collect mean column and benthic velocity data at representative transects at all three calibration flows in reaches 4 and 5 to validate mean column velocities and any simulated benthic velocities. This validation effort should ensure velocity data, including other dependent hydraulic parameters such

as shear stress, are accurate throughout the project's operational flow range and provide reliable information to conduct our environmental analysis (section 5.9(b)(5)). We estimate the addition of validation work would cost less than $5,000 including field work and analysis (section 5.9(b)(7)).

Water Surface Level Monitoring Locations

Applicant's Proposal

To establish an accurate relationship between flow and water surface elevation, FirstLight proposes to collect stream bed and water surface elevation data at each IFIM transect at various test flows. In reach 3, FirstLight would install three water level loggers: 1) upstream of Cabot Station but downstream of Rock Dam; 2) near Cabot Station, and; 3) Downstream of Cabot Station to assist with the calibration of a 2-D model in this reach. FirstLight would consider the need for additional calibration data (e.g., transects at alternate test flows) on a case by case basis during consultation with the technical study team.

Comments

Karl Myers requests the placement of additional water level loggers in the bypassed reach to describe the relationship between flow and water surface elevation. Specifically, Mr. Myers requests that FirstLight place additional loggers at the following locations: 1) in the pool immediately below Rock dam; and 2) on the west side of the river, in the main stem channel, upstream of Rawson Island.

Discussion and Staff Recommendation

Significant variation in channel elevation occurs at Rock Dam/Rawson Island, and FirstLight proposes to include at least one water level logger in this area. Without site-specific data regarding the hydraulic effects of Rock Dam/Rawson Island and the exact placement of the logger, we cannot determine if a single logger in this area is adequate or not. Therefore, the technical study team must determine this in the field, which is consistent with FirstLight's proposal.

Although FirstLight would install three water level loggers in reach 3 to assist calibration of the 2-D model, it does not propose to install water level loggers in any other reaches to ensure accurate model calibration. While water surface elevation measurements during transect data collection seems appropriate, we are concerned regarding the lack of other measurements to validate or calibrate the relationship between flow and water surface elevation. Considering the study reaches are defined in part based on differences in hydraulic conditions, some model validation may be appropriate in each reach. In order to ensure the accuracy of modeled conditions, we suggest FirstLight

deploy water level loggers in all study reaches to validate or calibrate the results of their proposed models in this study (section 5.9(b)(6)). Validated modeling efforts would accurately describe hydraulic conditions for the species of interest in this study and support or review of environmental effects (section 5.9(b)(5)).

Therefore, we recommend that FirstLight install additional water level loggers to validate/calibrate the proposed models in this study. FirstLight should determine the number and location of water level loggers after consultation with the technical study team. All water level loggers should be surveyed to a common vertical datum such as NGVD.[14] We estimate the cost of this modification to be approximately $6,000 (section 5.9(b)(7)).

Temperature Modeling for Mussels

Applicant's Proposal

FirstLight proposes to use hydraulic modeling to evaluate aquatic habitat suitability for mussels under various flow and operational conditions. Field data collection at transect locations would include cross-sectional depth, velocity, and substrate.

Comments

MADFW is concerned that temperatures during low flows and rate of temperature change caused by peaking operations may stress mussel populations potentially leading to interference with critical host-mussel interactions. MADFW requests temperature data collection and thermal modeling using methods similar to Castelli et al (2012) [15] to evaluate effects of project peaking flows on river temperatures, especially during low flow conditions. MADFW suggests FirstLight include temperature data in the persistent habitat modeling, and that the analysis reflect the rate of temperature change in suitable habitat during peaking operations.

MADFW also indicates that water temperature data collection should be delayed until after the decommissioning of the Vermont Yankee Nuclear Power Plant, and that

[14] NGVD (National Geodetic Vertical Datum) is a vertical control datum used to measure the elevation above or below mean sea level.

[15]Castelli, E., Parasiewicz, P., Rogers, N. 2012. Use of frequency and duration analysis for the determination of thermal habitat thresholds: application for the conservation of *Alasmidonta heterodon* in the Delaware River. Journal of Environmental Engineering 138(8): 886–892.

temperature data collection does not necessarily need to occur concurrently with study 3.3.1 or 3.3.16. At a minimum, MADFW recommends that FirstLight deploy temperature recording devices to capture temperature data in representative mussel habitats during peaking operations.

Discussion and Staff Recommendation

Hydraulic models associated with IFIM studies are flow-based models and are not suitable for thermal modeling without substantially more data than the current proposal accounts for, including local meteorological data. Additionally, we are not aware of any temperature thresholds, including thresholds for rate of change, that would identify suitable vs. unsuitable temperatures for state-listed mussels in the study area. It is unclear how FirstLight would use temperature data in its habitat analysis due to the lack of established temperature thresholds for these mussels (section 5.9(b)(6)). Furthermore, while the novel methods developed by Castelli et al. (2012) may provide a means to develop temperature thresholds, it is the resource agencies' responsibility to develop these thresholds for mussels, not FirstLight's. Therefore, we do not recommend collecting temperature data, modeling temperature, or including temperature in persistent habitat analyses for state-listed mussels as part of this study.

That said, we note that study 3.2.1 – *Water Quality Monitoring* would assess the potential effects of Turners Falls Project and Northfield Mountain Project operations on temperature. In addition, our recommendation for FirstLight to develop a plan and monitor temperatures between Cabot Station and Holyoke dam (see recommendation above in study 3.2.1) would provide temperature data, including temperature change associated with peaking operations. These efforts are consistent with other evaluations of project operations on water quality (section 5.9(b)(6)) and would likely provide the information MADFW is seeking.

1D vs. 2D Modeling for Mussels

Applicant's Proposal

FirstLight proposes to use a HEC-RAS model (1-dimensional model) and binary HSI criteria to identify suitable mussel habitat in reaches 4 and 5 under a variety of flow conditions. If conditions exceed any suitability thresholds defined by the HSI criteria, FirstLight would conduct a more detailed assessment involving additional transect data collection and HEC-RAS modeling of habitat persistence throughout a range of flows associated with project operations.

Comments

MADFW asserts the proposed 1-D model is not likely adequate to assess suitable habitat persistence for state-listed mussel species and requests a 2-D modeling approach similar to analyses conducted on the Delaware River[16] or a similar modeling approach that would accomplish the goals of this study and adequately model habitat persistence of state-listed mussels.

Discussion and Staff Recommendation

The proposed study is consistent with the general approach of MADFW's noted Delaware River studies and others[17] in that FirstLight would evaluate persistent habitat using several hydraulic criteria relevant to mussels throughout a range of operational flows. The difference, however, is that FirstLight proposes a 1-D model and the Delaware River studies use a 2-D model. A 1-D model is limited to identifying suitable habitat due to changes in discharge along a transect and defined transect boundaries whereas a 2-D model can identify suitable habitat due to changes in discharge and channel morphology throughout an entire reach. 2-D models are typically used to examine river segments with complex structure and hydraulics as they provide greater spatial resolution and, thus, a better prediction of suitable habitat. However, a 2-D model would require substantially more time and effort to develop because of the need for extensive bathymetric mapping of the study area (up to 35 miles of river). While some areas within reach 4 and 5 may contain complex hydraulics (near islands, sharp bends, etc.), the majority of these reaches are relatively uniform and consist mostly of run or pool habitat. Therefore, a 2-D model does not seem necessary to achieve the goals of this study (section 5.9(b)(7)).

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[16] Maloney, K.O., W.A. Lellis, R.M. Bennett, and T.J. Waddle. 2012. Habitat persistence for sedentary organisms in managed rivers: the case for the federally endangered dwarf wedgemussel (*Alasmidonta heterodon*) in the Delaware River. Freshwater Biology. 57:1315-1327.

Parasiewicz, P., Castelli, E., Rogers, J. N., & Plunkett, E. 2012. Multiplex modeling of physical habitat for endangered freshwater mussels. Ecological Modeling. 228:66.

[17] Steuer, J.J., T.J. Newton, and S.J. Zigler. 2008. Use of complex hydraulic variables to predict the distribution and density of unionids in a side channel of the Upper Mississippi River. Hydrobiologia. 610(1): 67-82.

Allen, D.C. and C.C. Vaughn. 2010. Complex hydraulic and substrate variables limit freshwater mussel species richness and abundance. *J. N. Am. Bethol. Soc.* 29(2):383-394.

Although 1-D models may not provide high resolution, they are widely accepted for IFIM studies (e.g., PHABSIM) and are more cost-effective than 2-D models (section 5.9(b)(6) and (7)). In addition, the accuracy of 1-D models can be improved by placing transects closer together, thereby reducing the variability in channel morphology between transects. Considering that MADFW itself would participate in the selection of transect locations in reach 4 and the close spacing of existing transects in reach 5 (usually less than 0.25 miles, Figure 3.3.1-3 in RSP), FirstLight's proposed 1-D HEC-RAS model should be able to produce accurate results, and we do not recommend that FirstLight construct a 2-D model to evaluate mussel habitat.

Transect Locations for Mussels

Applicant's Proposal

In reach 4, FirstLight would consult with the technical study team and use the mussel habitat survey data from study 3.3.16 to inform transect placement in suitable mussel habitat (in areas either occupied or unoccupied by mussels). In reach 5, FirstLight would use data from established transects from the existing flood insurance studies and the Corps' HEC-RAS model.

Comments

In order to accurately model habitat of state-listed mussels, MADFW requests replicate transects in three habitat types: occupied habitat, unoccupied suitable habitat, and unsuitable habitat.

Discussion and Staff Recommendation

FirstLight's proposal appears to meet MADFW's request, except for the collection of transect data in unsuitable habitat. When selecting transect locations for an IFIM study it is necessary to ensure that each habitat type in the river is represented; thus allowing for an evaluation of how potential changes in project operations and flows may influence suitability in each habitat type. Therefore, it is not appropriate to preclude specific habitat types, including unsuitable habitat, as FirstLight proposes (section 5.9(b)(6)). As such, we recommend FirstLight include all habitat types when placing IFIM transects in reach 4. We note there is adequate opportunity for the technical study team, which includes MADFW, to identify transect locations which should result in an adequate number of transects in all habitat types for our analysis. Since FirstLight currently proposes to identify transect locations after consultation with the technical study team, we do not estimate this modification would significantly increase study costs (section 5.9(b)(7).

In reach 5, existing transects from the Corps' HEC-RAS model overlap a majority of the known yellow lampmussel beds as well as adjacent areas which likely includes all habitat types. Based on our review of the existing transect information[18] and FirstLight's proposal, FirstLight would evaluate an adequate number of transects within all habitat types in reach 5 for our environmental analysis (section 5.9(b)(5)). Therefore, no additional transects are needed in reach 5 at this time.

Evaluation of all State-listed Mussels

Applicant's Proposal

FirstLight proposes to assess persistent mussel habitat at transects within suitable mussel habitat for existing state-listed mussels in reaches 4 and 5. The state-listed yellow lampmussel occurs in reach 5, and mussel surveys in study 3.3.16 would determine the presence of any state-listed species in reach 4.

Comments

MADFW and Donald Pugh request that FirstLight analyze project effects on mussel habitat regardless of documented occurrence. Specifically, MADFW requests that FirstLight model habitat persistence for all state-listed mussel species in all study reaches. Donald Pugh requests that FirstLight model shear stress in the bypassed reach to evaluate potential habitat for state-listed mussels with modified bypass flows.

Discussion and Staff Recommendation

FirstLight only proposes to evaluate project effects for mussel species that currently exist in the project-affected area. Based on a 2011 survey, no state-listed mussels are known to occur in the Turners Falls reservoir or between Turners Falls dam and the mouth of the Deerfield River (reaches 1 through 3);[19] therefore, FirstLight does not propose to evaluate project effects on state-listed mussels or potential habitat in these areas. In reach 4, FirstLight's analysis of project effects depends on the results of their survey to identify state-listed mussels and suitable habitat (study 3.3.16). In reach 5, existing yellow lampmussel populations warrant an analysis of project effects as proposed.

[18] See Figure 3.3.1-3 in the study plan. There are a large number of transects which overlap both occupied and unoccupied habitat for yellow lampmussels in reach 5.

[19] Biodrawversity. 2012. Freshwater Mussel Survey in the Connecticut River for the Turners Falls and Northfield Mountain Hydroelectric Projects. Amherst, MA.

FirstLight's approach is an appropriate and cost effective method considering that two of three mussel species may not occur in the project-affected area (section 5.9(b)(6) and (7)). Considering the lack of occurrence data, it is not appropriate to analyze operational effects on all state-listed mussels at this time. Without occurrence data, an analysis of all species in all reaches would not likely contribute to the development of license conditions as there is no clear nexus to project operations (section 5.9(b)(5)). As such, an evaluation of mussel habitat for all mussel species is not warranted at this time.

Rate of Change Analysis

Applicant's Proposal

FirstLight would evaluate the effects of peaking operation on mussel habitat suitability using binary HSI criteria (velocity, depth, shear stress, etc.) and a HEC-RAS hydraulic model

Comments

MADFW requests that modeling scenarios evaluate rates of change in physical habitat variables such as velocity and temperature that are associated with project peaking flows because the rates of change may influence habitat suitability just as the total change does.

Discussion and Staff Recommendation

FirstLight does not propose to use rates of change to evaluate effects on mussel habitat during peaking cycles, but would examine the effects of change using several flow-based HSI criteria. We address the request for modeling changes in temperature associated with project peaking operations above in *Temperature Modeling for Mussels*.

As for velocity, it is not clear how FirstLight would use the rate of change in velocity to identify suitable vs. non-suitable habitat as we are not aware of threshold or tolerance values for rates of change in velocity for mussels nor does MADFW identify an acceptable methodology to determine suitability thresholds for rates of change in velocity or other parameters (section 5.9(b)(6)). We note that rate of change in average velocity, and other hydraulic parameters would be available for all study transects as this could be calculated from the proposed transect data and operational flow data (i.e., difference in velocities over time at a particular transect). Therefore, we do not recommend FirstLight modify this study to include rates of change in velocity.

Clarification of Screening Effort

Applicant's Proposal

FirstLight proposes an initial "screening" effort or modeling effort which would use HSI criteria and a hydraulic model to determine persistence of suitable mussel habitat at various operational flows.

Comments

MADFW requests clarification on Task 2a – *Screening Level Mussel Assessment*, and asserts that the screening level assessment would only model habitat persistence of unsuitable habitat and would not achieve the goal of modeling suitable habitat and habitat persistence across the entire range of potential flows.

Discussion and Staff Recommendation

It appears MADFW misinterprets FirstLight's proposal to model suitable habitat persistence over the range of operational flows. In its proposal, FirstLight states its intent to model suitable habitat under a variety of operational flow conditions and determine habitat persistence. Considering the binary nature of the HSI criteria (i.e., habitat is either suitable or unsuitable) and the IFIM modeling approach, FirstLight's methodology would identify both suitable and unsuitable habitat throughout each modeled reach and at various flows. As such, this effort would satisfy the goal of this study and provide adequate data for our environmental analysis (section 5.9(b)(5)) and no modification is needed.

Study 3.3.2 - Evaluate Upstream and Downstream Passage of Adult American Shad

Project operation can affect the success of upstream and downstream migrations (e.g. timing, duration, and passage mortality) of adult American shad in the Connecticut River. FirstLight proposes a study to identify the effects of the Turners Falls and Northfield Mountain Projects on the upstream and downstream passage of adult shad utilizing radio telemetry, PIT-tag monitoring, and video monitoring.

Test Flow Replicates

Applicant's Proposal

FirstLight proposes to release three specific test flows (2,500, 4,400, and 6,300 cubic feet per second [cfs]) into the bypassed reach from the Turners Falls dam during the primary adult shad upstream passage season (late April through early June) and two additional late migration season test flows (1,000 and 1,500 cfs) from early June

to early July. FirstLight proposes to release each of the five test flows for three consecutive days and states that it may further refine the test flows based on the results of its proposed instream flow study 3.3.1.[20]

Comments

U.S. Fish and Wildlife Service (FWS) requests that FirstLight repeat each three-day release of the five test flows a minimum of three times throughout the migration season. Karl Meyer and Donald Pugh request that FirstLight repeat the release of the primary season test flows (late April to early June) four times, and that FirstLight release the two late-season test flows (early June to early July) for four days each and alternate between the test flows for the remaining duration of the study period. FWS explains that its requested replicates are critical to assure that different periods within the migration season are sampled to evaluate changes in fish behavior over a range of environmental conditions.

Discussion and Staff Recommendation

FirstLight did not propose to replicate releases of the proposed test flows. Evaluating each proposed test flow for a single three-day period, as proposed, would not provide data indicating how shad respond to flows throughout the shad migration season as environmental conditions change (e.g., run timing and water temperature) (section 5.9(b)(6)). As such, repeating the series of test flow releases would support a more robust analysis by describing the variability of fish movements within each test flow over the adult shad passage season (sections 5.9(b)(6) and (7)).

The primary adult shad upstream migration season (late April through early June) is approximately six weeks or 42 days long and the late migration season is about five weeks or 35 days long. Therefore, we question the feasibility of repeating the series of test flows four times during the primary migration season as requested by Karl Meyer and Donald Pugh. For example, providing the three test flows, four times, for three days each, would require a total of 36 days of testing within the 42-day primary upstream shad migration season. Additionally, and for reasons discussed above in the Prelude to this Appendix, it is appropriate to ramp flows between each test flow to avoid effects to shortnose sturgeon. We estimate that, including ramping, repeating the series of test flows four times would require 46 to 48 days of flow testing during the 42-day primary upstream shad migration season. Alternatively, FirstLight could easily repeat the series

[20] Study 3.3.1 will evaluate specific flow conditions and habitat attributes required for adult shad to facilitate a zone of passage within the bypassed reach and below Cabot Station.

of test flows three times as requested by FWS within the 42-day primary shad upstream migration as it would require 27 test flow days and 10-12 flow ramping days.[21]

Regarding the late migration season test flows and their repetition, Karl Meyer and Donald Pugh did not explain why a four-day release for each test flow is needed or why the entire late season must be sampled by alternating between the two test flows for the duration of the late season (sections 5.9(b)(4) and (7)). Alternatively, FirstLight's three-day test flow release proposal as modified by FWS's request for three repetitions would allow for an evaluation of changes in fish behavior over a range of changing environmental conditions throughout the 35-day late migration season (section 5.9(b)(7)).

Therefore, to support an analysis of adult shad migration behavior and responses to the test flows over the duration of their migration season over changing environmental conditions, we recommend that FirstLight modify its study plan to repeat each of the five test flows three times. Additionally, to avoid any effect this study may have on sturgeon spawning activity, egg incubation, and larval rearing within the Turners Falls bypassed reach, FirstLight should ramp the flows between each test flow and between each repeated set of flows for a duration of at least 24 hours.

Upstream Shad Migration Monitoring in the Turners Falls Power Canal

Applicant's Proposal

To evaluate upstream and downstream adult shad passage, FirstLight proposes to tag a total of 340 adult shad with radio- and PIT-tags, and an additional adult 340 shad with PIT-tags only (for a total of 680 tagged upstream migrating adult shad). FirstLight would tag 480 of these shad and release them at the downstream Holyoke Project (FERC No.2004). It would tag the remaining 200 at the Cabot Station fishway and release them upstream of the Turners Falls power canal at the Gatehouse fishway exit. The timing of the tagging and release efforts will depend on the timing of the shad run, but is anticipated to occur between April 21and May 19.[22]

Comments

FWS and Karl Meyer request additional tagging to evaluate the rate at which shad move through the Turners Falls power canal and Gatehouse fishway. They recommend that FirstLight tag and release 100 (50 radio- and PIT-tagged and 50 PIT-tagged only) adult shad in the Cabot station forebay at the Turners Falls power canal.

[21] We note that the first up ramp day and the last down ramp day may occur before and after, respectively, of the primary shad upstream migration season.

[22] Appendix D depicts the Turners Falls power canal and associated facilities.

FirstLight disputes the need to monitor upstream shad movements within the Turners Falls power canal, stating that there is existing information available to evaluate the effects of the canal and passage through the Gatehouse fishway under a varied range of operating conditions. FirstLight states that the Conte Anadromous Fish Research Center (Conte) has been collecting this information since 1999. FirstLight also referenced more recent telemetry data (2011 and 2012) collected by Conte and states that these data also include information on shad movement and passage in the power canal (section 5.9(b)(4)).

Discussion and Staff Recommendation

Information on upstream shad passage collected between 2007 and 2010 show that approximately 19-51% of the shad that volitionally enter the power canal exit the canal through the Gatehouse fishway.[23] Additionally, the draft report, *Results of Turners Falls Fishway Studies: 2012* prepared by Conte indicated that 85%, 73%, and 59% of the radio-tagged shad released into the power canal at Cabot Station exited the canal at the Gatehouse fishway in 2010, 2011, and 2012, respectively.[24] The median duration of the upstream migration within the 2.1-mile-long power canal (between Cabot Station to the vicinity of the Gatehouse) was found to be approximately eight days.[25] In contrast, the median transit time for the approximate 20-mile-long upstream migration between the Turners Falls dam and the upstream Vernon Hydroelectric Project (FERC No. 1904) for radio-tagged shad that passed the Turners Falls dam volitionally is only 1.6 days.[26] These data suggest that conditions (e.g. flow velocities, turbulence, etc.) within the Turners Falls power canal may be a barrier or hindrance to upstream migration (section 5.9(b)(5)).

While Conte's existing shad telemetry information cited by FirstLight may be useful to supplement this study, our review of the Conte telemetry reports indicates that these studies targeted shad movements and residence time in the vicinity of the Gatehouse fishway. While the Conte studies were able to establish the duration of each

[23] Calculations completed using information provided in Table 4.4.6-1 of the Pre-Application Document, filed by FirstLight on October 30, 2012.

[24] Catros-Santos, T. and A. Haro, 2012. Results of Turners Falls Fishway Studies: 2012. USGS Conte Lab Internal Report. (Filed by Commission staff on January 29, 2014).

[25] Personal Communication with Dr. Theodor Castro-Santos, U.S. Geological Survey, Conte Anadromous Fish Research Center, January 29, 2014 (Telephone Communications Memo filed by Commission staff on January 30, 2014).

[26] Castro-Santos, T. 2011. Analysis of American shad passage at Vernon Dam 2011. USGS Conte Lab Internal Report. (Filed by Commission staff on January 29, 2014).

radio-tagged shad's migration through the power canal (from Cabot Station to the Gatehouse) the study designs and telemetry receiver array placements do not appear to be sufficient to identify the specific locations of potential migratory barriers within the canal.

Given the role that the Turners Falls power canal plays as the primary upstream passage route for migrating shad, and the apparent migratory delays that may occur, it is appropriate to target the canal and shad movements within the canal with a new study (section 5.9(b)(7)). Tracking an additional of 50 radio- and PIT-tagged adult shad and 50 PIT-tagged only shad in the power canal, as requested by FWS and Karl Meyer (coupled with our recommendation below for the location and placement of additional radio telemetry receivers), should ensure that the necessary information is gathered to support an evaluation of project effects on shad migration through the power canal (section 5.9(b)(7)). Additionally, for reasons discussed below in Section II, *Study Requested but not Adopted by FirstLight***,** we note that these shad telemetry data will also provide valuable information to inform the need for and potential design of a detailed hydraulics model and study for the Turners Falls power canal.

For these reasons, we recommend that FirstLight modify study 3.3.2 to increase the proposed sample size of tagged adult shad by an additional 100 shad (50 radio- and PIT-tagged and 50 PIT-tagged only). These shad should be collected from the vicinity of the Cabot fish ladder (to ensure that the shad used are representative of fish that would reach Cabot Station volitionally), then tagged, and released into the Cabot Station forebay within the Turners Falls power canal. Tagging efforts and shad release schedules should be consistent with those proposed by FirstLight to provide tagged shad for monitoring throughout the upstream migration season. All migration and observable behavioral data collected in the Turners Falls power canal and throughout the study area should be correlated to project operations.

With the addition of 50 radio tags and 50 PIT-tags, we anticipate this recommended study plan modification will increase the cost of the study by approximately $15,000 (section 5.9(b)(7)).

Power Canal Radio Telemetry Receiver Locations

Applicant's Proposal

Within the Turners Falls power canal, FirstLight proposes to install telemetry receivers at the Cabot Station forebay, at the Cabot Station downstream bypass, Station

No. 1 forebay, and at the upstream end of the power canal immediately downstream of the Gatehouse fishway.[27]

Comments

To improve radio telemetry coverage within the power canal, FWS, Trout Unlimited, and Karl Meyer request that FirstLight install an additional radio telemetry receiver at the Conte building. Karl Meyer also requests the installation of a receiver in the Turners Falls power canal 400 feet downstream of the Gatehouse fishway.

Discussion and Staff Recommendation

As noted above, information regarding potential barriers to shad migration within the Turners Falls power canal is needed to identify and understand potential project effects on shad migration within the canal and to inform potential license conditions (section 5.9 (b)(5)). However, FirstLight's proposed receiver configuration for the power canal lacks the necessary coverage to evaluate specific shad upstream migration behavior throughout the canal. Providing this data at a higher level of resolution, with more receiver locations, will help identify where, within the power canal, shad may be encountering migration barriers. Simply adding the two requested telemetry receiver locations to the proposed study would not likely provide adequate coverage of the 2.1-mile-long power canal (section 5.9(b)(6)).

Upon review of aerial imagery, several more radio telemetry receiver stations are necessary to provide the level of detail needed to evaluate shad migration through the power canal and to identify where potential migration barriers may exist (section 5.9(b)(6) and(7)). We have identified six additional locations where radio telemetry receivers should be installed to provide the necessary coverage, plus the two additional locations requested by FWS and Karl Meyer: (1) immediately downstream of the Gatehouse fishway; (2) at the first bridge downstream of the Gatehouse fishway; (3) at the pipeline crossing near 3rd Street; (4) at the Power Street Bridge; (5) downstream of the Station 1 intake; (6) at the 11th Street Canal Bridge; (7) at the lower portion of the power canal just upstream of where the power canal widens; and (8) near the Conte building (see Appendix D). We selected these locations because they correlate to areas where hydraulic conditions within the canal may change as a result of a change in the canal's configuration (e.g., narrowing of the canal, widening of the canal, and/or changes in canal direction).

As discussed below in Section II, *Study Requested but not Adopted by FirstLight, Hydraulic Study of Turners Falls Power Canal,* we recommend that FirstLight use these

[27] We note that FirstLight proposed these telemetry receivers in this study with the primary intent of tracking downstream migrating adult shad.

detailed shad migration data to identify potential hydraulic barriers within the power canal and to determine the need for a hydraulic study of the power canal.

Therefore, we recommend that FirstLight install the two requested radio telemetry receivers and six additional receivers at the indicated locations along the power canal, as described above and identified in Appendix D. We anticipate the cost of this additional effort to be approximately $40,000.

Northfield Mountain and Fishway Telemetry / PIT-tag Receivers

Applicant's Proposal

FirstLight proposes to establish 19 fixed radio-telemetry receiver locations and 12 PIT-tag receiver locations.[28]

Comments

Several comments were made regarding improvements to the type and number of radio telemetry receivers and/or antenna arrays that FirstLight proposes.

To provide the intended telemetry coverage, FirstLight proposes to refine the telemetry array with field testing and to add additional antennas and/or receivers as needed; therefore, we do not see the need to address those comments herein. We expect this testing will ensure that the proposed radio telemetry equipment provides accurate and reliable data to achieve the goals and objectives of the study. We recommend that FirstLight include with its study report, a report on the telemetry array's testing and calibration. Stakeholders will have the opportunity to comment on the testing and calibration and the resulting telemetry data pursuant to section 5.15 of the Commission's regulations.

However, below we address requests for specific telemetry equipment at locations where FirstLight does not propose to provide telemetry coverage (i.e., Northfield Mountain Project upper reservoir and the Turners Falls Project fishways).

Fishways

Comments

Karl Meyer and FWS request radio telemetry stations at the entrances and exits of the three upstream fishways (Cabot Station, Spillway, and Gatehouse). Donald Pugh

[28] PIT-tag receiver locations are associated within the Turners Falls' upstream and downstream fishways.

requests the installation of an additional PIT antenna in the second turning pool of the Spillway fishway.

Discussion and Staff Recommendation

PIT-tag technology is well suited for evaluating fish passage through a confined space such as a fish ladder (section 5.9(b)(6)). Because all radio tagged fish will also be PIT-tagged, Karl Meyer's and the FWS's request would result in a duplication of effort and an increase in cost for the same data (section 5.9(b)(6) and (7)). FirstLight's approach of monitoring the fishways with PIT-tag technology is sufficient for evaluating how effective these facilities are at safely and efficiently passing fish upstream or downstream, which is a primary objective of this study (section 5.9(b)(1)). Therefore, we do not find it necessary to provide the requested radio-telemetry coverage at the Turners Falls Project fishways.

Regarding Donald Pugh's request for an additional PIT antenna within the second turning pool of the Spillway fishway, FirstLight proposes to include five PIT antennas at the Spillway fishway (at the entrance, before the first turning pool, at the turn pool exit, downstream of the counting window, and at the fish ladder exit). Installation of a PIT antenna within the second turning pool of the fishway would provide information to evaluate incremental shad migration through the Spillway fishway and would inform an evaluation of the effectiveness of and timely passage there that FirstLight's proposal would not provide (sections 5.9(b)(6) and (7)). Additionally, the installation of an additional PIT antenna within the Spillway fishway is a modest additional cost and level of effort (section 5.9(b)(7)). Therefore, we recommend FirstLight install a PIT antenna in the second turning pool of the Spillway fishway.

Northfield Mountain Upper Reservoir

Comments

Donald Pugh requests that a radio telemetry receiver and Yagi antenna be employed in the upper reservoir to verify entrainment.

Discussion and Staff Recommendation

The Northfield Mountain Project may entrain fish from the Connecticut River when filling its upper reservoir during pump back operations (section 5.9(b)(5)). FirstLight proposes to assume that any fish observed at the proposed telemetry array at the Northfield Mountain intake/tailrace, and not otherwise detected at an alternate telemetry location at a later date, are entrained into the upper reservoir and lost. However, this proposed approach does not provide a methodology to verify entrainment and would likely overestimate entrainment rates at the Northfield Mountain Project

(section 5.9(b)(6)). Donald Pugh's alternate approach, however, would detect tags in the upper reservoir, and, therefore, confirm and quantify the entrainment of tagged fish by the Northfield Mountain Project (section 5.9(b)(7)).

In order to confirm and quantify the entrainment of tagged fish by the Northfield Mountain Project we recommend that FirstLight implement radio telemetry tracking at the Northfield Mountain upper reservoir. This additional effort would only marginally increase the level of effort and cost of the study but would provide significantly more tangible data than FirstLight's proposal to better inform the development of potential license conditions (sections 5.9(b)(5), (6) and (7)).

Mobile Telemetry Tracking

Applicant's Proposal

In addition to the fixed radio-telemetry stations, FirstLight proposes weekly mobile tracking of radio-tagged shad throughout the 42-mile study area from the Holyoke Project (FERC No. 2004) upstream to Mount Hermon School, or until all tagged shad have been located.

Comments

MADFW, Karl Meyer, and Donald Pugh question the adequacy of FirstLight's proposed weekly mobile telemetry surveys to cover the entire study area and request that FirstLight conduct mobile tracking twice per week.

Discussion and Staff Recommendation

FirstLight proposes to continuously monitor tagged shad throughout the 42-mile study area with 19 fixed telemetry stations. The requesters did not articulate why the proposed weekly mobile telemetry surveys coupled with the fixed telemetry receiver stations is inadequate to meet the studies goals and objectives (section 5.9(b)(7)). Upon review of the proposed fixed telemetry array and coupled with the use of weekly mobile telemetry surveys, we find that FirstLight's proposal, as modified herein, would provide the necessary information on the upstream and downstream migrations of shad throughout the study area (section 5.9(b)(6)). As such, we find that the additional effort and cost of conducting the mobile telemetry surveys twice per week is not warranted (section 5.9(b)(7)).

Passage Induced Shad Mortality Assessments

Applicant's Proposal

To assess for passage-induced mortality, FirstLight proposes to utilize motion sensor telemetry tags (mortality tags). To assess any mortality, FirstLight proposes to monitor passage at four fixed telemetry stations (Cabot Station and Station No 1 tailraces, and the two dam spillway sites) and to use the weekly mobile tracking to identify areas where fish, subject to passage-induced mortality (downstream of Turners Falls dam), are likely to settle (e.g., deep pools), including the downstream area locally known as the Hatfield S-Turn, located between river miles (RM) 93 and 101.

Comments

MADFW and Trout Unlimited request that FirstLight use all mobile tracking efforts and all 19 fixed telemetry stations to verify mortality and throughout the entire study area, rather than just the tacking efforts that occur downstream of Turners Falls dam..

Donald Pugh also notes that passage-induced mortality would likely occur downstream of Cabot Station in an area where fixed telemetry stations are limited and, therefore, requests that mobile telemetry surveys for passage-induced mortality be conducted twice weekly in the study area downstream of Cabot Station.

Discussion and Staff Recommendation

In proposing to monitor for fish mortality at its fixed telemetry stations noted above, FirstLight suggests that it will only assess shad mortality in areas where passage-induced mortality may likely occur (e.g. entrainment or spill passage mortality). However, recording and reporting mortality data collected at all fixed telemetry stations and during the mobile tracking efforts throughout the study area would help inform study results (section 5.9(b)(6)). These data would track changing sample size as tagged shad may expire due to circumstances that may not be project induced, such as stresses endured during handling, tagging, transport, and spawning. For these reasons, we recommend that FirstLight record and document mortality data collected throughout the study area from all fixed telemetry stations and during mobile tracking efforts throughout the entire study area. Because FirstLight is already proposing to utilize motion sensor telemetry tags, there would be no additional cost to the collection of this data. There would, however, be some minor additional cost associated with data analysis and reporting (section 5.9(b)(7)).

Regarding Donald Pugh's request for twice weekly mobile telemetry surveys for passage-induced mortality at the Turners Falls Project, we note that FirstLight only

proposes to utilize the weekly mobile telemetry tracking to target areas where dead fish are likely to settle (e.g., quiescent areas and deep pools). While our recommendation above would opportunistically document and report all mortality detections (mobile and fixed telemetry) throughout the entire study area, the relatively narrow detection field of the fixed telemetry stations is not ideal for detecting non-moving, dead, or dying fish. In contrast, mobile telemetry surveys are much better suited for detecting immobile fish where the detection equipment is roving with full river coverage.

Even with mobile survey efforts, the carcasses of fatally injured or wounded tagged fish may leave the study reach undetected as they will be subject to drift, predation, and scavenging. The duration between mobile telemetry survey efforts, will therefore, directly influence the potential for carcass detections. While we did not recommend Donald Pugh's requested twice-per-week mobile surveys above for the entire study area, twice -per-week surveys downstream of Turners Falls dam for the purposes of an assessment of passage-induced mortality would be appropriate (section 5.9(b)(6)).

Therefore, , we recommend that FirstLight increase the frequency of mobile telemetry monitoring to twice per week in the riverine reach from Turners Falls dam at RM 122 downstream through the Hatfield S-Turn to RM 93. This added effort would reduce the amount of time, by half, that a carcass could be lost. We estimate that doubling the frequency of the mobile telemetry tracking in this 29-mile reach of river will increase the cost of the study by about $20,000 (section 5.9(b)(7)).

Video Monitoring Locations

Applicant's Proposal

To evaluate fishway efficiency and the total number of shad (vs. tagged shad) accessing the Spillway fish ladder, FirstLight proposes to deploy video camera(s) in the ladder. However, FirstLight does not provide details on the exact location of the camera installations. FirstLight explains that it will not video monitor the Cabot fishway because this ladder has been extensively studied.

Comments

Trout Unlimited requests that FirstLight conduct video monitoring of adult shad at the both the Spillway and Cabot Station fish ladder entrances to confirm the magnitude of shad passage and passage efficiency. Additionally, Trout Unlimited requests that FirstLight install a video camera at the Spillway, Cabot Station, and the Gatehouse fish ladder viewing windows. Karl Meyer indicates that a video camera only within the Spillway fish ladder, as proposed by FirstLight, is insufficient to determine the number of fish attracted to the dam and vicinity of the Spillway ladder.

Discussion and Staff Recommendation

Existing information is extensive with regard to monitoring operation of the Turners Falls' upstream fishways. As part of its license requirements, since 2007 FirstLight has digitally counted shad and other species at the viewing windows of all three Turners Falls fishways (Spillway, Cabot Station, and Gatehouse) and have annually filed this information with the Commission.[29] These annual reports provide the number of all fish, by species, including the total numbers of adult American shad migrating through each of the three fish ladders at Turners Falls. Therefore, video monitoring at the entrance and/or exits of these facilities, even FirstLight's proposed video monitoring only at the Spillway ladder, would provide little additional information beyond FirstLight's existing fish count data (section 5.9(b)(4)). Additionally, the data collected from FirstLight's proposed PIT monitoring locations would track individual tagged shad as they negotiate the fish ladders. These data can be applied or compared to the numbers of shad counted at the viewing windows as part of FirstLight's license requirements to evaluate passage efficiency of all three fish ladders, thus providing Trout Unlimited and Karl Meyer the information they seek. Therefore, given the required digital monitoring and proposed PIT-tag data collection efforts, the installation of video cameras to assess the magnitude of shad passage and passage efficiency is not necessary (section 5.9(b)(7)), although we do not object to implementation of FirstLight's proposal.

We recommend that FirstLight utilize the annual digital counting of all fish species at the three fish ladder viewing windows (i.e., Spillway, Cabot Station, and Gatehouse ladders), required by Article 38 of the current license, and the proposed PIT-tag monitoring to evaluate the effectiveness and efficiency of the three fish ladders. We expect only marginal increases in study costs, associated with data analysis (section 5.9(b)(7)).

Study 3.3.3 - Evaluate Downstream Passage of Juvenile American Shad

Project operations can affect the success of juvenile American shad out-migration in the Connecticut River due to project induced delay and entrainment injury and mortality. FirstLight proposes to assess the effects of the projects on timing, orientation, routes, migration rates, and survival of juvenile shad to determine if project facilities and operations affect downstream migrants. To do so, FirstLight proposes to utilize a combination of hydroacoustic technology, radio telemetry, and balloon-tags. FirstLight would use hydroacoustics to monitor the timing, duration, and magnitude of the juvenile

[29] Article 38 requires FirstLight to conduct (or pay others to conduct) post-operational studies to determine the effectiveness of the fish passage facilities in allowing for fish passage upstream of the Turners Falls Project. Article 38 also requires FirstLight to file annual reports detailing the operations of the facilities, including the numbers of all fish that are passed upstream at the three fish ladders.

shad migration at the Northfield Mountain intake, Cabot Station forebay, and the Gatehouse forebay from August through October. It would use radio telemetry techniques to assess downstream passage routes (i.e., past the Northfield Mountain Project, over the Turners Falls dam, in the Turners Falls power canal, through Station No 1 and Cabot Station powerhouses, and through the downstream fish bypass adjacent to Cabot Station). Finally, FirstLight would use balloon-tags to collect empirical turbine survival data.

Telemetry Receiver Locations

Applicant's Proposal

As part of Task 2, Evaluate Route of Passage, FirstLight proposes to tag groups of juvenile shad and release them upstream of the projects. FirstLight would position telemetry receivers and antennas to monitor the downstream out-migration through the project areas at eleven radio telemetry locations between the Shearer Farms, 0.5 miles upstream of the intake for the Northfield Mountain Project at RM 127.5, and the downstream Montague Wastewater treatment facility at RM 119.5. FirstLight's goal is to evaluate downstream passage routes through project facilities (i.e., spill passage at Turners Falls dam, through Turners Falls Gatehouse and power canal, Station No 1, Cabot Station, and the Cabot Station downstream fish bypass).

Comments

Several comments were made regarding improvements to the type and number of radio-telemetry receivers and/or antenna arrays that FirstLight proposes.

As noted in study 3.3.2 above, FirstLight proposes to refine the telemetry array with field testing and to add additional antennas and/or receivers as needed; therefore, we do not see the need to address those comments herein. We expect this testing will ensure that the proposed radio telemetry equipment provides accurate and reliable data necessary to achieve the goals and objectives of the study. We recommend that FirstLight include with its study report, a report on the telemetry array's testing and calibration. Stakeholders will have the opportunity to comment on the testing and calibration and the resulting telemetry data pursuant to section 5.15 of the Commission's regulations.

However, below, we do address requests for specific telemetry equipment at the Northfield Mountain upper reservoir, where FirstLight does not propose to provide telemetry.

Northfield Mountain Upper Reservoir

Comments

The National Marine Fisheries Service (NMFS) and Donald Pugh request a fixed telemetry receiver and Yagi antenna in the upper reservoir to detect any entrained juvenile shad missed at the project's intake/tailrace.

Discussion and Staff Recommendation

The Northfield Mountain Project may entrain fish from the Connecticut River when filling its upper reservoir during pump back operations (section 5.9(b)(5)). To evaluate the level of entrainment at Northfield Mountain, FirstLight proposes to deploy hydroacoustic transducers at the project's intake/tailrace on the Connecticut River. However, the mere presence of fish at the intake/tailrace, as detected by hydroacoustics, would not provide any definitive information on entrainment. As discussed in study 3.3.2 above, assuming shad detected via radio telemetry (or any other means) in the vicinity of the project's intake are entrained would not verify entrainment and would likely overestimate entrainment rates (section 5.9(b)(6)). Alternatively, radio tag detection in the upper reservoir would confirm and quantify any entrainment of tagged fish and could compliment the FirstLight's hydroacoustic and telemetry data from the intake/tailrace (section 5.9(b)(7)).

Therefore, we recommend that FirstLight implement radio-telemetry tracking at the Northfield Mountain upper reservoir. This additional effort would only marginally increase the level of effort and cost of the study but would provide data on entrainment of juvenile tagged shad at the Northfield Mountain Project that FirstLight should be considering when evaluating its intake/tailrace hydroacoustic data (section 5.9(b)(6) and (7)).

Downstream Survival

Applicant's Proposal

FirstLight proposes to evaluate the spillway and turbine survival of juvenile shad downstream passage at each type of turbine at Cabot Station and Station No 1, as well as at four bascule gates and one Tainter gate at the dam. FirstLight proposes to test one of the four larger turbines and the smaller turbine to evaluate shad turbine entrainment survival "at or near best efficiency conditions for each test unit," and extrapolate the results to similar turbines types.

FirstLight proposes to release 150 balloon-tagged juvenile shad into each tested turbine (at or near the turbines best efficiency). FirstLight would also release an

additional control population of 150 balloon-tagged shad into the development's tailrace. At the dam, FirstLight proposes to release 25 through each of the test gates.

Comments

Karl Meyers requests that FirstLight conduct the turbine survival study at each of the Turners Falls Project's 11 turbines under all operating conditions.

Discussion and Staff Recommendation

The six turbines at Cabot Station are of similar design with similar hydraulic capacities. Station No. 1 has five Francis turbines, four of which have similar hydraulic capacities, speeds, and double runners. The fifth turbine is about one quarter of the hydraulic capacity of the others and with a single runner. Mr. Meyer has not indicated why the sampling approach is inadequate to evaluate potential project effects and entrainment mortality through the project's turbines (section 5.9(b)(7)). FirstLight's proposal to extrapolate the results to each similar turbine type rather than testing all turbines is a generally accepted cost-effective method (section 5.9(b)(6)). Therefore, FirstLight's proposal will achieve the study objective of determining juvenile shad turbine entrainment survival at Cabot Station and Station No 1 (sections 5.9(b)(6) and (7)).

Regarding the request that FirstLight test each turbine under all operating conditions, FirstLight did not specifically state whether or not "near best efficiency conditions" is the typical operational scenario for the turbines during the juvenile shad outmigration season (August 15 through October). Entrainment mortality/survival rates through an individual turbine can vary greatly depending upon the flow through the turbine and the turbine's operating characteristics (e.g., operating efficiency, wicket gate settings, runner blade orientation, etc.). As a result, data collected as proposed by FirstLight, may not be representative of the typical turbine operating conditions during the juvenile shad outmigration season (section 5.9(b)(6)).

To ensure data collected through the turbine juvenile shad survival study are representative of typical turbine operating conditions during the juvenile shad outmigration season, we recommend that FirstLight consult with the FWS, MADFW, and the NMFS and establish the typical operating condition of each test turbine evaluated during the juvenile shad out-migration season. FirstLight should make recommendations regarding how these operating conditions would be incorporated into the study and file them for Commission approval with the Initial Study Report in September 2014. FirstLight should consider comments received, and if recommendations are not adopted, the filing should provide FirstLight's reasons based on project-specific information. We anticipate the cost of this consultation process would be marginal (section 5.9(b)(7)).

Study 3.3.4 – Evaluate Upstream Passage of American Eel at the Turners Falls Project

Turners Falls dam can affect the upstream migration of juvenile American eel. During the first study season, FirstLight proposes to conduct visual surveys at project facilities where eels likely congregate. During the second study season, FirstLight would deploy temporary eel traps in areas identified during the visual surveys to evaluate the potential for permanent long-term eel passage/traps at the project.

Visual Survey Locations

Applicant's Proposal

FirstLight proposes to conduct visual surveys at the following project facilities:

- Cabot Station spillway (emergency water-control gates).
- Cabot fishway (dewatered state, will provide some attraction water).
- Cabot log sluice.
- USGS Conte Lab flume outfall.
- Station No. 1 outfall.
- Small turbine and process water outfalls from the Cabot Canal.
- Spillway fishway attraction water stilling basin.
- Leakage points along the downstream face of Turners Falls dam (as site safety conditions allow).

Comments

Trout Unlimited and Donald Pugh request that FirstLight add the entrance to the Spillway fishway and the lower fishway pools to the list of sites to be surveyed for juvenile upstream migrating eel.

Discussion and Staff Recommendation

Although FirstLight does not include the project's Spillway fishway entrance and lower pool in its specific list of areas that it proposes to conduct visual surveys at, we note that in Section 3.9 *Matrix of Comments and Reponses* of the revised study plan, FirstLight indicates that this recommendation was adopted.

If not operating, the spillway fishway would likely be wetted by leakage and provide an area where eels may congregate (section 5.9(b)(5)). As a result, the entrance to the Spillway fishway and its lower pools should be included in the visual surveys of this study. Because it appears inclusion of this request was FirstLight's intent, our recommendation would not add to the studies cost (section 5.9(b)(7)).

Visual Survey Years

Applicant's Proposal

FirstLight proposes to conduct visual surveys for eels during the first study season and in the second study season deploy temporary eel traps at a minimum of three locations identified during the visual surveys.

Comments

Trout Unlimited and Donald Pugh request that visual surveys also be performed during the second study season. They justify the request by stating that as field conditions change, the number of eels present will likely change, and that the conditions that stimulate eels to move upstream are episodic and, therefore, visual surveys during the second year of the study will improve the likelihood of surveying migrating eels.

Discussion and Staff Recommendation

We interpret the request to be a conservative approach to reasonably ensure the visual surveys accomplish their goal in the event that the first study season survey results are inadequate due to episodic conditions.

Section 5.15 of the Commission's regulations require the annual review of ongoing studies and provides an opportunity to modify ongoing studies or to request new studies. In the event visual surveys for congregating eels during the first study season are inadequate or inconclusive due to the sporadic nature of the eel migration, this may warrant a modification of the proposed study pursuant to section 5.15 of our regulations. Therefore, until it is determined that the first season visual survey results are insufficient to meet the goals of the study, we find that modifying the study plan at this time to require visual surveys during the second study season would be premature.

Study 3.3.5 - Evaluate Downstream Passage of American Eel

Project operations and facilities may affect downstream migrating American eels (*Anguilla rostrata*) that pass through the Turners Falls and Northfield Mountain project areas due to entrainment and potential turbine mortality. Therefore, FirstLight proposes to conduct a study to evaluate the downstream passage of American eels. FirstLight's proposed study contains two primary goals: (1) obtain a better understanding of the migration timing and magnitude of adult, silver-phase American eel as it relates to environmental factors and operations of the Turners Falls and Northfield Mountain Projects; and (2) collect information to determine the impact of the Turners Falls and the Northfield Mountain Projects on the out-migration of silver eels in the Connecticut River. FirstLight proposes to assess potential project impacts to these eels using a combination

of approaches, including hydroacoustics, radio telemetry, and turbine mortality balloon-tags.

Telemetry Receivers and Locations

Applicant's Proposal

FirstLight states that telemetry receivers and antennas will be positioned to monitor the potential routes of passage/or entrainment including the Turners Falls dam, power canal, Cabot Station downstream bypass, and Northfield Mountain Project intake.

Comments

Several comments were made regarding improvements to the type and number of radio telemetry receivers and/or antennas arrays that FirstLight proposes.

As discussed above in studies 3.3.2 and 3.3.3, FirstLight proposes to refine the telemetry array with field testing and to add additional antennas and/or receivers as needed; therefore, we do not see the need to address those comments herein. We expect this testing will ensure that the proposed radio telemetry equipment will provide accurate and reliable data necessary to achieve the goals and objectives of the study. We recommend that FirstLight include with its study report, a report on the telemetry array's testing and calibration. Stakeholders will have the opportunity to comment on the testing and calibration and the resulting telemetry data pursuant to section 5.15 of the Commission's regulations.

However, we do address requests for specific telemetry equipment at locations where FirstLight does not propose to provide telemetry coverage (i.e., Northfield Mountain Project upper reservoir and the Turners Falls Gatehouse).

Northfield Mountain Upper Reservoir

Comments

FWS, NMFS, and Donald Pugh request the installation of a Yagi antenna in the upper reservoir to detect any entrained eels missed at the intake.

Discussion and Staff Recommendation

The Northfield Mountain Project may entrain fish, including adult American eels, when filling the upper reservoir during pump back operations (section 5.9(b)(5)). While the telemetry antenna array at the Northfield Mountain Project's intake would indicate whether American eel may be found in the vicinity of the intake, it would not confirm or

quantify the entrainment of the tagged fish (section 5.9(b)(7)). Telemetry data collected from the upper reservoir, however, would provide this information. As a result, we recommend that FirstLight provide telemetry coverage of the Northfield Mountain upper reservoir. This additional effort would not significantly increase the level of effort and cost of this study (section 5.9(b) (7)).

Turners Falls Gatehouse

Comments

NMFS, FWS, and Donald Pugh request the installation of radio-telemetry antenna array upstream of the Gatehouse to assess passage delay and to inform the study on the route of passage selected by out-migrating eels.

Discussion and Staff Recommendation

FirstLight proposes to install an antenna array immediately downstream of the Gatehouse (instead of upstream, as requested) to detect tagged fish passing from the reservoir through the Gatehouse and utilizing the Turners Falls power canal as the downstream migratory route. However, this proposed downstream antenna array would not provide data on any potential eel downstream migration delays in Turners Falls reservoir and eels milling near the Gatehouse. The requested upstream antenna array would provide this important information (section 5.9(b)(7)). However, we note that FirstLight is also proposing to monitor the Turners Falls reservoir in front of the dam with radio telemetry and to deploy hydroacoustics upstream of the Gatehouse.

While FirstLight also proposes to monitor the Turners Falls reservoir with radio telemetry, it is unclear if its' proposed Turners Falls reservoir telemetry array would adequately monitor fish in the area immediately in front of the Gatehouse. While the proposed hydroacoustic array should aid in determining fish behavior in front of the Gatehouse, telemetry data from tagged eels in the same area will aid in the interpretation of these hydroacoustic data (section 5.9(b)(7)). Therefore, to better understand the potential project effects on migration route selection and potential delayed downstream passage of American eels, we recommend that FirstLight provide telemetry detection coverage upstream of the Gatehouse. We anticipate the cost of this recommendation to be marginal (section 5.9(b)(7)).

Mobile Telemetry Tracking

Applicant's Proposal

To monitor passage-induced mortality of eels, FirstLight proposes to utilize motion sensor telemetry tags (mortality tags). FirstLight states that mobile tracking will

occur once per week in river reaches between release sites and five kilometers downstream of Cabot Station during and after releases to confirm routes and fates of passed fish. FirstLight would continue mobile tracking throughout the season until all tagged eels have left the area or water temperatures fall to 5°C.

Comments

NMFS requests that FirstLight conduct mobile tracking twice per week, rather than once per week.

Discussion and Staff Recommendation

As discussed above in study 3.3.2, FirstLight's proposed once-per-week mobile telemetry surveys are not likely to capture the full extent of eel mortality. For reasons discussed in study 3.3.2 above, we recommend FirstLight conduct its proposed mobile telemetry tracking for passage-induced American eel mortality at least twice per week and utilize all fixed telemetry stations to detect and report eel mortality. We estimate the cost of this added effort to be $10,000 (section 5.9(b)(7)).

Radio Telemetry Tag Battery Life

Applicant's Proposal

FirstLight proposes to use radio telemetry tags with a battery life of 50 days.

Comments

NMFS requests that FirstLight use radio telemetry tags with a battery life of 90 days to ensure the tags are functional throughout the duration of the study period.

Discussion and Staff Recommendation

The downstream silver eel migration season is typically between August and October (90 days). As a result, FirstLight's proposed use of 50-day battery life tags may not provide data on silver eels that pass the projects throughout the entire migration period (sections 5.9(b)(6) and (7)). Therefore, we recommend that FirstLight use radio telemetry tags for this study with a battery life of at least 90 days. This recommendation would only marginally increase the cost of this study (section 5.9(b)(7)).

Downstream Passage Survival

Applicant's Proposal

FirstLight proposes to use balloon-tags to determine empirical rates of turbine passage survival for eels entrained at the Turners Falls spillway, Station No. 1, and Cabot Station. FirstLight would release 50 tagged eels into each of three select turbines. It would also release 125 tagged eels above the dam to evaluate passage survival through the bascule and Tainter gates. FirstLight would operate the turbines at or near best efficiency during testing.

Comments

FWS seeks to have all appropriate turbine operating conditions tested (e.g., minimum load, full load, peak efficiency) and states that FirstLight should verify the typical operation of the turbines to be tested and expand the survival testing to include these conditions.

Discussion and Staff Recommendation

For reasons discussed above in study 3.3.3 – *Evaluate Downstream Passage of Juvenile American Shad*, it is appropriate that turbine survival data are representative of typical turbine operating conditions during the shad outmigration season (sections 5.9(b)(6) and (7)). Our recommendation for turbine operating conditions during mortality studies also pertain to American eels. However, it is unclear if FirstLight's proposal to test the turbines at best efficiency would be representative of typical operation conditions during the eel downstream migration season. Therefore, as discussed in study 3.3.3 above, we recommend that FirstLight consult with the FWS, MADFW, and the NMFS and establish the typical operating condition of each test turbine evaluated during this study. FirstLight should provide the results of this consultation and file them for Commission approval with the Initial Study Report in September 2014. FirstLight should consider comments received and if recommendations are not adopted, the filing should provide FirstLight's reasons based on project-specific information. Upon filing of the Initial Study Report, stakeholders are provided an opportunity for comment pursuant to section 5.15(c) of the Commission's regulations. We anticipate the cost of this consultation process would be marginal (section 5.9(b)(7)).

Hydroacoustics Study Duration

Applicant's Proposal

FirstLight proposes to conduct the silver eel downstream passage hydroacoustic monitoring portion of this study for one year, and proposes to conduct the study a second

year if the first-year study was conducted under a non-typical condition, and if deemed appropriate through discussions with the agencies.

Comments

To evaluate the timing of downstream migratory movements of silver eel and the year-to-year variability, NMFS, MADFW, and Donald Pugh request that FirstLight conduct the hydroacoustic portion of this study for two years.

Discussion and Staff Recommendation

Downstream silver eel migrations can vary greatly from year-to-year depending on many factors including, precipitation events, moon phases, temperature, and the age/size structure, and the population characteristics of the current upstream adult eel population.[30] Therefore, a single study season as proposed by FirstLight is inadequate (section 5.9(b)(6)) to account for these variables. Alternatively, a second season of hydroacoustic monitoring would provide more reliable information to understand presence, migration timing, passage route utilization, and entrainment at the Northfield Mountain project (section 5.9(b)(6) and (7)). This information is needed to inform our environmental review of potential project effects and to guide the reliable development of potential license conditions for the Turners Falls and Northfield Mountain projects (section 5.9(b)(5)).

Therefore, to address the year-to-year variability of downstream silver eel migrations we recommend that FirstLight implement the hydroacoustic component of this study for two study seasons between August 1 and October 31. We anticipate this recommended modification will increase the cost of the study by approximately $50,000 (section 5.9(b)(7)).

Study 3.3.6 - Impact of Project Operations on Shad Spawning, Spawning Habitat and Egg Deposition in the Area of the Northfield Mountain and Turners Falls Projects.

Operation of the Turners Falls and Northfield Mountain projects alter water depth and velocity which may affect spawning shad and their habitat. Therefore, FirstLight proposes to identify shad spawning sites and quantify spawning activity under various project operation scenarios. FirstLight would use its hydraulic model developed in study 3.2.2 to examine effects of historical and proposed operating conditions on the identified spawning areas.

[30] Tesch, F.-W. 2003. The Eel. Third Ed. Blackwell Science Publishing Company, Oxford, UK. 408 pp.

Surveys Downstream of Turners Falls Dam

Applicant's Proposal

FirstLight would conduct shad spawning surveys from Turners Falls dam to the Route 116 bridge in Sunderland, MA. A literature review of shad spawning locations, consultation with stakeholders, and a Phase I field survey would help identify shad spawning areas. Phase I surveys would initially occur twice per week but would increase to three times per week during peak spawning activity. In Phase II, FirstLight would manipulate project operation and observe peek shad spawning activity (at sites identified by Phase I) prior to, during, and after changes in project operation. FirstLight would collect various habitat and water quality data including point temperature measurements during the surveys.

Comments

MADFW and Donald Pugh request FirstLight modify shad survey efforts downstream of Turners Falls dam to include the following: 1) conduct Phase I surveys three times per week throughout the shad spawning season to ensure that all shad spawning areas are identified; 2) conduct spawning surveys during project-induced increases and decreases in flow as shad spawning behavior may be altered by either case; 3) record continuous temperature data at the upper- and lower-most sites selected for Phase II study.

Discussion and Staff Recommendation

The commenters request for three Phase I shad surveys per week throughout the entire spawning season regardless of spawning activity. We note that several resources are available to FirstLight for its proposed Phase I surveys including: previous shad surveys, stakeholder input, daily shad passage data at Holyoke dam, and existing information that describes environmental factors conducive to shad spawning. Considering this existing information and the length of shad spawning occurs over several weeks from early May to mid-June, FirstLight should be able to easily identify shad spawning areas under its proposed two surveys per week followed by three surveys per week during peak spawning (section 5.9(b)(6)). We find that the commenters recommended additional surveys during off-peak spawning would not likely identify more spawning areas compared to the existing proposal (section 5.9(b)(7)). Therefore, the cost associated with conducting these additional surveys is not justified (section 5.9(b)(7)).

MADFW and Donald Pugh also suggest surveys occur during flow increases as well as decreases. FirstLight did not specify under what flow conditions Phase I surveys would occur, but considering the frequency of survey and duration of the spawning

season, it would likely observe both flow conditions. In Phase II, FirstLight would manipulate project operation and observe changes in spawning activity before, during, and after changes in flow. Although it does not specifically state surveys would occur under both increasing and decreasing flow conditions in study 3.3.6, in its response to comments in section 3.9 *Matrix of Comments and Responses* in the revised study plan, FirstLight "adopts" the same request made by the NMFS on the proposed study plan. Therefore, we understand it is FirstLight's existing proposal to provide data during flow increases and decrease and, therefore, there is no need to modify the study plan.

We acknowledge that continuous temperature data in shad spawning areas is important to describe spawning conditions during the surveys as well as describe any operational effects on water temperature. As discussed in study 3.2.1 – *Water Quality Monitoring*, we recommend that FirstLight develop, in consultation with stakeholders, a temperature monitoring study plan for the Connecticut River between Cabot Station and the Holyoke dam to identify temperature and temperature rate of change associated with project operations.

Surveys in Turners Falls Reservoir

Applicant's Proposal

In Turners Falls reservoir, FirstLight proposes to target areas of suitable spawning habitat based on HSI curves. It would then use visual survey methods consistent with those described for the Phase I surveys downstream of Turners Falls dam to identify spawning activity in the target areas. FirstLight also notes that information collected during shad migration investigations, study 3.3.2 – *Evaluate Upstream and Downstream Passage of Adult American Shad*, may provide insight to determine locations and timing of shad spawning.

Comments

MADFW and Donald Pugh acknowledge that existing HSI curves may be helpful to identify shad spawning areas in the Turners Falls reservoir, but suggest that FirstLight's proposed survey efforts may not be adequate to identify shad spawning sites. Both commenters request FirstLight survey the entire reservoir (Turners Falls dam to Vernon dam) at least twice per week.

Discussion and Staff Recommendation

FirstLight acknowledges that little is known regarding the timing and location of shad spawning in the Turners Falls reservoir compared to downstream of Turners Falls dam. However, FirstLight does not provide sufficient detail regarding use of HSI curves,

survey frequency, or use of radio-tagged shad to identify spawning areas in the reservoir and it is unclear if its study plan, as proposed, would meet the stated goals.

Shad spawn in run or glide habitat between 3 and 18 feet deep.[31] Considering this wide range of suitable spawning depths, most of the Turners Falls reservoir may provide suitable habitat depending on flow. Project operation affects flow (magnitude, duration, and direction); therefore, it may not be reasonable to preclude certain areas of the reservoir from survey based solely on modeling results because changes in water depth or velocity could induce spawning in otherwise unsuitable areas (section 5.9(b)(5) and (6)).

Therefore, in addition to its proposed use of HSI curves and radio-telemetry data, we recommend FirstLight visually survey the entire reservoir to identify potential shad spawning sites. FirstLight should utilize the methods described for Phase I surveys downstream of Turners Falls dam (2-3 surveys per week based on shad density).

Based on suitable spawning depths and the reservoir profile information presented on page 3-89 of the PAD, our recommendation would increase the reservoir survey area by approximately 25% resulting in an estimated increased study cost of $15,000 (section 5.9(b)(7)).

Surveys in the Power Canal

Applicant's Proposal

While FirstLight proposes to identify shad spawning locations and evaluate potential impacts of operational changes in flow on shad spawning activity at confirmed spawning locations from Turners Falls dam downstream to the Route 116 bridge in Sunderland, MA, it does not propose to conduct surveys in the Turners Falls power canal.

Comments

The Watershed Council and Karl Meyer express concern regarding the lack of shad spawning surveys in the Turners Falls power canal.

Discussion and Staff Recommendation

As discussed above in study 3.3.2 - *Evaluate Upstream and Downstream Passage of Adult American Shad,* existing information on upstream shad passage through the power canal shows that a small percentage of upstream migrating shad in the power canal

[31] Stier, D.J. and Crance, J.H. 1985. Habitat suitability index models and instream flow suitability curves: American shad. U.S. Fish and Wildlife Service Biological Report 82(10.88).

exit the canal and pass upstream through the Gatehouse fishway. This suggests that conditions (e.g. flow velocities, turbulence) within the project's power canal may be a barrier or hindrance to shad migration. However, it is unclear if shad are spawning within the power canal and if the operational conditions affect these spawning activities. Any shad spawning data from the power canal would contribute to an analysis of potential project effects on shad spawning and migration (section 5.9(b)(5)). In addition, these spawning surveys would help identify the need for a detailed hydraulic study of the canal as discussed below in Section II. *Study Requested but not Adopted by FirstLight, Hydraulic Study of Turners Falls Power Canal*.

Therefore, we recommend FirstLight survey the power canal for shad spawning activity. FirstLight should utilize survey methods outlined for shad surveys downstream of Turners Falls dam, including visual surveys on foot along the length of the canal. We estimate the cost of this modification to be approximately $6,000 (section 5.9(b)(7)).

Shad Egg Collection Effort

Applicant's Proposal

FirstLight proposes to confirm Phase II spawning observations by deploying an ichthyoplankton net (a fine mesh net), to collect shad eggs downstream of identified spawning areas.

Comments

MADFW and Donald Pugh request FirstLight conduct egg netting before and after manipulation of water releases and compare the number of eggs collected to evaluate changes in spawning.

Discussion and Staff Recommendation

FirstLight only proposes to use egg collection as a means to confirm that observed surface activity is indicative of shad spawning activity. As such, shad egg collection efforts would be duplicative of confirmed visual surveys and may be utilized as a substitute for visual surveys.[32] However, it appears the commenters are requesting egg collections be used to quantify spawning activity versus confirming spawning activity as proposed by FirstLight. Utilizing egg collections to provide this high resolution data may

[32] Ross, R.M., Backman, T.W.H., and R. M. Bennet. 1993. Evaluation of habitat suitability index models for riverine life stages of American shad, with proposed models for pre-migratory juveniles (Biological Report 14. U. S. DOI). Washington, D.C.: U. S. Fish and Wildlife Service.

provide additional information on the productivity of the spawning activity. However, egg collections before and after flow manipulation is not necessary to evaluate changes in spawning behavior over a range of project operation and it is unlikely that this higher resolution data would be significantly more useful than the visual survey observations proposed (section 5.9(b)(7)). Therefore, we do not find a comparison of the number of eggs collected before, during, or after a project operational change necessary to evaluate project effects on shad spawning activity.

Shad Egg Collection and Effects on Shortnose Sturgeon

Applicant's Proposal

To avoid adverse effects on shortnose sturgeon, FirstLight filed a late amendment to its study plan, proposing to replace egg collection efforts in and adjacent to the shortnose sturgeon spawning area below Cabot Station with enhanced visual survey efforts and splash counts. FirstLight notes that egg collection efforts tend to duplicate visual surveys and that visual observation would fulfill the goals and objectives of this study.

Comments

In response to FirstLight's amendment to the study plan, the FWS filed a letter on February 12, 2014, noting that it had not been consulted on the proposed study plan amendment. FWS notes that FirstLight would likely implement the proposed study during the 2015 field season and, therefore, the FWS requests an opportunity to consult, during the 2014 field season on alternative study plan modifications to avoid potential effects on shortnose sturgeon.

Discussion and Staff Recommendation

The revised study plan, as designed, may result in effects on shortnose sturgeon. FirstLight's proposal to amend the revised study plan and eliminate the proposed egg collection efforts in and adjacent to the shortnose sturgeon spawning area below Cabot Station would avoid these effects. However, we recognize that the resource management agencies have not had an opportunity to consult with FirstLight or comment on the proposed amendment to this study. As a result, we recommend that FirstLight consult with the NMFS, FWS, MADFW, and Commission staff on an amendment to the revised study plan that would seek to avoid all effects to shortnose sturgeon and provide sufficient information. Following consultation, FirstLight should file with the Commission for approval, an amended study plan for study 3.3.6 when it files its Initial Study Report in September 2014. The amended study plan should document FirstLight's consultation efforts, consider comments received, and if recommendations are not adopted, provide FirstLight's reasons based on project specific information.

Study 3.3.7 - Fish Entrainment and Turbine Passage Mortality Study

Project operations may affect fish populations due to impingement, turbine entrainment, and turbine passage survival at the Northfield Mountain and Turners Falls projects. The goal of the proposed study is to assess fish impingement, turbine entrainment, and turbine passage survival at the projects.

Shad Egg and Larval Entrainment at Northfield Mountain

Applicant's Proposal

FirstLight is not proposing to conduct field studies evaluating shad egg and larval entrainment, but is proposing to conduct a similar study of juvenile shad using hydroacoustic monitoring and radio telemetry tracking in study 3.3.3 -- *Evaluate Downstream Passage of Juvenile American Shad*.

Comments

FWS, MADFW, and the Watershed Council request that FirstLight conduct field entrainment studies specific to early life stages (i.e., eggs and larvae) of American shad.

FirstLight does not agree that a field egg and larvae entrainment study is necessary; suggesting that, due to low natural egg and larval survival, shad egg mortality from entrainment would have no appreciable effect on the population, even if entrainment mortality were 100 percent.

Discussion and Staff Recommendation

Low natural egg and larval survival rates are typical of highly fecund species, such as American shad.[33] The U.S. Environmental Protection Agency (USEPA) Regional Analysis Document reports that natural American shad egg survival to the juvenile life stage is estimated at 0.0000182 percent. FWS noted that the EPA-calculated survival rate is misleading, and stated that a more accurate egg to Age 1+ stage survival rate is approximately 0.000978 percent. [34]

[33] Helfman, G. S., B. B. Collette, and D. E. Facey. 1997. The Diversity of Fishes. Blackwell Science, Inc. Oxford, UK. 528 pp.

[34] Savoy, T. F., and V. A. Crecco. 1988. The timing and significance of density-dependent and density-independent mortality of American shad. Fishery Bulletin 86(3): 467-482.

Given such low natural survival, FirstLight suggests that shad egg mortality from entrainment would have no appreciable effect on the population, even if entrainment mortality were 100 percent.

The potential for fish injury or mortality due to entrainment or impingement at a hydroelectric facility is dependent on a variety of factors, but is primarily dependent on the size of the fish.[35] Generally, fish that are smaller in size experience higher entrainment survival. As such, one study that evaluated entrained fish eggs and larvae at hydropower projects suggested that eggs and larvae experience high rates of survival – generally 95% or greater.[36] We note that in situ studies of entrainment survival of fish eggs and larvae are rare, expensive, challenging, and have shown mixed results.[37] For these reasons, we find that a study of shad egg and larval entrainment is not warranted at this time.

We note that FirstLight is proposing an empirical study on juvenile shad entrainment at the Northfield Mountain project (study 3.3.3). Therefore, if the first year studies on juvenile entrainment monitoring (study 3.3.3) at the Northfield Mountain project reveals high rates of juvenile entrainment, and/or a low abundance of juveniles in relation to the adult return rate that year (indicating potentially high egg and larval entrainment at Northfield Mountain), then further investigation into the potential effects of entrainment of earlier life stages of American shad at the Northfield Mountain project should be considered.

We recommend that FirstLight consult with FWS, NMFS, MADFW, and the Watershed Council after the 2014 results of the Evaluate Downstream Passage of Juvenile American Shad study (study 3.3.3) are available to assess the need for a second year study to further evaluate American shad egg and larval (or juvenile) entrainment at the Northfield Mountain project.

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[35] Cada, G.F., C.C. Coutant, and R.R. Whitney. 1997. Development of biological criteria for the design of advanced hydropower turbines. DOE/ID-10578. Prepared for the U.S. Department of Energy, Idaho Operations Office, Idaho Falls, Idaho.

[36] Cada, G.F. 1990. A Review of Studies Relating to Effects of Propeller-Type Turbine Passage on Fish Early Life Stages. North American Journal of Fisheries Management 10:418–26.

[37] Fish Passage Technologies: Protection at Hydropower Facilities, OTA-ENV-641 (Washington, DC: U.S. Government Printing Office, September 1995).

Study 3.3.10 - Assess Operational Impacts on Emergence of State-Listed Odonates in the Connecticut River

The timing, rate, and magnitude of water level fluctuations due to operation of the Turners Falls and Northfield Mountain projects may adversely affect state-listed riverine odonate larvae and tenerals.[38] Specifically, changes in water level may wash away emerging odonates as they climb up the riverbank to eclose. The degree of this effect is unknown; therefore, FirstLight proposes to collect data on odonate assemblage structure and emergence/eclosure behavior in the project area with a focus on state-listed species. One-time qualitative surveys would focus on detection and distribution of aquatic larval forms and quantitative surveys would characterize species-specific relative abundance as well as emergence[39] and eclosure behavior. FirstLight proposes to utilize results of its proposed hydraulic model (study 3.2.2) to categorize odonate occurrence data along a gradient of inundation frequency.

Sufficient Sample Size and Statistical Power

Applicant's Proposal

FirstLight proposes to conduct the quantitative surveys (Task 4) at four study reaches; two study reaches within the Turners Falls reservoir and two study reaches downstream of the Turners Falls dam. At least six 2-meter-wide transects would be established within each study reach, for a minimum of 24 transects. FirstLight indicates that more transects may be added depending on habitat variability within each reach, habitat preference of target species, variability in species density, and changes in species composition among transects (e.g., low density and high variability would trigger additional transects).

FirstLight proposes to identify and count emerging larvae, exuviae,[40] and tenerals at each transect and collect information on distance from water surface, elevation, bank slope, substrate, and percent cover. FirstLight would use correlation and regression analyses to examine the relationship between odonate emergence and site condition factors (e.g., water level, habitat, and weather conditions).

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[38] A teneral is a soft-bodied adult dragonfly (or other insect). The teneral life stage is very short and occurs immediately after the larva sheds its exoskeleton and becomes an adult; this process is known as eclosure.

[39] Emergence is defined here as the event in which a mature larval insect leaves the water, travels up the river bank and initiates eclosure.

[40] An exuvia is the shed exoskeleton of an insect.

Comments

MADFW expresses concern that the proposed data collection effort is not sufficiently robust to explain heterogeneity/variation of the sample data; therefore, the analysis would not adequately detect differences in trends. Specifically, MADFW suggests the proposed sample sizes are insufficient to support a multivariate statistical analysis; thereby, limiting any analysis to non-parametric tests which would undermine the utility of the analysis. To address these concerns, MADFW recommends that FirstLight collect additional information if the data does not meet sufficient power analysis standards that MADFW would confirm through consultation with FirstLight.

In response, FirstLight states that a robust statistical analysis for each species is a lofty and possibly unobtainable goal considering the rarity of some species and variability of habitat use and emergence timing. FirstLight states it would focus on preferred habitats of each species, which would allow for a more focused analysis but does not commit to additional data collection.

Discussion and Staff Recommendation

MADFW does not identify a suitable sample size to meet its requested statistical objectives with the exception of a suggested number of observations for one parameter, emergence speed. A power analysis, as requested by MADFW, requires an estimate of variances associated with all parameters. However, an estimate of variance cannot be established without first collecting some initial data (section 5.9(b)(6)). Given the expected high variance of multiple variables (e.g., numbers of rare species, emergence times, distances traveled, habitat preference, weather conditions, water fluctuations), it is unlikely FirstLight would meet MADFW's statistical power objectives with a practical level of survey effort (section 5.9(b)(7)). As such, FirstLight should ensure data are adequate to meet the objectives of the study plan, but we do not recommend FirstLight be required to collect additional data to achieve an unknown power analysis objective.

In regards to the use of multivariate or non-parametric statistical analyses, MADFW does not support its assertion that multivariate tests are necessary, nor does it fully describe what statistical tests are desirable, or why parametric tests are more suitable than the statistical approach proposed by FirstLight (section 5.9(b)(6) and (7)). FirstLight intends to evaluate odonate emergence data along a gradient of inundation frequency and use correlation and regression analyses, which include parametric or non-parametric statistical tests, to examine the relationship between odonate emergence and site condition factors. The selection of the most appropriate test is dependent on whether data are normally distributed or not, and both types of statistical tests are readily accepted within the scientific community (section 5.9(b)(6)). The current proposal, as modified below in our discussion under *Quantitative Survey Effort*, should provide data to meet the goals and objectives of this study and support an assessment of project effects (section

5.9(b)(5)). Evaluation of the need for additional data collection or analyses would occur following completion of the first study season and Initial Study Report, pursuant to section 5.15 of our regulations. As such, we do not recommend FirstLight modify its statistical approach as requested by MADFW.

Emergence Speed

Applicant's Proposal

FirstLight proposes to identify and count emerging larvae, exuviae,[41] and tenerals at each transect and collect information on distance from water surface, elevation, bank slope, substrate, and percent cover. For emergence speed, FirstLight proposes to document the time and location of emerging larvae observed until fully eclosed. FirstLight explains that it may modify its emergence speed methodology in consultation with MADFW depending on initial results.

Comments

MADFW states that the time it takes a teneral to complete the emergence process is a critical piece of information. MADFW believes that rate of emergence speed, in conjunction with a better understanding of the rate and magnitude of water level fluctuations (study 3.2.2), is necessary to enable assessment of project effects on the emergence process. Therefore, MADFW recommends FirstLight record emergence speed for a minimum of 10 observations per species or species group for a total of 50 observations.

In reply, FirstLight states that there is uncertainty about how effective this sort of data collection would be. FirstLight explains that there is little guidance in the literature on how to evaluate emergence speed and provide robust and representative data, adequately address potential confounding factors, and reduce observer bias. FirstLight states that this type of data collection is a time-intensive process that relies on seeing larvae as they exit the water (noting that many emerge at night), and it may be challenging to get a large number of observations for a range of species, especially rare species.

[41] An exuvia is the shed exoskeleton of an insect.

Discussion and Staff Recommendation

The methods and data collection proposed by FirstLight are generally consistent with previous studies on riverine odonates in the Connecticut River;[42] however, there are no readily accepted methods specific to measuring larvae travel speed and eclosure time (section 5.9(b)(6)). This effort would require observing emerging larvae soon after they emerge from the water and tracking individuals through vegetation or substrate until eclosure is complete, without disturbing the larvae and thereby affecting their behavior. Considering the expected low numbers of some state-listed species and thus potentially infrequent observations of actively emerging larvae, establishing a specific number of observations is challenging. However, emergence time and speed are important factors to support an analysis of operational effects (section 5.9(b)(5)). Therefore, we recommend FirstLight record a minimum of 10 observations per species or species group, provided that 10 individuals from each group are encountered during the emergence surveys. We expect this level of effort is consistent with FirstLight's proposal and should not add to the study cost (section 5.9(b)(7)). We note that FirstLight should continue to consult with MADFW, as proposed, to refine emergence speed methodologies.

Quantitative Survey Effort

Applicant's Proposal

FirstLight proposes to conduct the quantitative odonate surveys (Task 4) at four study reaches with a minimum of six 2-meter-wide transects in each reach. Transects would run perpendicular from the river upslope for approximately 12 meters. FirstLight states that surveyors could add more transects depending on habitat variability and other factors. Surveys would occur every two weeks from mid-May through late August.

Comments

MADFW is concerned that FirstLight's proposed study would effectively survey only 48 linear meters (160 feet) of river and is unlikely to provide sufficient spatial

[42] Martin, K. 2010. The transition zone: impact of riverbanks on emergent dragonfly nymphs. Implications for riverbank restoration and management. Ph.D. Dissertation, Antioch College.

Morrison, F., D. McLain, and L. Sanders. 2006. A Survey of Dragonfly Emergence Patterns Based on Exuvia Counts and the Results of River Bottom Transects at Selected Sites in the Turners Falls Pool of the Connecticut River. Submitted to New England Environmental, Inc., Energy Capital Partners, The Massachusetts Environmental Trust, and Franklin Land Trust.

coverage of different habitat conditions, nor a sufficient number of data observations for each species (or species group) to enable a robust data analysis. MADFW notes FirstLight did not define thresholds for additional transect data collection and suggests that transects run parallel to the river (instead of perpendicular). MADFW recommends that FirstLight ensure that transects are of sufficient length[43] and width to enable a thorough spatial coverage of emergence habitats. In addition, MADFW requests FirstLight stratify sampling effort within known emergence habitats (e.g., gradually sloping mud banks, natural vegetation, riprap, etc.) and then ensure sufficient observations are collected within each emergence habitat type. MADFW also suggests that FirstLight conduct surveys once per week to increase emergence detection and reduce the potential to miss a mass emergence event due to water level fluctuations.

In its reply, FirstLight indicates that its study plan includes increased transect widths from one to two meters and reiterates that surveyors may add more transects depending on habitat variability within each reach, habitat preference of target species, and variability in the density and species composition of exuviae among transects (e.g., low density and high variability may require additional transects). FirstLight states that the Task 3 (*Qualitative Surveys for Larvae and Exuviae to Determine Species Presence*) results would help inform this decision, and the study plan may evolve further depending on preliminary Task 4 (*Quantitative Surveys of Emergence/Eclosure Behavior*) results. FirstLight explains that it does not seek to examine every combination of habitat conditions in the Connecticut River, but proposes to focus on preferred habitats of target species.

[43] MADFW requested transects run parallel to the river for a minimum of 50 meters in previous comments.

Discussion and Staff Recommendation

Based on our review of the literature,[44] potential low numbers of rare state-listed species and the variability in odonate occurrence, emergence times, and other environmental variables, we conclude that FirstLight's proposed methodology is not likely to collect adequate information to evaluate potential effects of water level fluctuations on odonates (sections 5.9(b)(5) and (7)). Specifically, differences in habitat use and low numbers of samples in a single habitat type could skew the results of this study (section 5.9(b)(6)). As such, an increase in survey area throughout a variety of habitat types would improve our ability to assess project effects on odonates. Stratifying survey area by habitat types appropriate for odonate emergence (natural vegetation, gradual sloping mud/sand banks, and rock substrate), as requested by MADFW, is a reasonable and cost-effective approach to improve data collection and would support a better analysis (section 5.9(b)(6) and (7)).

Therefore, we recommend that FirstLight stratify the survey effort for Task 4 – *Surveys of Emergence/Eclosure Behavior*, to a minimum of six 2-meter transects in each *available* habitat type (natural vegetation, gradual sloping mud/sand banks, and rock substrate) in each study reach. This would increase effort up to 18 transects per reach or a potential of 72 2-meter transects per survey date or approximately 475 feet of the river bank. FirstLight should use the results of the aquatic habitat mapping study to help identify habitat availability within the study reaches. We estimate this additional survey effort and assessment would increase study costs approximately $90,000 (section 5.9(b)(7)). As described in the study plan, FirstLight should continue to collect additional transects, if needed, based on variability observed in the field.

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[44] Morrison, F., Mclain, D., and Sanders, L. 2004. A Survey of Dragonfly Species Two Years after Bank Stabilization at the "Urgiel – Upstream" Site, Gill, Massachusetts. Unpublished report to New England Environmental.

Mclain, D., F. Morrison, and L. Sanders. 2006. Bank Stabilization and Dragonfly Emergence, Population Dynamics, and Larval Ecology in the Turners Falls Pool of the Connecticut River - 2005 Field Season. Unpublished report to Northeast Generation Services, The Massachusetts Environmental Trust Fund, & Franklin Land Trust.

Martin, K. 2008. Impact of bank stabilization technique, boat wake, water level rise, and predation on the mortality rate, and eclosure success of odonate nymphs in Gill, MA: Results of the 2008 field season. Unpublished report (New England Environmental, Inc.).

Martin, K. 2010. The transition zone: impact of riverbanks on emergent dragonfly nymphs. Implications for riverbank restoration and management. Ph.D. Dissertation, Antioch College.

We acknowledge that longer transects parallel to the river may increase detection of odonates and result in a more robust data set. Previous surveys on the Connecticut River typically utilized 100-foot-long parallel transects at each survey site.[45] However, Martin (2010) used perpendicular transects 5 feet (1.5 m) in width. We find there is no difference between parallel or perpendicular transects as long as the total area surveyed is sufficient to collect data needed for our environmental review. Per our recommendation above, FirstLight should cover an adequate area and collect enough data to analyze project effects on emergent odonates (section 5.9(b)(5)). Therefore, the increased effort and cost to quantitatively survey large lengths (e.g., 50m per transect) of the river bank along parallel transects, as requested by MADFW, is not justified (section 5.9(b)(7)).

We also acknowledge that an increase in survey frequency (once per week vs. every other week), as requested by MADFW, would increase the likelihood of capturing all target species as they emerge. However, considering the environmental constraints under which data collection would occur (surveys only conducted on warm sunny days, average flow, stable water levels, etc.) it is unlikely FirstLight would be able to survey once per week while achieving all of the proposed constraints (section 5.6(b)(6)). In addition, considering the increased level of effort due to our recommendation above, doubling the sampling frequency is not justified (section 5.9(b)(7)).

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[45] Morrison, F., Mclain, D., and Sanders, L. 2004. A Survey of Dragonfly Species Two Years after Bank Stabilization at the "Urgiel – Upstream" Site, Gill, Massachusetts. Unpublished report to New England Environmental.

Mclain, D., F. Morrison, and L. Sanders. 2006. Bank Stabilization and Dragonfly Emergence, Population Dynamics, and Larval Ecology in the Turners Falls Pool of the Connecticut River - 2005 Field Season. Unpublished report to Northeast Generation Services, The Massachusetts Environmental Trust Fund, & Franklin Land Trust.

Martin, K. 2008. Impact of bank stabilization technique, boat wake, water level rise, and predation on the mortality rate, and eclosure success of odonate nymphs in Gill, MA: Results of the 2008 field season. Unpublished report (New England Environmental, Inc.).

Martin, K. 2010. The transition zone: impact of riverbanks on emergent dragonfly nymphs. Implications for riverbank restoration and management. Ph.D. Dissertation, Antioch College.

Quantitative Survey Constraints

Applicant's Proposal

FirstLight proposes to coincide quantitative surveys with weather and flow conditions that are conducive to emergence (warm sunny days at average or below average flow) and proposes to avoid weekends when boat traffic and shoreline wave action might interfere with emergence. In consideration of the potential for heavy rain to dislodge and wash away exuviae, FirstLight would not conduct surveys within two days after heavy rainfall. Furthermore, *to the extent possible*, FirstLight would coordinate with upstream hydropower operations to achieve relatively stable water levels prior to and during odonate surveys.

Comments

MADFW asserts that water level stabilization is the most important factor with the potential to affect survey results. MADFW suggests that surveys occur no sooner than 24-48 hours after stabilization of water levels, and that FirstLight modify project operations to the greatest extent possible to stabilize water levels for odonate surveys. MADFW is concerned that without stabilization of water levels (e.g., no peaking during a sufficient time window prior to field work), collected data would be highly biased toward individuals and species that travel far or fast enough to escape project effects; individuals that do not travel fast enough would be washed away by water level peaks and elude observation. In addition, MADFW acknowledges FirstLight's modification to delay surveys 48 hours after a significant rain event but requests a clear threshold regarding what constitutes a "significant rain event" to reasonably ensure that the threshold would not bias survey results.

Discussion and Staff Recommendation

We acknowledge that peaking operations and precipitation events may influence survey results by washing away exuviae from the river bank. As for a precipitation event, we note that identifying a specific threshold of rainfall is not practical because it depends on the duration and intensity of the event as well as the resistance of exuviae or substrate to mobilize and wash into the river (section 5.9(b)(6)). It is, however, appropriate for FirstLight to monitor local precipitation data and make a reasonable judgment as to whether or not the precipitation event would influence potential surveys and include any precipitation data and a justification for conducting or not conducting a survey after a precipitation event in the Initial Study Report. This would provide us with a means to ensure data is adequate for our analysis of project effects (section 5.9(b)(5)).

In regards to peaking operations, FirstLight proposes to maintain relatively stable water levels by coordinating with upstream hydropower projects, but it does not

explicitly state it would modify its own project operations, such as suspending peaking cycles, in order to stabilize water levels for 24-48 hours prior to odonate surveys. Peaking operations potentially wash away exuviae or tenerals that occur within the zone of operation, especially within the zone that project operation inundates and exposes frequently. Information regarding typical impoundment elevations and peaking operations are available in the PAD. Upon review of the PAD, we note that FirstLight typically maintains the Turners Falls reservoir between 180 and 184 feet mean sea level (msl) under most conditions (naturally routed flows of 30,000 cfs or less) and both projects typically operate as peaking facilities during the summer months with peaks in the morning and late afternoon. While FirstLight is licensed to operate at a maximum reservoir fluctuation of 9 feet, typical daily fluctuations are on the order of 1-4 feet (see chart on page 3-236 of the study plan) with a target elevation of 181.3 feet.

Considering actual operational patterns and the current proposal to coordinate with upstream hydropower operations to the extent possible, the surveys should occur under relatively stable conditions and produce reliable data to inform our environmental analysis (section 5.9(b)(5)). As such, we believe FirstLight's proposal is consistent with MADFW's request; thus, no additional project manipulation or commitment to suspend peaking operations is needed. We note that FirstLight should record and report information on reach-specific water levels during and prior to the surveys (see recommendation in *Water Level Fluctuation Analysis* below). This data, in combination with the survey information, should be adequate to describe water level conditions that may affect emergent odonates during the study and ensure reliability of the data set (section 5.9(b)(5)). We do, however, recommend FirstLight also provide precipitation data in the Initial Study Report including any justification for conducting or not conducting odonate surveys due to precipitation events. We estimate the cost to include precipitation data to be less than $1,000 (section 5.9(b)(7)).

Water Level Fluctuation Analysis

Applicant's Proposal

As part of Task 4, Quantitative Surveys of Emergence/Eclosure Behavior, FirstLight proposes to use water level data to identify the zones along each transect that have low, moderate, or high inundation frequency. Odonate survey data would include larval emergence speed, exuviae distance and height traveled from the water surface, water level, and time of day during each survey. Then, FirstLight proposes to compare the abundance, density, and species composition of emerged odonates along a gradient of inundation frequency provided by the hydraulic model (study 3.2.2). FirstLight also proposes to qualitatively describe boat wakes during the odonate surveys.

Comments

The Watershed Council expresses concern that water level logger deployment in study 3.2.2 would occur from August to November 2013, outside of this study window.[46] The Watershed Council finds it unclear whether or not the water level analysis would identify the rate of water level elevation change along the banks during this study. To sufficiently characterize water level fluctuations in relation to odonate emergence, the Watershed Council suggests FirstLight deploy water level loggers for more than one season and include the odonate study period.

The Watershed Council also recommends that Task 5 (Water Fluctuation Impact Assessment) or 6 (Report) should reference the boat wake assessment from study 3.1.2 - *Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability* to examine impacts of boat wakes in this study.

Discussion and Staff Recommendation

The Watershed Council assumes that FirstLight would use water level data from study 3.3.2 to characterize water level fluctuations in relation to odonate emergence. However, FirstLight's proposal indicates that it would collect water level data as part of this study. While FirstLight states that it would collect water level data, it does not specifically indicate how it would collect these data.

Water level data is needed to standardize field measurements (e.g., distance or height of exuvia from the water surface) at the time of the survey to determine the position of emergent odonates on the river bank because water levels may fluctuate during or between surveys. Deployment of four water level loggers (one per survey reach) would provide the data needed to standardize measurements and adequately evaluate odonate emergence success and potential project effects (section 5.9(b)(5) and (7)). Furthermore, if these water level loggers have the capability to record temperature, FirstLight would have data to evaluate emergence timing and temperature in relation to seasonal change and project operation.

Therefore, we recommend FirstLight deploy a water level logger (with the capability to record temperature) set to record data at 15-minute intervals, at each of the quantitative survey locations to accurately evaluate water levels, standardize field measurements, and describe temperature in relation to odonate emergence behavior. FirstLight should deploy all loggers at least two weeks prior to the initial odonate survey and retrieve loggers in order to characterize water level conditions for odonates before,

[46] In our September 13, 2013 determination for study 3.2.2, we require FirstLight to collect water level data during the months of April through November to capture seasonal variation in flows and ensure accuracy of the hydraulic model.

during, and after the emergence period. All loggers should reference a common vertical datum to ensure accuracy and utility of the data. We estimate the cost of this additional survey effort and assessment to be $5,000.

The Watershed Council also suggests that FirstLight use the boat wake assessment from study 3.1.2 to determine possible impacts from water level fluctuations exacerbated by boat wakes. We note that boat wakes can affect odonate emergence as indicated by past studies.[47] In this study, FirstLight proposes to qualitatively assess boat activity during odonate surveys, but it does not propose to use the more-detailed quantitative data measuring the frequency, amplitude, and speed of boat waves as described in study 3.1.2 as a part of this study. While FirstLight's proposed qualitative assessment of boat activity during the odonate surveys would support an evaluation of project effects at the time and location of the surveys, it would not help evaluate the impacts of boat traffic in other areas throughout the entire emergence period (section 5.9(b)(5) and (6)).

As such, we recommend FirstLight use the quantitative data collected under study 3.1.2, such as frequency, amplitude, and speed of boat wakes when evaluating effects on odonate emergence. We estimate that the cost of including this data in the odonate analysis would be approximately $2,000.

Study 3.3.11 - Fish Assemblage Assessment

Operations of the Turners Falls Project and Northfield Mountain Project have the potential to directly affect fish populations and habitat quantity and quality. FirstLight's study goal is to gather baseline information pertaining to the fish assemblage structure within the project area. Specific objectives would include:

- Document species occurrence, distribution, and relative abundance of resident and diadromous fish within the project area along spatial and temporal gradients.

[47] Morrison, F., Mclain, D., and Sanders, L. 2004. A Survey of Dragonfly Species Two Years after Bank Stabilization at the "Urgiel – Upstream" Site, Gill, Massachusetts. Unpublished report to New England Environmental.

Martin, K. 2008. Impact of bank stabilization technique, boat wake, water level rise, and predation on the mortality rate, and eclosure success of odonate nymphs in Gill, MA: Results of the 2008 field season. Unpublished report (New England Environmental, Inc.).

Martin, K. 2010. The transition zone: impact of riverbanks on emergent dragonfly nymphs. Implications for riverbank restoration and management. Ph.D. Dissertation, Antioch College.

- Describe the distribution of resident and diadromous fish species within reaches of the river and in relationship to habitat.

- Compare historical records of fish species occurrence in the project area to results of this study.

Sampling Design

Applicant's Proposal

FirstLight proposes a sampling a design utilizing mesohabitat-based strata that would include a minimum of 18 randomly located sampling stations within each strata.

Comments

The Nature Conservancy recommends that FirstLight consider additional replication within a sampling station.

Discussion and Staff Recommendation

We note that the proposed study is not designed to analyze the differences/similarities in the fish assemblage among stations within a single sampling stratum, but rather to allow for the analysis of differences/similarities among mesohabitat strata and sampling seasons within the study area. Therefore, replicates within a sampling station are not necessary (section 5.9(b)(6)) and we do not recommend it. The study, as proposed, will satisfy the study objective and produce results with an associated level of statistical uncertainty that would allow for the critical evaluation of the study.

Mussel Host Fish Evaluation

Applicant's Proposal

FirstLight does not propose to evaluate mussel larvae on host fish as a part of this study.

Comments

MADFW requests laboratory-based glochidial assessments to determine suitable host fish species of state-listed mussel species, with particular emphasis on two species the yellow lampmussel and the eastern pondmussel.[48] MADFW states this information

[48] Glochidia are the microscopic larvae of mussels. Glochidia typically attach to the gills of certain fish species (hosts) during the mussel's early life stages. A glochidial

would ensure appropriate assessment of fish passage and habitat persistence for all key host fish species. MADFW asserts that without a firm understanding of key host fish species, the design of any potential fish passage devices based on target fish swimming speeds, approach velocities, and attraction flows would be difficult. Furthermore, MADFW asserts that instream habitat alterations may affect host fish presence in reaches both above and below the project and any associated loss in host abundance would result in mussel population declines.

FirstLight does not propose to evaluate mussel larvae on host fish, stating the relationships are well understood and the results of this study would provide data on the distribution and relative abundance of potential host fish species.

Discussion and Staff Recommendation

We note at least two studies have previously evaluated host fish species for the yellow lampmussel; FirstLight listed the host fish species from these studies in its study plan (Table 3.3.11-1).[49] The fish host for the eastern pondmussel is unknown. However, this mussel species does not occur in the project area based on recent surveys conducted in support of this project.[50] Most importantly, MADFW does not explain how passage at Turners Falls Dam for a potential unknown host fish of the eastern pondmussel would mitigate for any potential project effect and, therefore, has not adequately established a nexus between potential project effects and the resource to be studied (section

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assessment would require a laboratory environment to determine which species of fish each mussel species utilizes as a host.

[49] Kneeland, S. C., Rhymer, J. M., Mar. 2008. Determination of fish host use by wild populations of rare freshwater mussels using a molecular identification key to identify glochidia. Journal of the North American Benthological Society 27 (1), 150–160.

Wick, P.C. 2006. Fish hosts and demographics of *Lampsilis cariosa* and *Leptodea ochracea*, two threatened freshwater mussels in Maine. MS Thesis. University of Maine, Orono, Maine.

[50] Biodrawversity, (2012). Freshwater Mussel Survey in the Connecticut River for the Turners Falls and Northfield Mountain Hydroelectric Projects. Amherst, MA: Author. Biodrawversity and The Louis Berger Group, Inc. (LBG). (2012). Freshwater mussel survey in the Connecticut River for the Vernon, Bellows Falls, and Wilder Hydroelectric Projects. Prepared for TransCanada Hydro Northeast Inc.

5.9(b)(5)).[51] Further, it is not clear why passage for a potential host fish species is needed to enhance state-listed mussel populations as there is no evidence to suggest passage of a resident species upstream or downstream of the Dam would result in increased mussel population (section 5.9(b)(4)). Therefore, we do not recommend laboratory-based glochidial assessments to determine suitable host fish species of state-listed mussel species.

FirstLight's Proposed Amendment to the Revised Study 3.3.11

In its comments dated July 15 on proposed Study Plan 3.3.11, NMFS recommended a modification of the study to eliminate the potential for effects on shortnose sturgeon. Specifically, NMFS recommended that: (1) no electrofishing occur in the reach of the Connecticut River below the Deerfield River; and (2) a seasonal restriction be placed on sampling in the Turners Falls bypassed reach to ensure that no electrofishing is carried out when shortnose sturgeon may be present (April 15 – June 30).

While NMFS did not provide any additional comments on FirstLight's revised study plan for Study 3.3.11, FirstLight now proposes additional modifications to the study plan to avoid potential impacts to shortnose sturgeon.[52] Specifically, FirstLight now proposes to amend the revised study plan to omit all field sampling efforts in the Connecticut River downstream of the Deerfield River confluence and to rely on existing fish assemblage data for this reach.

FirstLight notes that in 2009, an electrofishing survey of the area below Turners Falls dam downstream to the Route 116 Bridge was conducted as part of a larger Environmental Protection Agency (EPA) effort, and that sampling occurred at three 1-km stations in the bypassed reach and eight 1-km stations between the bypassed reach and the Route 116 Bridge in Sunderland (Figure 1). As such, FirstLight proposes to utilize these data, coupled with the field data FirstLight will obtain in the Turners Falls reservoir, to evaluate species composition and relative abundance downstream of the Deerfield River confluence with the Connecticut River.

In response to FirstLight's amendment to the study plan, the FWS filed a letter on February 12, 2014, noting that it had not been consulted on the proposed study plan amendment. FWS notes that FirstLight would likely implement the proposed study

[51] except for possibly one location in the lower Holyoke impoundment noted in Study 3.3.16, *Habitat Assessments, Surveys, and Modeling of Suitable Habitat for State-Listed Mussel Species in the CT River Below Cabot Station.*

[52] Letter filed by FirstLight with the Secretary of the Commission on January 28, 2014 (Accession No. 20140128-5102).

during the 2015 field season; and, therefore, the FWS requests an opportunity to consult during the 2014 field season on alternative study plan modifications to avoid potential effects on shortnose sturgeon.

Discussion and Staff Recommendation

The revised study plan, as proposed may result in effects on shortnose sturgeon. FirstLight's proposal to amend the revised study plan would eliminate this concern. However, we recognize that the resource management agencies with jurisdictional responsibilities have not had an opportunity to consult with FirstLight or comment on the proposed amendment to this study. As a result, we recommend that FirstLight consult with the NMFS, FWS, MADFW, and Commission staff on an amendment to the revised study plan that would seek to avoid all effects to shortnose sturgeon and provide sufficient information needed by the jurisdictional agencies and the Commission for their needs. Following consultation, FirstLight should file with the Commission for approval, an amended study plan for study 3.3.11 when it files its Initial Study Report in September 2014. The amended study plan should document FirstLight's consultation efforts, consider comments received, and if recommendations are not adopted, provide FirstLight's reasons based on project-specific information. We estimate the cost of this recommendation to be between $5,000 and $10,000, depending on the extent of the consultation process (section 5.9(b)(7)).

Study 3.3.13 - Impacts of the Turners Falls Project and Northfield Mountain Project on Littoral Zone Fish Habitat and Spawning Habitat

Project operations and associated water level changes potentially impact fish spawning success and spawning habitat quality and quantity, including habitat dewatering, nest/egg exposure, and/or nest abandonment. Therefore, FirstLight proposes to determine if project operations impact littoral fish species and their habitat. The study would assess the timing and location of fish spawning in the littoral zone; delineate, qualitatively describe, and map shallow-water habitat types subject to inundation and exposure due to project operations; and evaluate potential impacts of impoundment fluctuation on nest abandonment, spawning fish displacement, and egg dewatering.

Egg Traps

Applicant's Proposal

FirstLight proposes to utilize existing literature to determine typical spawning periods and preferred habitat of target species followed by field surveys to visually identify any fish nests, egg masses/deposits, and/or spawning activity.

Comments

In order to assist in the identification of spawning habitat for white sucker, walleye, and other riverine broadcast-spawning fish species, Vermont Agency of Natural Resources (VANR) requests that FirstLight deploy egg traps in some of the lower tributaries with suitable spawning habitat influenced by project operations.

Discussion and Staff Recommendation

FirstLight does not propose to supplement visual field surveys with egg trapping efforts for white sucker and walleye. Identification of walleye and white sucker spawning habitat is needed to evaluate potential effects of water level fluctuations on spawning habitat (section 5.9(b)(5)). However, the use of egg traps as suggested by VANR, are not necessary to identify suitable spawning habitat. Egg traps are typically deployed to document spawning activity in habitats previously surveyed and identified as suitable spawning habitat; thus, egg traps would not help identify addiotnal spawning habitat beyond the visual survey (section 5.9(b)(7)).

We note that lack of egg detection using egg traps does not necessarily correlate to a lack of potential spawning habitat or indicate potential project effects on that habitat. We acknowledge egg traps could verify the use of identified spawning habitat and the timing of spawning, but FirstLight's literature review and subsequent visual surveys should provide adequate information on timing and location of spawning to assess potential effects of project operations on littoral zone spawning habitat (section 5.9(b)(6)). As such, the additional cost of deploying, monitoring, and processing egg trap data is not warranted (section 5.9(b)(7)). Therefore, we do not recommend FirstLight deploy egg traps to identify spawning habitat.

Water Quality and Water Levels

Applicant's Proposal

FirstLight proposes to collect data on fish species, spawning habitat and nest depths, temperature, water clarity (secchi disk), and several descriptors of habitat type. FirstLight would also collect descriptive information including sediment/grain sizes associated with nests, embeddedness, approximate diameter of identified nests, presence of fish at nests, presence of aquatic vegetation, nest abandonment, and sedimentation of eggs/nests.

Comments

In addition to the parameters proposed by FirstLight, VANR requests that FirstLight collect water quality data (DO, pH, and conductivity), along with deployment

of additional water level loggers to facilitate an effects analysis of project operations on target species.

Discussion and Staff Recommendation

Water quality data such as temperature are important considerations in this study as spawning activity varies by species-specific temperature thresholds. However, it is unclear how DO, pH, or conductivity would inform study results and VANR does not indicate why this data is needed to meet the study goals and objectives (section 5.9(b)(7)).

VANR also suggests FirstLight deploy water level loggers to facilitate an evaluation of project effects on target species. Water level fluctuations due to project operations may dewater fish nests/egg masses or cause spawners to abandon nests (section 5.9(b)(5)). While FirstLight proposes to measure the depth of fish nests during its survey efforts, given the allowed fluctuation of the Turners Falls reservoir of up to 9-feet in elevation, a measurement of depth at the time of the survey is immaterial unless that depth is correlated to reservoir elevation (section 5.9(b)(6)). Therefore, it is appropriate for FirstLight to record the nest depths as proposed but to also document the reservoirs elevation in proximity to the survey/ nest location at the time of the survey and correlate the depth measurements to reservoir water level data. Once FirstLight depth measurements are correlated to the reservoirs elevation, the HEC-RAS model (described in study 3.2.2) would be a useful analysis tool, capable of delineating water surface elevation in relation to project operation and identifying potential effects of water level fluctuation on fish spawning habitat, nest abandonment, spawning fish displacement, and egg dewatering (section 5.9(b)(6)).

Therefore, we recommend FirstLight deploy water level loggers, set to record at 15-minute intervals, and correlate observed field measurements such as depth of fish nests, egg masses, and suitable habitat to reservoir elevations. During the 2015 study season, FirstLight should deploy water level loggers at the same locations utilized during the 2014 field season for study 3.2.2 to capture the entire spawning and egg development period of target fish species. We estimate the cost of additional water level loggers and standardization of field measurements to be $10,000 (section 5.9(b)(7)).

Study 3.3.14 - Aquatic Habitat Mapping of Turners Falls Impoundment

The Turners Falls and Northfield Mountain project operations result in water level fluctuations that may affect littoral zone species and their habitat. Therefore, FirstLight proposes to characterize and map aquatic mesohabitat distribution within the Turners Falls impoundment and identify any potential effects of operations on this habitat. FirstLight indicates that the data generated by this study would help provide a framework for data analysis efforts relative to operations and impoundment modeling.

Use of Side-Scan Sonar

Applicant's Proposal

FirstLight proposes to conduct a field survey that would focus on the zone of reservoir fluctuation (i.e., 176 to 185 feet above mean sea level) and shallower areas (1 foot deep) at low-pond elevation. Surveys would characterize mesohabitat including substrate type, cover, and depth. Visual surveys would identify substrate in shallow areas and use of an underwater camera, ponar dredge, or sediment probe would determine substrate composition in deeper water.

Comments

The Vermont Agency of Natural Resources (VANR) requests a side-scan sonar system, validated by ponar dredge samples or sediment probes; to collect habitat data because it is concerned that turbidity in the lower river may hamper FirstLight's proposed visual assessments including use of the underwater camera.

Discussion and Staff Recommendation

The use of specialized technology such as VANR's suggested side-scan sonar may be valuable in deep-water habitat not otherwise easily evaluated, or where the geographic scope of the survey area is so vast (such as marine environments) that the technology becomes an affordable and more efficient tool. However, in this case, this technology is not necessary to characterize shallow littoral zone habitat that is directly visible or easily described using underwater cameras in combination with ponar dredge samples or sediment probes to confirm observations. The habitat mapping techniques proposed by FirstLight utilizes widely accepted methods within the scientific community for littoral zone aquatic habitat mapping (section 5.9(b)(6)) and would provide the data needed to complete our environmental review and inform the license conditions (sections 5.9(b)(5) and (7)). As such, the additional cost of implementing a side-scan sonar survey is not warranted (section 5.9(b)(7)) and we do not recommend it.

Sediment Grain Size Analysis

Applicant's Proposal

FirstLight proposes to visually characterize substrate size and relative composition using six categories including silt/clay, sand, gravel, cobble, boulder, and bedrock under a common classification scheme based on Wolman (1954).[53] In deeper water, FirstLight proposes to use an underwater camera, ponar dredge, or sediment probe to assist with substrate classification. [54]

Comments

In order to quantify the composition of substrates collected from the ponar grab samples, VANR requests a laboratory analysis of grain size percent composition by weight using the modified Wentworth scale[55]. VANR asserts this would provide additional information without much additional effort.

Discussion and Staff Recommendation

VANR suggests that FirstLight use a finer scale sediment classification system than proposed. The Wentworth scale classifies substrate from clay (< 3.9 µm) to boulders (> 256 mm) using 16 different size categories. We note that the Wolman (1954) methodology can incorporate the modified Wentworth scale to define particle size. FirstLight simply proposes to use only six categories of particle size typically used during visual surveys so that surveyors can more easily classify substrate to describe benthic habitat (section 5.9(b)(6)).

VANR does not explain how a greater resolution of substrate particle size composition from ponar grab samples would improve benthic habitat characterization or assist with an evaluation of project effects (section 5.9(b)(5) and (7)). Typically, a detailed laboratory analysis of substrate size is used to describe sediment composition in small, well-defined areas and not to characterize habitat over large river segments such as FirstLight's study area (section 5.9(b)(6)). As such, a greater resolution of particle size

[53] Wolman, M.G., 1954. A method of sampling coarse river-bed material. Transactions of American Geophysical Union 35.

[54] A ponar sampler is a small clamshell dredge used to sample sediment in aquatic ecosystems.

[55] The Wentworth scale is a common sediment classification system based on particle diameter.

via laboratory analysis is not needed to meet the goals and objectives of this study or to inform our analysis of potential project effects (section 5.9(b)(5) and (7)) and we do not recommend it.

Study 3.3.15 – Assessment of Adult Sea Lamprey Spawning within the Turners Falls Project and Northfield Mountain Project Areas.

Operation of the Turners Falls and Northfield Mountain projects may affect sea lamprey spawning behavior, habitat, and spawning success. Therefore, FirstLight proposes to identify sea lamprey spawning sites and evaluate the effects of project-related water level and flow changes on spawning habitat, behavior, redd condition, and spawning success.

Radio Tagging below the Turners Falls Project

Applicant's Proposal

FirstLight proposes to release a total of 40 radio-tagged lamprey and track these fish to their spawning habitat. FirstLight would release 20 lamprey near the Route 116 bridge approximately 16 miles downstream of the Turners Falls Project and an additional 20 lamprey upstream of the Turners Falls Gatehouse into the reservoir.

Comments

NMFS, MADFW, and Donald Pugh suggest that FirstLight's proposed number of radio-tagged lamprey is inadequate. The commenters believe that some lamprey released at the Route 116 bridge would migrate out of the project area or upstream of Turners Falls dam and would not be useful to identify downstream spawning habitat. The commenters request FirstLight increase the sample size of radio-tagged lamprey. MADFW and Donald Pugh specifically request FirstLight release a total of 50 radio-tagged lamprey.

Discussion and Staff Recommendation

We note that a previous lamprey tracking study between Holyoke dam and the Turners Falls Project used a total of 45 tagged lamprey.[56] However, with our recommendation below in *Spawning Habitat Surveys*, FirstLight would rely on telemetry data as well as routine surveys of suitable spawning habitat to identify active spawning

[56] Massachusetts Cooperative Fishery Research Unit. 1986. Movement of sea run lampreys, *Petromyzon marinus*, during the spawning migration in the Connecticut River. Fishery Bulletin: Vol 84 No 3.

sites. With this combination of habitat surveys and its proposed telemetry tracking, FirstLight should be able to adequately identify suitable lamprey habitat and known spawning areas within the project area with a sample size of 20 tagged lamprey(section 5.9(b)(6)). Therefore, the cost of additional tagging is not justified (section 5.9(b)(7)).

Spawning Habitat Surveys

Applicant's Proposal

Once the radio-tagged lamprey are detected at the spawning sites, FirstLight would survey the adjacent habitat and monitor the area every 3-4 days to evaluate project effects.

Comments

The FWS, MADFW, and Donald Pugh express concern about the lack of habitat-based surveys to locate lamprey spawning sites.

The FWS suggests that a lamprey spawning assessment that relies solely on tagging and tracking of lamprey to identify spawning sites is flawed because lamprey may migrate out of the project-affected area and/or may not select currently known spawning habitat. In order to adequately identify and describe spawning sites throughout the project-affected area, FWS requests FirstLight include the habitat survey described in an earlier draft of its' study plan.[57]

MADFW and Donald Pugh note that over 50% of the lamprey passed at the Holyoke project also passed the Gatehouse fishway at the Turners Falls Project. The commenters suggest if a similar trend would occur during this study, approximately 10 lamprey would be available to locate spawning habitat downstream of the Turners Falls Project. To address this concern, the commenters request that FirstLight survey all potential spawning locations, map all suitable spawning habitat, and identify whether or not spawning/redd construction occurs at each site between the Turners Falls Project and the downstream Route 116 bridge.

Discussion and Staff Recommendation

FirstLight's proposal would likely identify some spawning areas by tracking radio-tagged lamprey to their spawning sites. However, by relying solely on tracking efforts,

[57] FirstLight originally proposed a habitat-based survey in the study plan but replaced these methods with the current proposal (radio-telemetry and tracking to identify spawning habitat).

FirstLight's study would be limited by the migration pattern and spawning site selection of only 40 individual lamprey. As noted by FWS, tagged lamprey may not spawn within the project-affected area or they may not migrate to confirmed spawning sites or suitable habitat known from previous observations. A habitat survey which focuses on potentially suitable spawning habitat and confirmed spawning sites from Vernon Dam to the Route 116 bridge is a more appropriate method that would ensure adequate data collection for our analysis of project effects (section 5.9(b)(5) and (6)).

Therefore, instead of limiting the survey to locations where tagged fish are observed, we recommend FirstLight include habitat-based surveys to locate all areas of suitable spawning habitat with a focus on the areas described in its' study plan.[58] FirstLight should utilize the applicable methodology described in Task 1 and Task 2 of its study plan to describe, map, monitor, and evaluate all suitable and actively utilized spawning habitats in the project-affected area. We estimate the cost of this modification to be approximately $35,000 (section 5.9(b)(7)).

Egg Surveys and Redd Caps

Applicant's Proposal

FirstLight proposes to monitor suitable spawning habitat every 3 to 4 days and record a variety of data including water quality, velocity, embeddedness, depth, structural observations of redds (e.g., scour, sedimentation), and notes on spawning behavior over a range of project operation. FirstLight would also cap a subset of redds and count emerging larvae.[59] FirstLight would compare all data to project operations to describe project-related effects on spawning habitat and spawning success.

Comments

NMFS, MADFW, and Donald Pugh suggest that FirstLight's proposal does not adequately evaluate sea lamprey spawning success. Specifically, the commenters assert that FirstLight only defines spawning success as the condition of redds before and after a peaking cycle and successful emergence of larvae from capped redds. The commenters also question the use of redd caps, indicating this method may bias study results. To address these concerns, the commenters request that FirstLight determine the

[58] FirstLight provides a comprehensive list of potentially suitable spawning areas under the Project Nexus section of the study plan on page 3-293.

[59] Redd capping is a technique wherein a fine-mesh net or other such device is placed around a redd, in order to trap emerging fry for measurement.

presence/absence of eggs in a subset of lamprey redds as an additional measure of spawning success.

Discussion and Staff Recommendation

FirstLight's proposed redd capping would evaluate successful construction and maintenance of redds, egg deposition, egg development, and successful emergence of larvae.[60] In addition, an inspection of the condition of redds should indicate whether or not redds are affected by project operations. Results of the redd surveys and redd capping would provide the same data, and some additional data, than provided by egg surveys. Therefore, it is unclear how a separate effort for egg collection would contribute to our analysis of project effects (section 5.9(b)(7)).

As for potential bias of redd caps, MADFW and Donald Pugh indicate that caps may mitigate the effects of water level fluctuation, and NMFS suggests the caps may collect fine sediment and hamper subsequent larvae counts. If redd capping mitigates the effect of water level fluctuations (e.g., retains moisture during exposure, dampens high flow velocity), FirstLight may observe this during routine monitoring. Additionally, its' proposed hydraulic model (discussed below), would identify habitat/redds that are subject to dewatering and water level fluctuations. Furthermore, we note that FirstLight proposes to utilize a generally accepted method within the scientific community for its redd capping surveys (section 5.9(b)(6)).[61] Therefore we find it unlikely that sedimentation of capped redds would be problematic. However, if sedimentation does occur due to redd caps, FirstLight should note this during routine monitoring. Based on our review of the proposed methodology, redd capping should support an evaluation of spawning success and provide adequate data for our environmental analysis and collection of eggs as an added measure of spawning success is unnecessary (section 5.9(b)(5)).

Surveys and the Range of Potential Effects

Applicant's Proposal

[60] Although FirstLight indicates that it adopted an egg survey in their response to comments in section 3.9 of its study plan, it only includes a proposal for redd capping in the text of the study plan.

[61] Fox, M., J.C. Graham and S. Frank. 2010. Determining Adult Pacific Lamprey Abundance and Spawning Habitat in the lower Deschutes River sub-basin, Oregon. Department of Natural Resources Confederated Tribes of Warm Springs Reservation, OR.

FirstLight proposes to closely monitor 25 lamprey redds over a range of project operation and record changes in water velocity, depth, water temperature, sediment, overall redd condition, and exposure/dewatering of the redd. FirstLight would then classify redds into categories describing the degree of project effect on redd condition and/or spawning behavior.

Comments

NMFS, MADFW, and Donald Pugh suggest that redd abandonment is a possible effect of project operation and request that FirstLight monitor redds while flows are increasing as well as decreasing to observe potential redd abandonment. In addition, the commenters request that FirstLight compare redd observations between high-impact areas and low-impact areas to determine if the degree of impact varies by location.[62]

Discussion and Staff Recommendation

Although FirstLight does not explicitly state it would monitor redd abandonment, it would monitor spawning behavior under various project operations to describe any potential effects of project operation on spawning success and classify effects into one of four categories. We agree that project operation may result in redd abandonment and expect that FirstLight record this observation according to their current proposal to classify effects on spawning behavior (section 5.9(b)(5)).

As for comparisons between high- and low-impact areas, the project effects may differ depending on proximity to project discharge points or other factors. FirstLight does not indicate specifically where it would focus its detailed monitoring efforts for the 25 redds. We expect that it may locate suitable habitat and redds in "high impact" and "low impact" areas in order to describe a range of project effects, but the large survey area coupled with detailed monitoring of only 25 redds may limit the effects analysis to the areas FirstLight chooses to monitor. Therefore, to supplement the analysis, we recommend FirstLight not limit its detailed monitoring to only 25 redds, but utilize all survey data, including the location and depth of suitable habitat and redds, for comparison with results of the hydraulic model in study 3.2.2. FirstLight should then determine if spawning areas/redds are subject to dewatering and describe the degree of project-related water level fluctuation at each spawning site.

[62] A high-impact area would be an area where water level fluctuation is greatest due to peaking operation, such as immediately below Cabot Station. A low-impact area would be an area where water level fluctuation is relatively small such as the river segment near the Route 116 bridge.

FirstLight should utilize the hydraulic model to assist with the evaluation of project effects for several other studies so the additional cost of utilizing the model in this analysis should be minimal (section 5.9(b)(7)).

Study 3.3.16 - Habitat Assessment, Surveys, and Modeling of Suitable Habitat for State-listed Mussel Species in the CT River below Cabot Station

The timing, rate, and magnitude of releases from the Turners Falls Project may adversely affect state-listed mussel populations[63] although the degree of these effects is unknown. Therefore, FirstLight proposes to conduct mussel surveys, characterize mussel habitat in the study area, and develop HSI criteria to aid the evaluation of project effects on state-listed mussel species and their habitat.

Study Data Consistency

Applicant's Proposal

FirstLight proposes to survey the area from Cabot Station to the Route 116 bridge in Sunderland, MA (part of reach 3 and all of reach 4)[64] for state-listed mussels and suitable habitat. In reach 5, FirstLight indicates that existing survey information collected by Holyoke Gas and Electric is sufficient to support the development of HSI criteria. Then, FirstLight would use the data collected in this study and existing information from Holyoke and other sources, to assist the development of HSI criteria and evaluate the effects of peaking operations as described in study 3.3.1 - *Conduct Instream Flow Habitat Assessments in the Bypass Reach and below Cabot Station*.

Comments

MADFW suggests the mussel survey methodologies utilized by Holyoke Gas and Electric for the Holyoke Project (FERC Project No. 2004) may not be consistent with the methodologies proposed in this study and asserts that data collected for the Holyoke Project would not be sufficient to meet its requirements for this study. Instead, MADFW requests that FirstLight only use the data collected for the mussel assessment outlined in

[63] Massachusetts state-listed mussels that potentially occur include Yellow lampmussel (*Lampsilis cariosa*), eastern pondmussel (*Ligumia nasuta*) and dwarf wedgemussel (*Alasmidonta heterodon*).

[64] Reach numbers correspond to the descriptions provided in study 3.3.1. Reach 3 extends from Rawson Island to the USGS gage at Montague, which includes the Cabot Station tailrace. Reach 4 extends from the USGS gage at Montague downstream to the Route 116 bridge and reach 5 is downstream of the 116 bridge to a natural hydraulic control at Dinosaur Footprints Reservation.

study 3.3.1 pursuant to the approved methodologies under this study. MADFW suggests this would ensure adequate data collection to describe the distribution and habitat of state-listed mussels in reach 5.

Discussion and Staff Recommendation

As indicated by FirstLight, information on mussels from Sunderland, MA downstream to Holyoke dam and reaches 1-3 already exists (section 5.9(b)(4)).[65] This information includes survey data on mussel species, relative abundance, and habitat (depth, substrate, cover, and general water velocity conditions). Holyoke Gas and Electric has conducted mussel surveys in the Holyoke impoundment every four years with the most recent surveys in 2013 and 2009. While MADFW believes that these existing data would not meet its study needs, it does not specifically indicate why. Upon our review of MADFW's original study request, we find that the Holyoke data would meet MADFW's goals and objectives for the study.

MADFW also asserts that FirstLight should only use data collected under approved methodologies of this study for the mussel assessment in study 3.3.1. However, it did not raise any specific concern regarding the applicability, adequacy, or integrity of the existing information for reach 5 (section 5.9(b)(4)), nor has it justified the additional cost of implementing the proposed study in reach 5 where data currently exists (section 5.9(b)(7)).

We reviewed the existing 2009 mussel survey results for reach 5 and found the survey methodology is generally consistent with the proposed methods in this study. Therefore, data previously collected between Sunderland and the Holyoke dam for reach 5 should provide suitable information to meet the goals and objectives of this study and inform our environmental review (section 5.9(b)(4), (5), and (7)).

Mussel Tagging

Applicant's Proposal

FirstLight proposes to collect standard morphometric data (e.g., size, shell erosion) and site data (i.e., location, extent, elevation) in suitable mussel habitat from Cabot Station to the Route 116 bridge in Sunderland, MA. FirstLight would measure (in mm)

[65]Tighe and Bond. 2010. Holyoke Project FERC No. 2004 Rare Mussel Species Survey Report 2009. Prepared for Holyoke Gas & Electric Department, Holyoke, Massachusetts.

Biodrawversity. 2012. Freshwater Mussel Survey in the Connecticut River for the Turners Falls and Northfield Mountain Hydroelectric Projects. Amherst, MA.

all state-listed mussel species encountered and the first 50 individuals of common species, to enable assessment of size distribution and recruitment. FirstLight would express abundance of mussel species in terms of catch-per-unit-effort, such as number of mussels per hour of search.

Comments

In addition to FirstLight's proposal, MADFW requests FirstLight tag all state-listed mussels and the first 50 individuals of non-listed species for long-term monitoring and quantitative population estimates, stating that mussel tagging is essential for a mark-and-recapture assessment of population size and estimates of detection probability, thus adding quantitative rigor to FirstLight's proposed timed-search approach.

Discussion and Staff Recommendation

Typically, MADFW's requested mussel tagging is a technique applied when conducting long-term monitoring of mussel populations and is not necessary to characterize the distribution, abundance, demographics, or habitat use of mussels (section 5.9(b)(6)). We note that MADFW's own published guidelines for conducting mussel surveys for state-listed species does not describe mussel tagging or repeat surveys as part of its approved protocols.[66]

A mark-recapture survey could yield more rigorous estimates of population size. However, the level of effort and cost associated with tagging all state-listed species and the first 50 individuals of all common species then resurveying multiple times would significantly increase costs and would not provide information necessary for our environmental review of potential project effects on mussel species (section 5.9(b)(7)). FirstLight's proposal to characterize mussel abundance as catch-per-unit effort utilizes a widely accepted approach and would provide an estimate of relative abundance useful for our environmental analysis (section 5.9(b)(5) and (6)). As such, tagging mussel species and conducting the repeated surveys associated with a mark-and-recapture strategy to monitor mussel populations is not warranted and we do not recommend it.

HSI Criteria for all State-listed Mussels

Applicant's Proposal

FirstLight proposes to develop HSI criteria for all Massachusetts state-listed mussel species documented within the 35-mile reach between Cabot Station downstream

[66] MADFW. 2013. Endangered Species Survey Guidelines: Freshwater Mussels. Massachusetts Department of Fisheries and Wildlife, Natural Heritage and Endangered Species Program.

to Dinosaur Footprints Reservation.[67] FirstLight intends to utilize these criteria to assess potential effects of project operations on existing state-listed mussels and their habitats. FirstLight would use a mussel survey and other relevant survey data to determine which species are present and potentially affected by project operations.

Comments

MADFW requests FirstLight create data-driven HSI criteria for all three state-listed mussel species regardless of species presence as determined by the proposed survey. MADFW suggests past qualitative studies were not sufficient to determine species absence; therefore, an analysis of all three state-listed species is warranted. If FirstLight does not find state-listed mussels in sufficient abundance to develop HSI criteria, MADFW recommends supplementing the development process with additional data collected in adjacent sections of the Connecticut River or other sites in the Northeastern United States.

Discussion and Staff Recommendation

MADFW does not believe that HSI curves should be developed only for mussels discovered by FirstLight's proposed survey. We acknowledge that confirming species absence is likely impossible with a single survey, irrespective of methodology, but previous surveys conducted between Turners Falls dam and the Deerfield River were performed by an experienced mussel biologist, targeted probable mussel habitat, and covered a substantial area in reaches 1-3 (Turners Falls dam downstream to Deerfield River Confluence). Further, the survey efforts proposed in this study for reach 4 and ongoing surveys in reach 5 by Holyoke Gas & Electric (FERC Project No. 2004) provide an adequate assessment of mussel presence in the project area (section 5.9(b)(4)).

Similar to our discussion in study 3.3.1 under *Evaluation of all State-listed Mussels*, it is not appropriate to require FirstLight to develop HSI criteria for all state-listed mussel species regardless of occurrence because if mussels do not occur, it is unlikely that any subsequent effects analysis would inform license conditions. Without any valid occurrence data, development of HSI criteria for all species is not warranted at this time because there is no clear nexus to project operations (section 5.9(b)(5)).

[67]Dinosaur Footprints Reservation is an eight-acre park approximately 3 miles north of Holyoke, MA.

Quantitative Data Collection

Applicant's Proposal

FirstLight proposes to conduct a habitat assessment and survey for state-listed mussel species downstream of Cabot Station to the Route 116 bridge in Sunderland, MA. The study would identify and map potential habitat and provide a species list, species richness, relative abundance, and catch-per-unit effort. FirstLight would also collect information on depth, substrate, cover type, and benthic velocity for each individual state-listed species encountered to provide data for category I HSI criteria development.[68]

Comments

MADFW asserts that quantitative habitat measurements are necessary to develop HSI curves for state-listed mussel species in order to accurately assess the persistence of mussel populations and their habitat. Although FirstLight proposes to use the MADFW mussel habitat survey guide,[69] MADFW suggests the methods outlined therein are not adequate to develop HSI criteria. MADFW requests quantitative data collection using a "structured randomized approach in unsuitable habitat, unoccupied suitable habitat and occupied habitat…" to inform HSI criteria development.

Discussion and Staff Recommendation

MADFW does not specify a methodology that would satisfy its request for a structured, randomized approach. We interpret MADFW's request as data collection within an adequate number of randomized points in all three habitat types (i.e., unsuitable, unoccupied suitable, and occupied). As proposed, FirstLight would collect data to inform HSI criteria development at all occupied mussel habitat encountered during the survey, but would not collect data in unoccupied habitat.

Data collection in occupied habitat would be useful for HSI criteria development, but we question the need for data collection in unoccupied habitat. Typically, data-driven HSI criteria (category II) are developed by examining frequency distributions of microhabitat attributes (velocity, depth, etc.) measured at locations that are occupied by

[68] Category I HSI criteria are developed by a team of experts (Delphi team) using professional judgment and existing information.

[69] MADFW. 2013. Endangered Species Survey Guidelines: Freshwater Mussels. Massachusetts Department of Fisheries and Wildlife, Natural Heritage and Endangered Species Program.

the target species (section 5.9(b)(6)).[70] In order to produce data-driven HSI criteria, FirstLight needs a sufficient number of observations across a range of mussel density and habitat conditions. Collecting microhabitat attributes from unoccupied habitats would not inform the development of HSI criteria and would increase the cost of the study (sections 5.9(b)(6) and (7)). Therefore, the collection of quantitative data from unoccupied habitats is unnecessary.

Validation of Delphi-developed HSI Criteria

Applicant's Proposal

FirstLight proposes to develop quantitative binary HSI criteria for all state-listed mussel species documented in the 35-mile reach between Cabot Station and Dinosaur Footprints Reservation (upstream of the Holyoke dam) based on field data collected for this study, existing information on state-listed species in other locations, and expert opinion. A Delphi team would review and modify, if needed, the draft HSI criteria prior to a final review by all stakeholders.

Comments

MADFW expresses concern regarding development of HSI criteria using the Delphi method, asserting that habitat thresholds may be too broad, possibly resulting in overestimation of available mussel habitat in the Connecticut River. MADFW requests that FirstLight validate panel recommendations with additional data collection such as iterative measurements of velocity during or after a change in flow conditions at existing mussel beds. MADFW also requests to serve a key role in the selection of Delphi panel members.

Discussion and Staff Recommendation

When HSI criteria are not available for a species in an IFIM study, a panel of species experts may synthesize HSI criteria. This methodology is termed the Delphi

[70] Waddle, T.J., ed. 2001. PHABSIM for Windows: User's Manual and Exercises: Fort Collins, CO, U.S. Geological Survey, 288 p.

Layzer, J.B. and L.M. Madison. 1995. Microhabitat use by freshwater mussels and recommendations for determining their instream flow needs. Regul. Rivers: Res. Mgmt. 10:329-345.

technique[71] and is consistent with accepted scientific practice (section 5.9(b)(6)). This technique uses field data, information from published and gray literature, and expert opinion of experienced biologists. We note that a substantial amount of habitat suitability data for the target mussel species in this study already exists,[72] which should promote the development of sound HSI criteria in a cost-efficient manner (section 5.9(b)(7)). If the Delphi team identifies a need for supplemental validation efforts to develop HSI criteria, we note there is nothing in FirstLight's proposal that would preclude this effort. As such, we do not recommend FirstLight conduct additional data collection to validate HSI criteria at this time.

MADFW requests a key role in the selection of the expert Delphi panel. As the state agency responsible for the protection of state-listed species, MADFW's involvement in the selection of the Delphi panel is appropriate. We recommend that FirstLight consult with MADFW during the selection process to determine an appropriate panel of experts for this study. We estimate that this recommendation would not increase study cost as FirstLight's proposal already incorporates the consultation process (section 5.9)(b)(7)).

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[71] Crance, J.H. 1987. Guidelines for using the Delphi Technique to develop habitat suitability index curves. U.S. Fish and Wildlife Service. Biological Report. 82(10.134) . 21 pp.

[72] Biodrawversity and LBG (Biodrawversity and The Louis Berger Group, Inc.). 2012. Freshwater Mussel Survey in the Connecticut River for the Vernon, Bellows Falls, and Wilder Hydroelectric Projects. Prepared for TransCanada Hydro Northeast Inc.

Maloney, K.O., W.A. Lellis, R.M. Bennett, and T.J. Waddle. 2012. Habitat persistence for sedentary organisms in managed rivers: the case for the federally endangered dwarf wedgemussel (*Alasmidonta heterodon*) in the Delaware River. Freshwater Biology. 57:1315-1327.

Parasiewicz, P., Castelli, E., Rogers, J. N., & Plunkett, E. 2012. Multiplex modeling of physical habitat for endangered freshwater mussels. Ecological Modeling. 228:66.

Tighe and Bond. 2010. Holyoke Project FERC No. 2004 Rare Mussel Species Survey Report 2009. Prepared for Holyoke Gas & Electric Department, Holyoke, Massachusetts.

Study 3.3.17 - Assess the Impacts of Project Operations of the Turners Falls Project and Northfield Mountain Project on Tributary and Backwater Area Access and Habitat

Operation of the Turners Falls and Northfield Mountain projects may affect tributary/backwater access due to minimum pond or downstream minimum flow conditions. Therefore, FirstLight proposes to survey these tributary/backwater areas to identify potential barriers or constrictions to fish access, assess the adequacy of minimum flows downstream of Turners Falls dam, and evaluate the need for enhancement or mitigation measures.

Additional Water Quality and Level Loggers

Applicant's Proposal

FirstLight proposes to collect bathymetry and water quality (i.e., dissolved oxygen, temperature, turbidity, and pH) data of tributary mouths under full-pond or high-flow conditions. FirstLight would follow-up with habitat (e.g., substrate, depth, and velocity) surveys and collection of stream-bed profile and water quality data under low-pond or low-flow conditions. Each survey would photo-document and delineate tributary confluences and backwater areas with a sub-meter accuracy GPS unit. If low-water surveys identify potential barriers (depth less than one foot in tributary thalweg), FirstLight would then model hydraulic conditions over a range of operational water levels to evaluate changes in tributary access.

Comments

VANR requests FirstLight deploy water level loggers in tributary areas to collect a full year of hourly depth and temperature data to determine if water level fluctuations from project operations cause impediments to fish movement into and out of project-affected tributary areas, asserting these data would provide more conclusive results. VANR also requests *additional* water quality data collection (including temperature, dissolved oxygen, pH, turbidity, and conductivity) in areas where access is impeded.

The Watershed Council also suggests FirstLight deploy water level loggers in project-affected tributary areas to assist with visual observations of potential barriers or constrictions to fish access. The Watershed Council specifically recommends water level loggers for Fourmile Brook and Fall River and notes that Fall River typically provides the

only flow (except leakage) to the bypass channel unless Connecticut River flows exceed project capacity.[73]

Discussion and Staff Recommendation

FirstLight's proposal includes many of the water quality parameters requested by VANR, except for conductivity. VANR does not explain why the proposed water quality data collection is not adequate or how *additional* data collection including conductivity would better inform our environmental analysis (section 5.9(b)(5) and (7)). As for conductivity, we find there is no clear relationship between conductivity and fish access to tributaries; therefore, collecting conductivity data is not warranted (section 5.9(b)(6)) and we do not recommend it.

In regards to water level data, we expect FirstLight intends to use data from study 3.2.2 - *Hydraulic Study of Turners Falls Impoundment, Bypass Reach and below Cabot Station* and study 3.3.1 - *Conduct Instream Flow Habitat Assessments in the Bypass Reach and below Cabot Station* to provide water level information needed for this study. This water level data, in combination with bathymetric mapping in this study would be useful to model water level fluctuations in the mouths of tributaries, including Fourmile Brook and Fall River, if potential barriers are discovered during low-pond/low-flow surveys. Deployment of additional water level loggers may provide some additional data on potential barriers. However, it is unlikely that this data would contribute any new information collected during the proposed surveys because these surveys would capture the range of project operations with observations at both high- and low-water levels (section 5.9(b)(5) and (7)). Therefore, additional water level loggers are not needed to assess fish access to tributaries and we do not recommend them.

Study 3.3.18 - Impacts of the Turners Falls Canal Drawdown on Fish Migration and Aquatic Organisms

FirstLight annually dewaters the Turners Falls power canal for several consecutive days to allow for inspection and maintenance of the power canal and facilities. This annual dewatering has the potential to affect juvenile American shad and American eel migration and aquatic life inhabiting the canal because of desiccation, degraded water quality, and increased predation. Therefore, FirstLight proposes to conduct a survey of fish and other aquatic organisms (e.g., freshwater mussels and mudpuppies) during the

[73] We note that during certain times of the year, FirstLight does have a minimum flow requirement for the bypassed reach.

Fourmile Brook drains into Turners Falls reservoir upstream of the Northfield Mountain tailrace. Fall River joins the Connecticut River immediately downstream of Turners Falls dam.

2014 canal drawdown to document species presence, estimate relative densities, and determine status of juvenile sea lamprey (stranded, alive, dead). FirstLight would also measure water quality and map wetted areas. FirstLight states that the collected information would assist in the identification and evaluation of potential measures to reduce adverse effects.

Sampling frequency

Applicant's Proposal

FirstLight proposes to implement the proposed field survey methods one time and as soon as practicable after dewatering has been completed. These methods include making observations of aquatic organisms, mapping sufficiently wetted areas, and collect water quality data from the wetted areas. FirstLight proposes this single survey immediately after the canal drawdown to enable it to collect survey data prior to any significant avian predation effects that may bias the survey.

Comments

FWS, NMFS, Trout Unlimited, and Donald Pugh request multiple surveys of aquatic life and water quality during the canal drawdown to assess continued impacts. FWS and Donald Pugh request a minimum of three survey events (immediately after the drawdown is complete, in the middle of the drawdown period, and immediately prior to refilling the canal). NMFS requests sampling immediately following the drawdown with a second survey specifically to evaluate the fate of juvenile sea lamprey in exposed substrates. Trout Unlimited suggests monitoring pool size and water quality following at least two times following the initial drawdown survey and that one survey occur the last day prior to refilling the canal.

FirstLight does not propose multiple surveys and states that survey results would not yield useful information due to avian predation.

Discussion and Staff Recommendation

Historically, FirstLight has dewatered the power canal for several consecutive days on an annual basis to inspect and maintain the canal. The duration of the canal outage will effect aquatic organisms (i.e., the longer the outage, the greater the effect). As such, FirstLight's proposed single survey will not provide adequate data to assess the full extent of the drawdown effects on aquatic organisms, including loss due to predation and desiccation (section 5.9(b)(6) and (7)). Therefore, multiple surveys of the power canal during drawdown are necessary to fully understand the extent to which project operations effect aquatic resources and to inform the need for potential protection measures to protect aquatic organisms during the power canal outages (sections 5.9(b)(5)

and (6)). Repeating the survey prior to the canal's rewatering would provide information on the extent of the effects associated with duration of the drawdown period, including prolonged desiccation, predation, and poor water quality (section 5.9(b)(6)). This additional information could be provided with a single follow-up survey event conducted the day prior to the refilling of the canal and comparing the results of the two survey events, including the status of juvenile sea lamprey, as requested by NMFS. The effort and cost of conducting three surveys would not provide any significant additional information that would inform our environmental review (sections 5.9(b)(5) and (6)). Therefore, the cost associated with conducting more than two survey events is not warranted (section 5.9(b)(7)).

We recommend that FirstLight repeat the proposed survey detailed in Task 1 (Conduct Aquatic Organism Survey of Canal During 2014 Drawdown) the day prior to the canal rewatering, and include a comparison of the two survey results in the study report to provide data needed to conduct a thorough assessment of drawdown effects on aquatic organisms in the canal. We estimate the cost of this additional survey effort and assessment would increase the cost of the study by $45,000 (section 5.9(b)(7)).

Fish Rescue

Applicant's Proposal

FirstLight does not propose to rescue fish captured during the canal drawdown surveys.

Comments

Donald Pugh suggests that all live fish collected by electrofishing or seining should be rescued from the dewatered power canal and returned to the river.

Discussion and Staff Recommendation

Our recommended modification above, to repeat the canal drawdown surveys for fish and other aquatic organisms prior to the canal's rewatering is intended to provide information on the extent of the effects associated with duration of the drawdown period, including prolonged desiccation and predation of fish. Providing fish rescues as requested would remove fish from the study area and subsequently, bias the study's results (section 5.9(b)(6)). Therefore, we do not recommend the implementation of fish rescues after the first survey event. While a fish rescue could be provided after our recommended second survey without biasing study results, we note that the second survey event will occur immediately before the power canal would be returned to service. Therefore, the requested fish rescue after the second survey would provide little benefit. We note, however, that if study results indicate the need for measures to protect aquatic

organisms within the power canal during the canal's outage, the evaluation and consideration of fish rescue measures may be appropriate for our environmental review.

Water Quality

Applicant's Proposal

During its proposed canal drawdown surveys, FirstLight proposes to collect water quality data (temperature, dissolved oxygen, turbidity) in all remaining pools except for the zone 7 pool. Within the zone 7 pool, at a location selected in consultation with resource agencies, FirstLight proposes to continuously collect only water temperature data with a long-term temperature logger.

Comments

Trout Unlimited and Donald Pugh request that FirstLight measure dissolved oxygen in zone 7 (at the upper and lower ends) after the canal is initially drained, mid-way through the drawdown period, and at the end of the last day of the drawdown.

FirstLight states that zone 7 remains sufficiently wetted by leakage at the canal gatehouse and that this leakage, with its egress through the Keith Drainage Tunnel, appears to provide sufficient flow and depth to support aquatic species. FirstLight implies that the request for DO monitoring is outside the scope of the study stating, "This is a biological assessment of the power canal."

Discussion and Staff Recommendation

During the power canal's drawdown, dissolved oxygen concentrations within zone 7 may be affected by a number of variables including temperature and biological oxygen demand (section 5.9(b)(5)). FirstLight did not provide any information that would indicate if the rate and turnover of flow through the pool in zone 7 is sufficient to maintain adequate dissolved oxygen levels during the canal drawdown. Therefore, to understand the potential effects project operations may have on dissolved oxygen, it is appropriate to monitor dissolved oxygen in within the zone 7 pool (section 5.9(b)(6)) during the canal drawdown. As such, we recommend that FirstLight consult with FWS, NMFS, and MADFW on two appropriate locations for measuring dissolved oxygen within the zone 7 pool. Dissolved oxygen measurements at these locations should be conducted in conjunction with each of the two canal drawdown surveys for aquatic organisms. For reasons discussed above, we do not recommend Trout Unlimited's or Donald Pugh's request for intermediate dissolved oxygen sampling during the duration of the canal's drawdown.

Study 3.3.19 – Evaluate the Use of an Ultrasound Array to Facilitate Upstream Movement to Turners Falls Dam by Avoiding Cabot Station Tailrace

Applicant's Proposal

The Cabot Station tailrace offers an area of false attraction to upstream migrating adult shad. As a result, FirstLight proposes a study to evaluate ultrasound to deter upstream migrating shad away from the Cabot Station tailrace and facilitate their continued migration up the bypassed reach to the Turners Falls dam and the Spillway fishway. FirstLight proposes to implement the study during the second field season and after the results of Study 3.3.2 - *Evaluate Upstream and Downstream Passage of Adult American Shad* are available for consideration.

Comments

Comments on this study were received from the FWS, Trout Unlimited, the Watershed Council, Karl Meyer, and Donald Pugh. Generally, these comments fell into three categories: (1) study seasons, with the commenters supporting the implementation of this study during both the first and second study seasons; (2) methods for deployment of the ultrasound array; and (3) methods for monitoring the array's effectiveness, including suggestions for hydroacoustic monitoring and video monitoring.

Discussion and Staff Recommendation

FirstLight would use information from study 3.3.2 to inform its decisions regarding this study. Some of the goals of study 3.3.2 are to evaluate: (1) shad migration delay at the Turners Falls project; (2) bypass flows that facilitate the upstream migration of shad to Turners Falls dam; and (3) effects of Station No 1 operations on upstream shad migrations in the bypassed reach. These evaluation data can be used to inform the methods and design of this study (e.g., ultrasound array design, layout, and placement; array testing at appropriate bypass flows) (section 5.9(b)(6)). Therefore, we conclude that the commenters' desire to implement study 3.3.19 concurrently with study 3.3.2 in the first field season would be premature (section 5.9(b)(6)).

We recommend that FirstLight evaluate the study 3.3.2 results, consider the recommendations from stakeholders noted above, and make any necessary modifications to its study 3.3.19 proposed methodology. FirstLight should file, for Commission approval, an amended study 3.3.19 with its updated study report in September 2015. The amended study 3.3.19 should address stakeholder comments and recommendations. If FirstLight does not adopt a recommendation, FirstLight should provide its reasoning based on project-specific circumstances (e.g., study 3.3.2 results).

II. Study Requested but not Adopted by FirstLight

In this section, we discuss our findings on the study requested by stakeholders that was not adopted by FirstLight. We base our findings on the study criteria outlined in the Commission's regulations [18 C.F.R. section 5.9(b)(1)-(7)].

Hydraulic Study of the Turners Falls Power Canal

Study Request

Project operations may affect flows, velocities, turbulence, and water levels within the Turners Falls power canal, which is used as the primary migratory route for upstream migrating shad. Karl Meyers requests a study of the hydraulic conditions within the Turners Falls power canal as it relates to shad migration.

Existing information on upstream shad passage through the power canal shows that of the shad that passed upstream of Cabot Station into the power canal, only a small percentage continue upstream and pass through the Gatehouse fishway, suggesting that conditions within the power canal may be resulting in barriers to migration and delay. The objective of the requested study is to develop an understanding of the flow and velocity characteristics within the power canal that may result in hydraulic barriers.

Discussion and Staff Recommendation

FirstLight proposes a series of hydraulic models in the Turners Falls power canal as part of Study 3.2.2 *Hydraulic Study of Turners Falls Impoundment, Bypass Reach and below Cabot Station* and Study 3.3.8 *Computational Fluid Dynamics Modeling in the Vicinity of the Fishway Entrances and Powerhouse Forebays*. However, these proposed hydraulic models focus locally on fishway entrances, powerhouse intakes, and hydraulic gates where hydraulic forces are complex and where flow velocities are high and may change significantly.[74] FirstLight explains that it does not propose comprehensive hydraulic study in the main canal due to the lack of water level fluctuation in the canal.

Existing information in the PAD shows that, of the shad passed upstream of Cabot Station into the power canal, only a small percentage of these fish continue upstream and pass through the Gatehouse fishway, suggesting that conditions within the power canal

[74] First Light will perform CFD studies at:(1) the power canal in front of the Station No. 1 powerhouse; (2) the Station No. 1 intake racks; (3) the power canal in front of the Cabot Station powerhouse; (4) the Cabot Station intake racks; (5) the Cabot fishway entrance; and (6) the Spillway fishway entrance.

may be a migration barrier[75]. FirstLight's proposed hydraulic modeling of the four distinct locations within the power canal would only target the forebays and intakes of the two powerhouses on the power canal and would not address these upstream shad passage concerns within the entire canal (section 5.9(b)(7)). However, it is unclear whether shad are encountering hydraulic barriers to passage or simply terminating their upstream migration to spawn within the canal itself

As discussed above in Study 3.3.2 - *Evaluate Upstream and Downstream Passage of Adult American Shad,* we recommend that FirstLight deploy an intensive array of radio telemetry receivers throughout the power canal and track upstream migrating shad through the power canal. Additionally, in Study 3.3.6 – *Impact of Project Operations on Shad Spawning, Spawning Habitat and Egg Deposition in the Area of the Northfield Mountain and Turners Falls Projects*, we recommend that FirstLight conduct shad spawning surveys in the power canal. Results from each of these studies may shed more light on shad migrating/spawning behavior within the power canal before FirstLight is required to conduct more extensive hydraulic studies. For example, telemetry data would provide information on the location of potential hydraulic barriers within the power canal (e.g., identifying where shad migrations stall) and spawning data from study 3.3.6 will assist in determining if shad migrations stall due to suitable spawning habitats.

While we do not recommend the requested study at this time, FirstLight should use the results from each of these studies to further inform the need for the requested hydraulic study of the Turners Falls power canal (section 5.9(b)(4)). If the results indicate that shad migrations within the power canal stall due to a hydraulic barrier(s), FirstLight should use study data to identify specific migration areas of concern and within the power canal to target these location(s) for further study. If necessary, FirstLight should then develop a study plan, in consultation with stakeholders, to conduct hydraulic modeling of the area(s) of concern to assess water level fluctuations, velocity distribution, and/or turbulence barriers at the location(s).

[75] See discussion on Study 3.3.2 Evaluate Upstream and Downstream Passage of Adult American Shad.

APPENDIX C

STUDIES AFFECTED BY THE CLOSURE OF VERMONT YANKEE AND ASSOCIATED STUDY SCHEDULE AMENDMENTS

Study	Study Amendment	Final Study Report Due
3.2.1 -- Water Quality Monitoring Study	Conduct Field Work Components in 2015	March 1, 2016
3.3.1 -- Conduct Instream Flow Habitat Assessments in the Bypass Reach and below Cabot Station	Initiate Study in 2014	March 1, 2016
3.3.2 -- Evaluate Upstream and Downstream Passage of Adult American Shad	Conduct Field Work Components in 2015	March 1, 2016
3.3.3 -- Evaluate Downstream Passage of Juvenile American Shad	Conduct Field Work Components in 2015	March 1, 2016
3.3.5 -- Evaluate Downstream Passage of American Eel	Initiate radio telemetry and hydroacoustics in 2015	March 1, 2017
3.3.6 -- Impact of Project Operation on Shad Spawning, Spawning Habitat and Egg Deposition in the Area of the Northfield Mountain and Turners Falls Projects	Conduct Field Work Components in 2015	March 1, 2016
3.3.7 -- Fish Entrainment and Turbine Passage Mortality Study	Initiate Study in 2015	March 1, 2016
3.3.10 -- Assess Operational Impacts on Emergence of State-Listed Odonates in the Connecticut River	Initiate Study in 2015	March 1, 2016
3.3.11 -- Fish Assemblage Assessment	Initiate Study in 2015	March 1, 2016

Project Numbers: P-2485-063, P-1889-081

Study	Study Amendment	Final Study Report Due
3.3.13 -- Impacts of the Turners Falls Project and Northfield Mountain Project on Littoral Zone Fish Habitat and Spawning Habitat	Conduct Field Work Components in 2015	March 1, 2016
3.3.15 -- Assessment of Adult Sea Lamprey Spawning within the Turners Falls Project and Northfield Mountain Project Areas	Initiate Study in 2015	March 1, 2016
3.3.19 -- Evaluate the Use of an Ultrasound Array to Facilitate Upstream Movement to Turners Falls Dam by Avoiding Cabot Station Tailrace	Conduct study in 2016	March 1, 2017

Project Numbers: P-2485-063, P-1889-081

APPENDIX D

RECOMMENDED LOCATIONS OF RADIO TELEMETRY RECEIVERS IN THE TURNERS FALLS POWER CANAL

Document Content(s)