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OFFICE OF ENERGY PROJECTS

Project No. 1889-085 – Massachusetts
Project No. 2485-071 – Massachusetts
FirstLight Hydro Generating Company

Douglas Bennett
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FirstLight Power Resources, Inc.
99 Millers Fall Road
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**Subject: Determination on Requests for Study Modifications – Turners Falls
Project and Northfield Mountain Pumped Storage Project, Study 3.3.3**

Dear Mr. Bennett:

Pursuant to 18 C.F.R. § 5.15 of the Commission's regulations, this letter contains the determination on requests for modifications to the approved study plan for the relicensing of FirstLight Hydro Generating Company's (FirstLight) Turners Falls Project No. 1889 and Northfield Mountain Pumped Storage Project No. 2485 (projects). The determination is based on the study criteria set forth in sections 5.9(b) and 5.15(d) of the Commission's regulations, applicable law, Commission policy and practice, and staff's review of the record of information.

Background

A study plan determination for the projects was issued on February 21, 2014, to address FirstLight's proposed aquatic studies, including study 3.3.3 (*Evaluate Downstream Passage of Juvenile American Shad*). FirstLight filed an interim study report for study 3.3.3 on October 14, 2016. As required in section 5.15 of the Commission's regulations, the study report describes FirstLight's progress in implementing the approved study plan, and an explanation of variances from the study plan. The report indicated that the radio-tagging and hydroacoustic components of the study did not provide sufficient information to satisfy the objectives of the study. FirstLight held study report meetings on October 31 and November 1, 2016, and filed meeting summaries on November 15, 2016.

Comments

Comments on the study report and meeting summaries, including requests for study modifications, were filed by the U.S. Fish and Wildlife Service (FWS), the National Marine Fisheries Service (NMFS), the Massachusetts Division of Fisheries and Wildlife (Massachusetts DFW), the Connecticut River Conservancy (CRC), and Karl Meyer. FWS, NMFS, Massachusetts DFW, and CRC requested that FirstLight repeat the radio-tagging component of the study; and FWS and NMFS requested that FirstLight repeat the hydroacoustic component of the study. FirstLight filed reply comments on January 17 and February 7, 2017.

Extension Request

In its February 7, 2017 reply comments, FirstLight stated that repeating the study would not produce reliable results or provide significant additional data to inform the development of license requirements. Rather than undertake the additional effort and cost associated with repeating study 3.3.3, FirstLight proposed to evaluate the need, cost, and feasibility of environmental measures related to downstream juvenile shad passage, in consultation with resource agencies. FirstLight stated that it would submit a report in July 2017 on the progress of its consultation with resource agencies, including whether an agreement could be reached on protection, mitigation, and enhancement measures. FirstLight requested that the Commission defer its decision on the need to repeat study 3.3.3 until after the progress report was submitted at the end of July 2017.

Commission staff issued a study modification determination on February 17, 2017, deferring the decision on study 3.3.3 until after July 2017. FirstLight filed a progress report on July 31, 2017 stating that it was continuing to meet with resource agencies and other interested stakeholders to discuss potential measures for downstream juvenile shad passage. FirstLight requested another extension until April 30, 2018, to allow additional time to further explore protection, mitigation, and enhancement measures with resource agencies. On August 17, 2017, Commission staff issued a letter granting FirstLight additional time to consult with resource agencies on protection, mitigation, and enhancement measures for downstream juvenile shad passage. Commission staff required FirstLight to file a progress report by February 28, 2018, and stated that a decision on the need to repeat all or parts of study 3.3.3 would be made after FirstLight filed the progress report.

On February 23, 2018, FirstLight filed the progress report stating that it was still consulting with resource agencies and other stakeholders on environmental measures related to downstream shad passage. FirstLight stated that it was planning to evaluate the feasibility of installing a barrier net near the tailrace of the Northfield Mountain Pumped Storage Project to test its feasibility for protecting juvenile shad and other aquatic species from becoming entrained at the project. FirstLight stated that it expects to complete a

final report on the barrier net feasibility test by March 1, 2019. FirstLight requested that the Commission delay action on the requested study modifications for study 3.3.3 until February 28, 2019 to allow additional time to test the feasibility of the barrier net. FirstLight stated that it intends to file an amended final license application for the projects by June 30, 2019. FirstLight filed correspondence from NMFS, FWS, Massachusetts DFW, and CRC indicating that they did not object to FirstLight's request for an extension of time.

On March 16, 2018, Commission staff issued a letter requesting additional information on the barrier net study, whether FirstLight was discussing any other downstream passage measures with resource agencies and other stakeholders, and reports from previously conducted studies. Commission staff stated that the additional information was needed to make a more informed decision on the latest request for an extension of time and that an additional one-year extension until February 28, 2019 could unreasonably delay the licensing process for the projects.

FirstLight responded to the Commission's information request on April 6, 2018, and provided additional information about the proposed barrier net feasibility test and the requested reports. FirstLight indicated that it is considering other options for protecting juvenile shad at the Turners Falls Project, including a plunge pool below one of the bascule spillway gates at Turners Falls Dam, and measures for screening juvenile shad that are migrating through the power canal.

Determination on Extension Request

Study 3.3.3 was required by Commission staff to determine the effect of the projects on juvenile shad outmigration. Stakeholders have raised issues with FirstLight's study and have requested study modifications.

FirstLight initially proposed an extension of time for staff to issue its determination on the study modification requests so that FirstLight could consult with resource agencies and attempt to reach agreement on environmental measures related to downstream juvenile shad passage. It has now been over a year since Commission staff initially deferred its decision on the study modification requests and FirstLight has not reached agreement on any environmental measures related to downstream juvenile shad passage, and there is no indication at this time that the consultation efforts are likely to resolve the underlying issues raised by the study modification requests. The modification requests are still pending at the Commission and must be addressed by Commission staff in accordance with section 5.15(c) of the Commission's regulations. Accordingly, there is no justification for further delaying staff's determination. Therefore, FirstLight's request for an additional one-year extension of the determination on the study modification requests for study 3.3.3 is denied.

Study Plan Determination

Pursuant to section 5.15(d) of the Commission's regulations, any proposal to modify a required study must be accompanied by a showing of good cause, and must include a demonstration that: (1) the approved study was not conducted as provided for in the approved study plan, or (2) the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.

As indicated in Appendix A, the requested modifications to study 3.3.3 are not approved. The bases for not modifying FirstLight's study plan are explained in Appendix B. Please note that nothing in this determination is intended, in any way, to limit any agency's proper exercise of its independent statutory authority to require additional studies. If you have any questions, please contact Bill Connelly at (202) 502-8587, or via e-mail at william.connelly@ferc.gov.

Sincerely,

Terry L. Turpin
Director
Office of Energy Projects

Enclosures: Appendix A – Summary of Determination on Requested Modifications to Approved Studies
Appendix B – Staff Recommendations on Requested Modifications to Approved Studies

APPENDIX A

SUMMARY OF DETERMINATION ON REQUESTED MODIFICATIONS TO APPROVED STUDIES

Study	Recommending Entity	Adopted	Adopted in part	Not Adopted
3.3.3 – Evaluate Downstream Passage of Juvenile American Shad	FWS, NMFS, Massachusetts DFW, CRC, Mr. Karl Meyer			X

APPENDIX B

STAFF RECOMMENDATIONS ON REQUESTED MODIFICATIONS TO APPROVED STUDIES

Study 3.3.3 – Evaluate Downstream Passage of Juvenile American Shad

Background

Relevant Project Facilities and Operation

Turners Falls Project

The Turners Falls Project No. 1889 (Turners Falls Project) and Northfield Mountain Pumped Storage Project No. 2485 (Northfield Mountain Project) (collectively, projects) are located on the Connecticut River in Franklin County, Massachusetts, Windham County, Vermont and Cheshire County, New Hampshire. The projects are located between the Vernon Hydroelectric Project No. 1904 (Vernon Project) and the Holyoke Hydroelectric Project No. 2004 (Holyoke Project), which are located approximately 20 miles upstream and 35 miles downstream of the Turners Falls Project, respectively.

The Turners Falls Project is a conventional hydroelectric project that operates in both peaking and run-of-river modes, depending on inflows. The project consists of two dams, the Montague dam that includes four bascule gates and the Gill dam that includes three tainter gates (collectively, the Turners Falls Dam). The Turners Falls Project impoundment also serves as the lower reservoir for the Northfield Mountain Project.

A gatehouse at the Turners Falls Project includes 15 gates that release water into a 2.1-mile-long power canal that includes two generating facilities: Station No. 1 and Cabot Station. There are also eight power canal spillway gates that are adjacent to Cabot Station and a log sluice gate in the Cabot Station forebay with a weir for downstream fish passage.

The Turners Falls Project includes three upstream fish passage facilities located at the Montague Dam, gatehouse, and Cabot Station.

Northfield Mountain Project

The Northfield Mountain Project is a pumped storage hydroelectric facility that generally operates in pumping mode during low-load periods and in generating mode during high-load periods. The project uses the Turners Falls impoundment and an upper reservoir on Northfield Mountain that is located to the east of the Connecticut River.

When operating at maximum pumping mode, the project's approximate hydraulic capacity is 15,200 cubic feet per second (cfs). When operating at maximum generation mode, the approximate hydraulic capacity is 20,000 cfs. The intake/tailrace of the Northfield Mountain Project is located approximately 5.2 miles upstream of Turners Falls Dam.

Study Goal and Objectives

The goal of study 3.3.3 was to determine if project operation affects juvenile American shad outmigration. The objectives of the study included: (1) assessing the effects of the projects on the timing, orientation, routes, migration rates, and survival of juvenile shad; (2) determining the proportion of juvenile shad that pass downstream through the power canal versus over the dam under varied operational conditions, including a range of spill conditions; (3) determining the rate of downstream movement through the project, including: (a) within the impoundment, (b) over the dam and through the bypassed reach, and (c) through the power canal; (4) determining survival rates for juveniles that are spilled over or sent through the dam gates under varied operation conditions, including up to full spill during the annual fall power canal outage period; (5) determining downstream passage timing, route selection, and rate of movement of juvenile shad through the Turners Falls Project's power canal to the Station No. 1 powerhouse, Cabot Station powerhouse, and the downstream fish bypass located near the Cabot Station powerhouse; (6) determining the rate of entrainment at the Northfield Mountain Project; (7) determining the survival rate for juvenile shad entrained at the Station No.1 powerhouse; and (8) determining the survival rates for juvenile shad entrained at the Cabot Station powerhouse.

Study Methods

FirstLight used radio telemetry to evaluate route selection, rate of movement, and escapement¹ during the annual power canal drawdown for emigrating juvenile shad, pursuant to study objectives 1, 2, 3, 5, and 6. FirstLight tagged 218 juvenile shad with radio tags and released them at three locations: (1) in the Turners Falls Project impoundment, 1.5 miles upstream of the Northfield Mountain Project's intake/tailrace;

¹ Escapement is not listed in the study objectives for study 3.3.3 and is not specifically defined in the study report. Staff interprets escapement in the context of the study to refer to the ability of juvenile shad to travel downstream through the power canal during drawdown or after the canal is refilled and successfully pass downstream into the tailrace. Staff assumes that this part of the study aligns most closely with objectives 1 and 5 to assess the effect of project operation on survival and route selection.

(2) in the Turners Falls Project impoundment, 1.25 miles upstream of Turners Falls Project Dam; and (3) in the power canal of the Turners Falls Project.

FirstLight used stationary radio antennas to monitor downstream movement rates and route selection from September 28 to December 4, 2015. FirstLight also tagged 50 juvenile shad with “mock tags” to serve as a control group.² To evaluate juvenile shad escapement during the annual power canal drawdown, FirstLight also released 17 radio-tagged juvenile shad into the power canal at the onset of canal dewatering and conducted a single mobile tracking survey the following day to monitor juvenile shad movement as the canal dewatered.

FirstLight installed hydroacoustic arrays at the Northfield Mountain Project intake/tailrace and the Turners Falls Project’s Cabot Station powerhouse to estimate entrainment rates for juvenile shad emigrants, pursuant to study objectives 1, 5, and 6. FirstLight also installed a hydroacoustic array in the power canal to document the timing, magnitude, and duration of the juvenile shad downstream migration period, pursuant to study objectives 1 and 5. FirstLight recorded data during the 2015 juvenile shad outmigration period, from August 1 to November 14, 2015.

To evaluate downstream passage survival and injury rates pursuant to study objectives 1, 4, 7, and 8, FirstLight tagged 662 juvenile shad with balloon tags and released them at three locations: (1) the turbine intake at the Turners Falls Project’s Cabot Station powerhouse; (2) the turbine intake at the Turners Falls Project’s Station No. 1 powerhouse; and (3) bascule spillway gates 1 and 4 at the Turners Falls Project Dam.³ After passage, live and dead shad were captured and the condition of each was examined and recorded.

² To quantify the effects of handling and tagging on fish used in radio telemetry studies, investigators typically tag the control fish with “dummy tags,” which have the same physical characteristics as the radio tags used in the study, and hold the control fish for the duration of the study. The mortality rate observed for the control fish represents the effects of handling and tagging and is used to adjust the observed survival rates of the radio-tagged fish. FirstLight tagged the control fish with tin weights (mock tags) rather than dummy tags. The weight and size of the mock tags were similar to the radio tags used in the study. FirstLight held the control group in a 90 gallon tank for seven days to monitor mortality and assess tag retention.

³ To quantify downstream passage survival and injury rates, fish can be tagged with balloon tags, which inflate after a pre-determined amount of time. Fish are released into the passage route (*e.g.*, turbine intake or downstream bypass). The balloon inflates after passage and allows the fish to be recovered and inspected for mortality and injuries.

Study Results

Radio-tagging Study

Out of the 218 juvenile shad that were released for the radio telemetry study, FirstLight detected 113 individuals migrating downstream at a rate of 0.31 river miles per hour (rm/h), as relevant to study objectives 1 and 3. FirstLight detected 18 juvenile shad that migrated out of the Turners Falls Project impoundment: two of them passed over the Turners Falls Dam and 16 passed from the impoundment to the power canal, as relevant to study objectives 1 and 2. Out of the two fish that passed over Turners Falls Dam, one individual continued through the bypassed reach at a rate of 1.45 rm/h, as relevant to study objective 1 and 3. For the 16 tagged shad that entered the power canal, 12 were never detected again and did not provide further information about rate of movement or route selection to downstream areas. The four remaining individuals exhibited a mean rate of movement of 0.03 rm/h through the power canal, as relevant to study objectives 1, 3, and 5.

Out of the 17 radio-tagged shad that were released into the power canal during the annual drawdown, 10 were not detected during the mobile tracking survey, 5 did not move from the release site, 1 was detected near the Cabot Station powerhouse, and 1 was detected near the Station No. 1 powerhouse. No route of passage out of the power canal could be confirmed for the two fish that were last detected near the powerhouses, as relevant to study objectives 1 and 5.

As part of the radio telemetry study, FirstLight observed an entrainment rate of 3.9 percent at the Northfield Mountain Project for one of the juvenile shad cohorts passing downstream through the impoundment based on detecting 3 radio-tagged shad in the upper reservoir out of 77 radio-tagged shad that were detected in the area. However, 14 fish were last detected in the Northfield Mountain Project tailrace when the project was operating in pump mode and may have been entrained.

During the radio telemetry study, 40 percent of the control fish lost their tags and 80 percent of the control fish died within 48 hours. According to FirstLight, the inherent problems of handling and tagging juvenile shad had a negative effect on the effectiveness of the study and its findings, and the results are likely inadequate to definitively determine route selection and travel times due to the effectively small sample size.⁴

⁴ While juvenile shad radio tag studies have been successfully completed at other projects (*e.g.*, the Vernon Project), juvenile shad are fragile and can experience high mortality rates from handling and tagging.

Hydroacoustic Study

The hydroacoustic array at Cabot Station documented that juvenile shad were present throughout the study period (August 1 to November 14, 2015), as relevant to study objectives 1 and 5. However, high levels of milling behavior by shad-sized targets in the Turners Falls Project power canal prevented FirstLight from estimating the timing and magnitude of juvenile shad outmigration with the hydroacoustic array that was located in the power canal.⁵ Similarly, FirstLight could not use the hydroacoustic data collected at the Northfield Mountain Project to estimate entrainment due to excessive milling observed in the data set, which is relevant to study objective 6.⁶

FirstLight estimated that 1.66 million shad-sized targets were entrained at Cabot Station during the study period. FirstLight observed that most of the entrainment occurred at Cabot Station units 1 and 6. FirstLight identified multiple daily and seasonal peaks in entrainment during the study period. A daily entrainment peak generally occurred around 8:00 PM, as relevant to study objective 5. Based on observations at the downstream fish bypass at Cabot Station, FirstLight estimated that an average of approximately 43 percent of juvenile shad exit the power canal via the downstream bypass at Cabot Station and 57 percent are subject to entrainment at Cabot Station, as relevant to study objective 5.

Balloon Tag Study

The downstream passage survival component of the study indicated that the 1-hour survival rate for juvenile shad was generally higher for fish passing downstream through the turbines at the Cabot Station and Station No. 1 powerhouses than over the bascule gates at the Turners Falls Dam, as relevant to study objectives 1, 4, 7, and 8. Specifically, survival rates were 95 percent at Cabot Station Unit 2; 76.6 percent at Station No. 1, Unit 1; 67.8 percent at Station No. 1, Units 2 and 3; 63 percent across a range of flows at Bascule Gate 1; and 64.8 percent across a range of flows at Bascule Gate 4. Injury rates were higher for fish passing over the bascule gates. Specifically,

⁵ Milling occurs when individuals are not moving in a uniform downstream direction, but are moving in multiple directions over time. FirstLight states that milling behavior reduces the ability of the split beam system to enumerate individual targets, as there are no means to account for targets moving in and out of the same beam or targets moving between beams (*i.e.*, targets are subject to being counted multiple times).

⁶ FirstLight also explained that the single beam transducers that were used for hydroacoustic sampling could only be mounted in front of the intake, a point at which fish were not obligated to pass due to low water velocities.

injury rates were 8.7 percent at Cabot Station, Unit 2; 20.6 percent at Station No. 1, Unit 1; 7.7 percent at Station No. 1, Units 2 and 3; 29.6 percent at Bascule Gate 1; and 44.3 percent across a range of flows at Bascule Gate 4. FirstLight concluded that the Francis turbine units at Station No. 1 had the smallest runner diameter and the highest rotation rates of the different turbines tested, which likely contributed to lower survival rates at Station No. 1. FirstLight also concluded that the boulder and concrete structures downstream of Bascule Gates 1 and 4 likely had the greatest detrimental effects on the passed juvenile American shad.

Requested Study Modifications

Radio-tagging Study

NMFS, FWS, Massachusetts DFW, and CRC state that the radio-tagging component of the study failed to meet the study objectives and request that FirstLight repeat the study. CRC states that the poor survival and swimming performance of the control fish suggests that the results from the radio-tagged fish may not be reliable. Massachusetts DFW states that accurate entrainment rates could not be estimated with the radio-tag data because a large percentage of the tagged fish were not detected after they were released into the impoundment. In addition, NMFS, FWS, Massachusetts DFW, and CRC state that the results of the radio-tagging study are insufficient for evaluating route selection (*i.e.*, study objectives 1, 2, and 5) because of the limited number of tagged fish that passed over the Turners Falls Dam and entered the power canal. Furthermore, FWS and Massachusetts DFW indicate that the results of the study are insufficient for evaluating the effects of different operational scenarios on route selection (*i.e.*, study objective 2) because of the limited number of tagged fish reaching the Turners Falls Project. NMFS states that the results of the study are insufficient for estimating the rate of movement in the canal (*i.e.*, study objectives 1, 3, and 5) because of the limited number of tagged fish entering the power canal. Lastly, FWS and Massachusetts DFW state that the survey conducted during the power canal drawdown was insufficient to adequately document juvenile shad movements and escapement during the annual drawdown (*i.e.*, study objectives 1 and 5).

Hydroacoustic Study

NMFS, FWS, Massachusetts DFW, and CRC state that the hydroacoustic component of the study failed to meet the study objectives (*i.e.*, objectives 1, 5, and 6), and FWS and NMFS request that FirstLight repeat the hydroacoustic component. Based on the milling behavior exhibited by juvenile shad in the power canal, FWS, Massachusetts DFW, and CRC state that the hydroacoustic array in the power canal did not provide sufficient information about the timing of the juvenile shad downstream migration, and Massachusetts DFW and FWS state that the power canal array did not

provide sufficient information on the duration and magnitude of the downstream migration (*i.e.*, study objectives 1 and 5). In addition, all four commenters state that the hydroacoustic array at the Northfield Mountain Project did not provide usable entrainment information (*i.e.*, study objective 6) because of the amount of milling detected in the project tailrace.

Additional Operational Scenarios

Mr. Karl Meyer states that Station No. 1 operated continuously from mid-July through mid-October in 2016 and requests that FirstLight evaluate the effects of this operational scenario should the study 3.3.3 be repeated.

Reply Comments on Requested Study Modifications

In its January 17, 2017 response to the requested study modifications, FirstLight states that repeating the hydroacoustic entrainment study at the Northfield Mountain Project is not feasible because safety concerns at the intake/tailrace prevent the installation of a hydroacoustic array at a suitable location for measuring juvenile shad entrainment rates. Instead of repeating the study, FirstLight suggests that data collected during an entrainment study that was conducted at the Northfield Mountain Project intake/tailrace in 1992 (LMS, 1993) would be suitable for evaluating juvenile shad entrainment at the project under current operating conditions.⁷ FirstLight states that the LMS (1993) entrainment estimate is likely conservative (*i.e.*, that more fish were entrained in 1992 than would be under current conditions) because a similar number of adult shad migrated upstream of the Turners Falls Project in 1992 and 2015,⁸ and because the Northfield Mountain Project operated in pumping mode more frequently in 1992.⁹

In a letter filed on January 27, 2017, FWS states that the LMS (1993) study was not sufficient for evaluating entrainment at the Northfield Mountain Project because: (1) the total pumping capacity of the project has increased from 12,000 cfs to 15,000 cfs since 1992; (2) thermal conditions in the Turners Falls Project impoundment have

⁷ The LMS (1993) entrainment study estimated entrainment rates at the Northfield Mountain Project from August 9 to October 27, 1992, as well as the total number of fish entrained during the study.

⁸ FirstLight indicates that a similar number of juveniles would be expected to spawn in each year based on the number of adults observed at the project.

⁹ FirstLight states that operating the Northfield Mountain Project in pump mode more frequently in 1992 would have entrained more juvenile shad than in 2015.

changed since the decommissioning of the Vermont Yankee nuclear power plant in December 2014; (3) juvenile shad were present at the beginning and end of the 1992 study, which means the study did not include the beginning and end of the downstream migration period; (4) the hydraulic capacity of the Vernon Project has increased from 11,000 cfs to 17,000 cfs; and (5) the Vernon Project has since implemented downstream passage measures, which could potentially increase the number of juvenile shad that survive downstream passage at Vernon and could be entrained by the Northfield Mountain Project. In a letter filed January 31, 2017, CRC agrees with FWS that the LMS (1993) study was insufficient for evaluating entrainment at the Northfield Mountain Project under current conditions.

In its February 7, 2017 response to FWS, FirstLight states that repeating the hydroacoustic portion of the study would not produce reliable results or provide significant additional data to inform the development of potential license requirements. FirstLight also states that repeating the radio-telemetry aspects of the study would not add significant information to the record to inform license requirements, and that the level of effort and cost of repeating study 3.3.3, in whole or in part, would be in the range of hundreds of thousands of dollars. Rather than undertake the additional effort and cost associated with repeating study 3.3.3, FirstLight proposes to evaluate the need, cost, and feasibility of measures related to downstream juvenile shad passage, in consultation with resource agencies. On August 17, 2017, Commission staff issued a letter granting FirstLight additional time to consult with the resource agencies on downstream passage measures.¹⁰ Then, on February 23, 2018 and April 6, 2018, FirstLight filed letters indicating that it is still consulting with resource agencies and other stakeholders on environmental measures related to downstream shad passage. FirstLight states that it is investigating the feasibility of installing a barrier net near the tailrace of the Northfield Mountain Project to protect juvenile shad and other aquatic species from becoming entrained at the project. FirstLight also indicates that it is considering potential measures to improve juvenile shad downstream passage at the Turners Falls Project, including installing a plunge pool below the Turners Falls Dam and using screens to protect juvenile shad that are migrating through the power canal.

¹⁰ A full account of FirstLight's extension request and Commission staff's letters granting the extension can be found in the cover letter of this study modification determination.

Discussion

Study modifications were requested for the radio-tagging and hydroacoustic components of the study, which were undertaken to meet study objectives 1, 2, 3, 5, and 6.¹¹ Four of the study objectives are related to: juvenile shad migration rates through the Turners Falls Project bypassed reach and power canal; downstream passage route selection at the Turners Falls Project; and the timing of juvenile shad downstream migration (*i.e.*, objectives 1, 2, 3, and 5). The other objective is related to entrainment at the Northfield Mountain Project (*i.e.*, objective 6).

To determine whether a showing of good cause has been made to support the requested study modifications, the following discussion evaluates FirstLight's study results and information from other studies to assess whether or not sufficient information is available for an analysis of the environmental effects of the projects on juvenile American shad downstream migration rates, route selection, timing, and entrainment into the Northfield Mountain Project.

Migration Rates

FirstLight conducted the radio-tagging study, in part, to quantify the rate of juvenile shad downstream migration through the project via a variety of project structures as relevant to study objectives 1, 3, and 5. The purpose of analyzing migration rates is to provide information for an analysis of the potential effects of the project on juvenile shad downstream migration, including whether the project delays downstream migration. Although the requested study modifications call into question the reliability of the information collected during the radio-tagging component of the study based on high mortality rates and tag loss in the control group and the small number of tagged fish that

¹¹ None of the study modification requests pertained to the balloon tag component of study 3.3.3, which analyzed the survival of juvenile shad passing downstream over the Turners Falls Dam and through the Turners Falls Project's turbines at Station No. 1 and Cabot Station, as relevant to study objectives 4, 7, and 8, respectively. Although FWS and Massachusetts DFW stated that the radio-tag survey conducted during the power canal drawdown was insufficient to adequately document escapement during the annual drawdown, the study report for study 3.3.18 (Impacts of the Turners Falls Canal Drawdown on Fish Migration and Aquatic Organisms) indicates that juvenile shad were among the fish that were stranded in the power canal following the annual dewatering event. From this information, it is evident that the annual drawdown affects the survival of juvenile shad in the power canal, which can be used by staff in its environmental analysis of project effects.

reached the Turners Falls Dam and power canal, there are some data available from the study that can be used to ascertain whether delay is occurring at the projects.

Data collected during the 2015 field season suggest that some delay occurs in the area of the Northfield Mountain Project intake/tailrace and the Turners Falls Project power canal. One potential indicator of delay is milling, which was observed by the hydroacoustic arrays deployed in the intake/tailrace area and power canal.¹² In addition, tagged fish released upstream of the Northfield Mountain Project had lower movement rates than fish released upstream of the Turners Falls Dam (0.27 rm/h versus 0.43 rm/h, respectively).¹³ Separately, the number of fish milling in the power canal tended to increase as the number of generating turbines increased (up to four turbines), and then declined slightly with five and six turbines generating.¹⁴ The information from the power canal hydroacoustic array is qualitatively consistent with the limited data provided by the four fish that FirstLight tracked in the power canal, which suggest a slower overall mean rate of movement in the power canal than in the Turners Falls impoundment (0.03 and 0.31 rm/h, respectively). This information is likely sufficient for an analysis of the project effect on juvenile shad downstream migration rates.

Route Selection

To address study objectives 1, 2, and 5, FirstLight conducted the radio tagging study to evaluate route selection at the Turners Falls Dam and in the Turners Falls Project power canal. As cited in the requested study modifications, the poor survival of the control fish and the small number of test fish that reached the dam and power canal limit the analysis of the effects of project operation on route selection. However, some data from the study and other sources can be used to evaluate route selection.

Data collected at Great River Hydro, LLC's Vernon Project, located 20 miles upstream of the Turners Falls Dam provides information on the likelihood of juvenile

¹² Fish migrating downstream typically travel in a relatively straight path. When migrating fish encounter an obstacle or cannot detect the necessary cues to continue downstream, their path becomes circuitous and convoluted as they search for a way to continue (Barry and Kynard, 1986; Venditti *et al.*, 2000; Adams *et al.*, 2001). This searching behavior is referred to as "milling."

¹³ See FirstLight's January 17, 2017 response to comments. FirstLight did not state how many fish were included in the calculation of the movement rate of each group.

¹⁴ See FirstLight's January 17, 2017 response to comments.

shad passing over the Turners Falls Dam versus through the power canal. In 2015, Great River Hydro, LLC released 310 radio-tagged juvenile shad upstream of the Vernon Project Dam. Route selection data is available for 170 of the individuals.¹⁵ Great River Hydro, LLC recorded discharge data for all available passage routes (*e.g.*, spillway, turbines, downstream passage facilities) at the time of passage for each tagged shad.¹⁶ Collectively, the operation and passage data suggest that the majority of the juvenile shad passed through the route with the greatest proportion of project discharge (Figures 1 and 2). The data from the Vernon Project is qualitatively consistent with the limited data provided by FirstLight's radio-tagging study at the Turners Falls Project. Specifically, 11 tagged shad reached the Turners Falls Project on October 12, 2015, and 10 passed into the power canal, which was passing approximately 60 to 68 percent of project discharge at the time of passage.¹⁷ Based on this information, it appears likely that juvenile shad route selection at the Turners Falls Project is predominantly influenced by the proportion of discharge through the available passage routes.

¹⁵ See Great River Hydro, LLC's January 17, 2017 revised report for study 22 (*Downstream Migration of Juvenile American Shad - Vernon*) in FERC Docket No. P-1904.

¹⁶ See Appendix I-3 of Great River Hydro, LLC's January 17, 2017 revised report for study 22.

¹⁷ See Figures 4.2.2-2 and 4.2.4-1 of the interim study report for study 3.3.3.

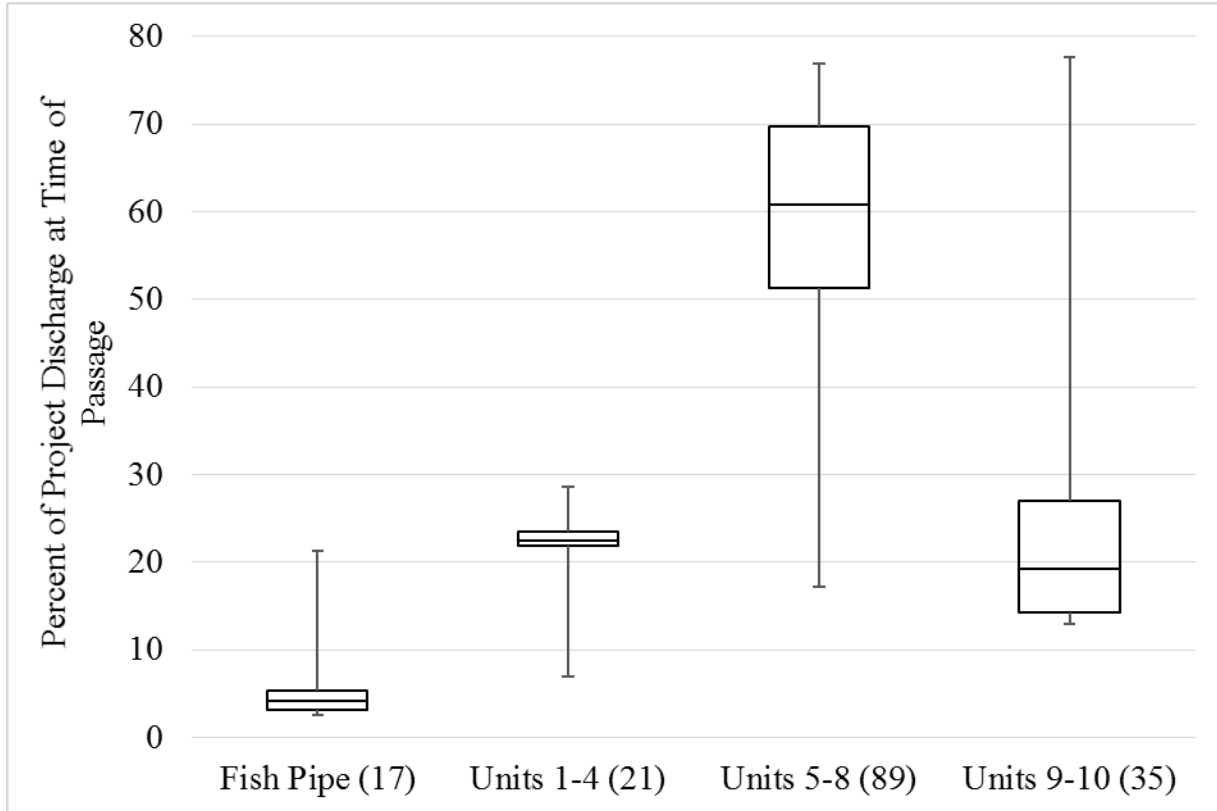


Figure 1. Boxplots showing the percent of project discharge through each of the passage routes at the Vernon Project at the time of juvenile shad passage through each route. The total number of fish that used each passage route is shown in parentheses in the labels on the x-axis. Data from the fish tube, log sluice, upstream fishway, and spillway are not shown because few fish used those routes. The whiskers show the range of the data, the box represents 75 percent of the data, and the line inside the box is the median. (Source: Staff analysis of Appendix I-3 of Great River Hydro’s January 17, 2017 revised report for study 22.)

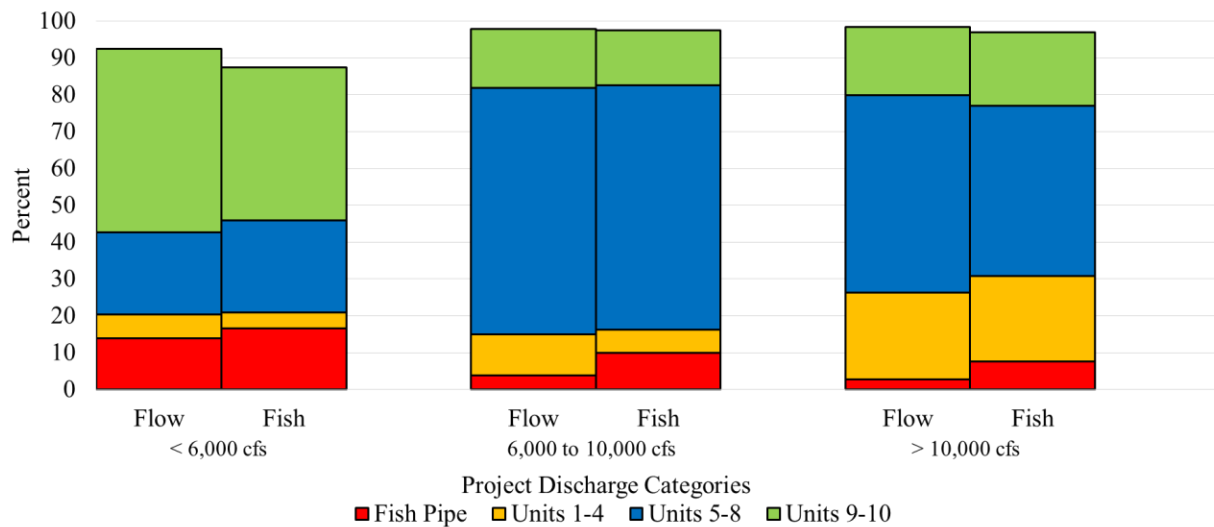


Figure 2. Bar chart displaying the percent discharge (“flow,” left column of each group) and the percent of fish (“fish,” right column of each group) that passed through each of the downstream passage routes when total project discharge was less than 6,000 cfs, 6,000 to 10,000 cfs, and greater than 10,000 cfs. The columns do not add up to 100 percent because four infrequently used routes are not shown (*i.e.*, the fish tube, log sluice, upstream fishway, and spillway). In addition, one fish was detected passing through units 1-4 and another through units 5-8 when these units were not operating; these fish were excluded from the analysis. (Source: Staff analysis of Appendix I-3 of Great River Hydro’s January 17, 2017 revised report for study 22.)

Timing, Duration, and Magnitude of Migration

FirstLight attempted to address, with a hydroacoustic study in the power canal, the aspects of study objectives 1 and 5 related to the timing, magnitude, and duration of the juvenile shad downstream migration period. Although the hydroacoustic array did not provide sufficient information for the analysis due to high levels of milling behavior by shad-sized targets in the Turners Falls Project power canal, some information about these migration characteristics is available from study 3.3.3 and other sources.

Juvenile shad were present during the entire hydroacoustic component of the study that ran from August 1 to November 14, 2015, which provides an estimate for the duration of the juvenile shad migration period. This time period is consistent with observations from studies of juvenile shad migration near the Holyoke Project that is located downstream of the projects on the Connecticut River. Savoy *et al.* (2004) stated the downstream migration in the Holyoke Project impoundment may begin as early as August and continue through November. Similarly, using juvenile shad hatch date estimates, O’Donnell and Letcher (2008) also suggested that downstream migration may

begin as early as August in the Holyoke and Turners Falls impoundments and continue into November.

Even though FirstLight could not use the power canal hydroacoustic array to estimate the number of juvenile shad migrating through the canal, FirstLight estimated that Cabot Station entrained approximately 1.66 million juvenile shad during the study period, which represents an estimate of the minimum number of juvenile shad migrating past the project.¹⁸

Lastly, the Cabot Station hydroacoustic array provided information about daily and seasonal peaks in the number of juvenile shad migrating through the canal, which could potentially be affected by project operation because generation, in part, determines the amount of flow through the power canal.

Collectively, this information is likely sufficient for an analysis of project effects on timing, duration, and magnitude of juvenile shad migration through the project.

Entrainment at the Northfield Mountain Project

To address study objective 6, FirstLight conducted the hydroacoustic study at the Northfield Mountain Project intake/tailrace to estimate entrainment rates of juvenile shad emigrants. However, the hydroacoustic data collected at the Northfield Mountain Project cannot be used to estimate entrainment due to the excessive milling observed in the data set. Accordingly, the following discussion assesses whether the LMS (1993) study suggested by FirstLight is sufficient to characterize entrainment at the intake/tailrace of the Northfield Mountain Project under existing environmental conditions.

LMS (1993) used a net located in the tailrace of the upper reservoir to estimate entrainment rates in terms of the number of fish entrained per hour of pumping and per cubic meter of water pumped from August 9 to October 27, 1992, as well as the total number of fish entrained during the study. LMS (1993) estimated that the project entrained 37,260 juvenile shad during the study.

While FWS suggests that changes to the environmental conditions at the projects since 1992 render the data from the LMS (1993) study obsolete, there is evidence that the data from the 1992 study are still relevant.

¹⁸ The Cabot Station powerhouse hydroacoustic array would not have counted juvenile shad passing through the Station No. 1 powerhouse, the Cabot Station log sluice, or the bypassed reach.

The operational data FirstLight provided in its January 17, 2017 letter indicates that the Northfield Mountain Project operated in pump mode more frequently in 1992 than in 2015 when the hydroacoustics study was conducted by FirstLight, which suggests that the LMS (1993) study may provide a more conservative estimate of entrainment that could be used as a “worst-case” scenario of the potential effects of the proposed project on juvenile shad entrainment. In addition, the results of study 3.3.9 (*Two-Dimensional Modeling of the Northfield Mountain Project Intake/Tailrace and Connecticut River Upstream and Downstream of the Intake/Tailrace*) provide intake velocity profiles within the Northfield Mountain Project tailrace that reflect the increased pumping capacity of the project since 1992 and can be compared to estimates of juvenile shad swimming speed to evaluate entrainment potential.

Although FWS is correct that the LMS (1993) study did not span the entire juvenile shad downstream migration period (i.e., early August to mid to late November), the August 9 through October 27, 1992 study period in the LMS (1993) study includes the majority of the juvenile shad downstream migration period, including periods of peak migration that can be used for an analysis of entrainment rates.

Regarding FWS’s concern about the number of juvenile shad available for entrainment in 1992 and 2015, data from the Connecticut Department of Energy and Environmental Protection’s (Connecticut DEEP) juvenile shad abundance index values for 1992 and 2015 indicates that abundance was relatively similar between the two study years (7.2 and 8.5, respectively) and is smaller than the differences observed between many consecutive years (e.g., 2010 and 2011; Figure 3).¹⁹ The similarity in abundance values between 1992 and 2015 suggest that the number of juvenile shad that could potentially be entrained at the Northfield Mountain Project was comparable in 1992 and 2015 despite the increases in capacity at the Vernon Project, the implementation of downstream passage measures at the Vernon Project, and the decommissioning of the Vermont Yankee nuclear power plant. Based on our assessment of the environmental conditions at the projects, the LMS (1993) study is likely sufficient for an analysis of the rate of juvenile shad entrainment at the Northfield Mountain Project during downstream migration.

¹⁹ The Connecticut DEEP Juvenile Alosine Seine Survey has collected data on the number of juvenile shad between Holyoke, Massachusetts and Essex, Connecticut since 1978. The index is a geometric mean of the number of juvenile shad collected at seven stations from July through October. While the survey stations are located downstream of the Turners Falls Project, the survey provides information about the production of juvenile shad in the Connecticut River and is used in stock assessments conducted by the Atlantic States Marine Fisheries Commission.

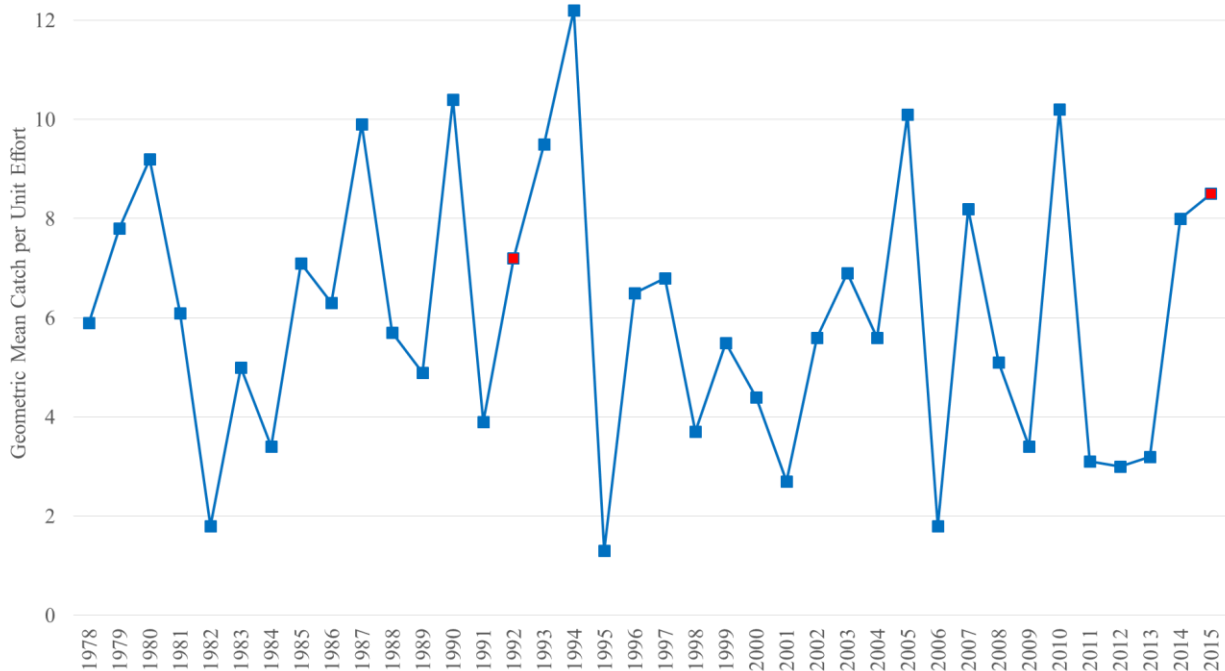


Figure 3. Connecticut DEEP Juvenile Alosine Seine Survey annual index of abundance for juvenile shad. The red dots indicate the index values for 1992 and 2015. (Source: Staff analysis of Appendix F of CRASC (2017).)

Staff Recommendation

The radio-tagging and hydroacoustic studies conducted as part of study 3.3.3 did not provide robust data for analyzing project effects on migration rates (as relevant to study objectives 1, 3, and 5), route selection (as relevant to study objectives 1, 2, and 5), the timing of juvenile shad downstream migration (as relevant to study objectives 1 and 5), and the entrainment rate at the Northfield Mountain Project intake/tailrace (as relevant to study objective 6). Nonetheless, information from study 3.3.3 and other data are likely sufficient for an analysis of the environmental effects of the project. Specifically, it is staff's assessment that: (1) the hydroacoustic study and the radio-tagging study are sufficient for an analysis of project effects on juvenile shad downstream migration rates; (2) data collected at the Vernon Project and information from the radio-tagging study are sufficient for an analysis of project effects on juvenile shad route selection; (3) data collected at the Holyoke Project and the Turners Falls Project, along with the hydroacoustic study are sufficient for an analysis of project effects on timing, duration, and magnitude of the juvenile shad migration through the project; and (4) the LMS (1993) study is sufficient for an analysis of the rate of juvenile shad entrainment at the Northfield Mountain Project during downstream migration.

Although repeating the hydroacoustic and radio-tagging components of study 3.3.3 could provide additional information that could improve these analyses, there is no certainty that additional studies would be any more successful than studies that have already been completed, given the project-specific conditions and species-specific issues involving radio-tagging juvenile shad. There is also no certainty that further study would provide greater insight into the effects of the project on juvenile shad outmigration success than what is already known from the studies discussed above. In addition, repeating the study would require substantial additional cost (*i.e.*, as much as \$400,000) and potentially delay the relicensing proceeding and implementation of protective measures at the Turners Falls Project and the Northfield Mountain Project. Based on the existing information related to project effects on downstream juvenile shad passage, we do not have good cause to approve the requested study modifications and do not recommend requiring FirstLight to repeat the hydroacoustic or radio-tagging components of study 3.3.3, either under the already-studied operational scenarios or under any additional operational scenarios.

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