April 13, 2018

VIA ELECTRONIC FILING

To: Stakeholders

Re: FirstLight Hydro Generating Company, Turners Falls Hydroelectric Project (FERC No. 1889) and Northfield Mountain Pumped Storage Project (FERC No. 2485).
Response to Comments re: Study 3.3.19-Continue to Evaluate the Use of an Ultrasound Array to Facilitate Upstream Movement to Turners Falls Dam by Avoiding Cabot Station Tailrace

Dear Stakeholders:

FirstLight appreciates the constructive comments received on Study 3.3.19-*Continue to Evaluate the Use of an Ultrasound Array to Facilitate Upstream Movement to Turners Falls Dam by Avoiding Cabot Station Tailrace Plan* (Attachment A- Study Plan). FirstLight has considered all the proposed modifications recommended in the comment letters received from U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), Connecticut River Conservancy (CRC), and Karl Meyer (Attachment B). Since the 2018 study is considered a Proof-of-Concept study, some of the recommendations will be incorporated into this year's study plan while others will be reconsidered during subsequent studies to fine-tune the system, if results are positive.

The goal of this study is to determine if an ultrasound barrier could be used to repel adult shad from the Cabot Station tailrace and facilitate upstream movement to the Spillway fishway at Turners Falls Dam. Testing in 2016 demonstrated that fish reacted to the sound within the first two hours of the ultrasound system being activated, However, further sound testing in the fall of 2017 indicated that signal strength of the sound system attenuated in the Cabot tailrace flow.

The proposed 2018 Proof-of-Concept study is based primarily on work conducted at Hydro Quebec's Rivière des Prairie Hydroelectric Facility to guide emigrating spent adult shad away from the intakes. We are proposing to move the ultrasound array outside the influence of the Cabot Station tailrace flows and make use of the same frequency, duration pulses, and transmission strength and time as the successful Hydro Quebec system.

Stakeholders proposed several additional data analysis methods to consider for the study. However, it is not our intent to model time-dependent effects for this proof-of-concept study. We will perform a competing risks analysis using Cox Proportional Hazards (CoxPH) regression to understand why tagged fish transition from one state to the next. For this study, those states are within the ensonified region and outside of the region. A series of simple, two state CoxPH models will assess movement within the Cabot Station tailrace and the bypass reach. Time-dependent covariates include the bypass flow (sum of Station No. 1 discharge, PaperLogic/Turners Falls Hydro (if operating) Spillway Ladder attraction/fishway flow, and spill over Turners Falls Dam), Cabot Station discharge (cfs), and diurnal (day/night) will be analyzed. If it is confirmed in 2018 that the ultrasound array is deterring shad from entering the Cabot fishway and they move up the bypass reach, we will consider the suggested analysis methods during subsequent years of testing and fine-tuning the system.

The DIDSON camera will be intermittently deployed at various depths from a boat to obtain a qualitative assessment as to how the shad behave as they approach the sound array. Stakeholders expressed a concern regarding the behavioral response that the shad and other fish will have to the 190 dB sound pressure (for the previous study the sound pressure was 160 dB). Deploying the DIDSON camera to observe the reaction of fish to the sound should provide insight to address this concern. Shad and Blueback Herring are the only two species in the vicinity of the project that would be able to detect/hear ultrasound, regardless of sound pressure level, so there will be no effect on any other migratory or resident species. The 190 dB sound pressure has been used successfully for several years at Hydro Quebec’s Rivière des Prairie Hydroelectric Facility with good results. Exposure to 190 dB sound pressure levels should not negatively impact shad physically. Previous research has demonstrated that behavioral reactions vary depending on the strength of the ultrasound signal. In general, sound pressure levels less than 160 dB may be ignored, whereas above this level directional avoidance will begin to occur with more predator avoidance behavior being exhibited as the pressure levels continue to increase (i.e., predator is getting closer and an attack may be imminent).

As described in detail in Appendix A of the study plan, previous shad telemetry studies have indicated that 80% of the early tagged shad released at Holyoke arrive at Cabot tailrace while less than half (35%) of those tagged later in the season arrive at Cabot tailrace. Since it is important to maximize the number of tagged shad arriving at Cabot tailrace to increase the power of the analysis, we plan to tag and release shad early in the season. Based on historic counts, we believe the tagged shad will arrive at Cabot tailrace by the end of May and propose to conclude testing at the end of May; however, if the shad migration season starts late, we will adjust the planned schedule. Considering stakeholder comments, we adjusted the flow release schedule and plan to ramp up the bypass flow April 30, with 6,500 cfs for 3 days, 4,400 cfs for 3 days, and 3,500 cfs for 3 days, followed by a ramp up day back to 6,500 cfs to begin the 3-day cycle for each of the 3 flows again.

MAY						
S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

ramp day
6,500 cfs
4,400 cfs
3,500 cfs

Stakeholder comments included several requests for additional stationary receivers in the study area. We agree with stakeholder comments that the detection efficiency at the Montague Wastewater Treatment Plant was less than optimal during previous studies. Instead of adding an additional receiver on the other side of the river as suggested, we plan to move this receiver (Station 2) downstream between Third and Fourth Islands where the river is narrower and shallower to optimize our ability to detect all the fish that enter and exit the study area. We will also add an additional receiver in the Cabot tailrace area intended to capture the width of the river (farfield). We also plan to take measures to bolster detection probability at Stations 8[1] and 3, and ensure that they are as high as possible. We do not plan to install additional receivers on river right, (far side of the dam from the Gatehouse) since during the 2015 telemetry study only two (2) shad were detected on river right and 19 were detected on river left. Radio receiver Station 12 at the Spillway ladder was plagued with false positives from fish known to be in the Turners Falls Impoundment so we are not proposing to increase the detection range of this receiver. The Lotek receivers do employ antenna switching.

Stakeholders recommended that a field relationship be developed for the test of radio tag locations and associated power readings on receivers. Since the received signal power as a function of distance is non-linear and greatly affected by water conductivity and other variables on a near continuous basis, the level of effort required to collect and model the requested information is far greater than what is required for this proof-of-concept assessment. Also, it is not the intent of the study to assess fine-scale movement trajectories. The intent is to see if the ultrasound array keeps fish out of the Cabot tailrace while guiding them to the bypass reach. With the inclusion of a farfield antenna in the Cabot tailrace, FirstLight can determine if fish are outside the ensonified region yet within the tailrace. If the detection probability at the farfield antenna is high enough, then it can reliably be used to assess movement into and out of the tailrace area. Further, we believe that CoxPH modeling is not appropriate for fine-scale behavioral assessments. An assumption of CoxPH modeling is that transition between states is instantaneous. In terms of CoxPH and competing risk assessments, a fish is either in one location (reach) or they are not.

Smaller tags were requested by Stakeholders, however smaller radio tags increase the rate of regurgitation. Analytical methods, like mark-recapture, assume that marks are neither created nor destroyed throughout the course of the study. Failure to meet this assumption would put results into question. Of the 71 dual tagged study fish in 2015 that arrived at PIT antennas, only two (2) were found to have dropped their tags (recapture at PIT receiver and no recapture at radio receiver in vicinity). This rate of tag loss is acceptable, and did not significantly bias our results. It is not clear if the smaller radio tags would result in the high rate of tag retention as in 2015; therefore, we do not feel reducing the size of the radio tag is advisable . We agree to increase the burst rate of the tags to 3 seconds. We plan to deploy beacon tags as our false positive reduction technique relies on beacon tags placed in the water to provide information on what true detections look like.

The transducer locations for the 2018 study have been selected to minimize the effects of turbine discharge air entrainment on the transmission of ultrasound in the study area to the extent possible. Sound measurements recorded after the system has been installed will determine whether a continuous sound field of sufficiently high sound pressure levels is achieved at the edge of the tailrace across its length from downstream to upstream. Sound field measurements will be made for multiple generation scenarios, to the extent possible, and the resulting data will be provided in the study report (including graphical plots showing sound pressure levels throughout tailrace area and adjacent river channel).

Study set-up will begin in mid-April depending upon river flows.

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[1] Station 8 is located upstream of Rawson Island. Station 3 is located on each side of Smead Island.

Sincerely,

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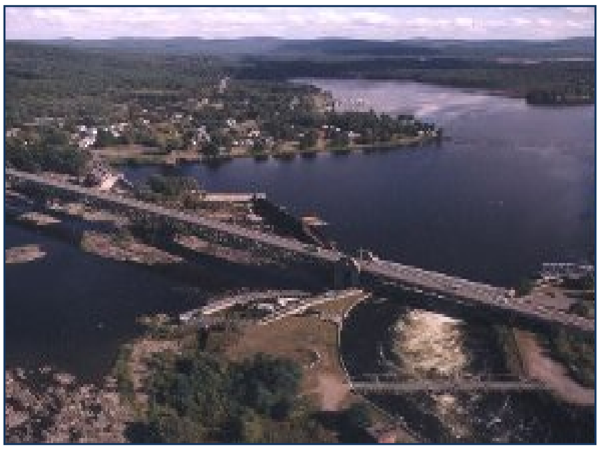
Attachment A- Study Plan,
Attachment B- Comments on Study Plan

Attachment A- Study Plan

STUDY PLAN

FOR THE TURNERS FALLS HYDROELECTRIC PROJECT (NO. 1889) AND NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT (NO. 2485)

Study 3.3.19 – Evaluate the Use of an Ultrasound Array to Facilitate Upstream Movement to Turners Falls Dam by Avoiding Cabot Station Tailrace (2018 Study)



JANUARY 2018

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1.0 INTRODUCTION AND OBJECTIVES

Unlike most other fish species, it has been demonstrated that American Shad (*Alosa sapidissima*) are able to detect sound up to 180 kHz (Higgs et. al., 2004). Previously, it was proposed that ultrasound detection in shad involves swim bladder extensions; however, more recent work indicates that the utricle, an organ found in inner ear of some Clupeids, allows detection of ultrasonic stimulation (Higgs et. al., 2004). The researchers speculate that Clupeids can detect the ultrasonic clicks of one of their major predators, echolocating cetaceans.

There are examples of high frequency sound being successfully used to deter fish in the family Cluipeidae including Alewife, Blueback herring and American Shad (shad). High frequency sound is used at the James A. Fitzpatrick nuclear power plant located on Lake Ontario, and was found to reduce impingement of Alewife by more than 80 percent and its use was approved by the regulatory agencies. Similar avoidance by herring species was noted where sound was tested at hydroelectric sites. In field trials in the early 1980s to develop a guidance system for downstream-migrants in the First Level Canal of the Holyoke Canal System, emigrating adult shad avoided, but were not well guided, by an ultrasonic array. However, upstream migrants were guided well and even stopped entirely by the ensonified field (Kynard & Taylor, 1984). Creating an ensonified field caused adult shad to leave their preferred location in the river upstream of trashracks at Holyoke Dam while the sound system was on.

Blueback Herring also avoided the ultrasound field and behaved like shad in the Holyoke Canal studies (Kynard & Taylor, 1984). Acoustic barriers have been used for migrating Blueback Herring on the Savannah River (Richard B. Russell Dam) and Santee River (St. Stephen fish lift) in South Carolina and emigrating Blueback Herring on the Mohawk River in New York (Crescent Project, FERC No. 4678; Vischer Ferry, FERC No. 4679). Evidence from previous studies that attempted to produce behavioral avoidance by adult shad suggests that ultrasound is an effective stimulus (Carlson and Popper, 1997).

Since 2006, Hydro-Québec has successfully used an ultrasound device in front of the water intakes of the Rivière-des-Prairie Hydroelectric Facility to guide downrunning spent adult shad away from the intakes (Guindon and Desrocher, 2016a). Based on the success of the ultrasound guidance system, Hydro-Québec is currently studying efforts using ultrasound to prevent adult shad from entering the Rivière des Prairies and guide them to other outlets (Guindon and Desrocher, 2016b).

An evaluation of the use of an ultrasound array to deter adult shad from the Cabot Station tailrace and facilitate their upstream movement through the bypass reach to Turners Falls Dam was a study request by U.S. Fish and Wildlife Service (USFWS), New Hampshire Fish & Game Department (NHFGD) and Connecticut River Conservancy (CRC). A potential alternative to the current configuration of fish ladders at the Turners Falls Project would be to minimize[1] attraction to the Cabot ladder and operate a single fish passage facility further upstream. In the spring of 2016, an ultrasound study was conducted to deter adult shad from entering the Cabot Station tailrace and facilitate upstream movement into the bypass reach. Fish behavior was evaluated with a combination of radio telemetry and Passive Integrated Transponders (PIT), as well as a Dual Frequency Identification SONAR (DIDSON) camera installed at the entrance to Cabot Fish Ladder, within the vicinity of the ultrasound array. Count data from the DIDSON camera revealed that there was no significant difference between median daily fish counts on days that the array was on and when it was off. However, when the count data from the DIDSON were further analyzed on an hourly scale, within the first two hours of when the ultrasound system was activated (“on”), there was a significant

[1] What is considered effective at minimizing the attraction to the Cabot tailrace is discussed later in this document.

interaction effect between the system status (on or off). This suggested that there was an effect of the Ultrasound array on adult shad.

This study plan builds on knowledge gained in 2016, and furthers the investigation into whether the use of ultrasound technology would be an effective method to minimize shad attraction to the Cabot ladder, while moving shad up the bypass channel. In 2016, air entrainment from the Cabot Station turbine discharge and fish ladder flow significantly increased the attenuation and scattering of the sound field, effectively reducing sound pressure levels below thresholds that would elicit strong and prolonged avoidance reactions from adult shad unless fish were within the immediate vicinity of the transducers including at the fish ladder entrance. This is most likely why we observed a reaction near the fish ladder entrance for the two hours subsequent to turning the system back on in 2016. In the previous study, there were three transducers mounted to a pole with different horizontal orientations, located on the fish ladder wall near the entrance and two transducers, with different horizontal orientations, mounted on a pole installed approximately at the midpoint on the back of the powerhouse. Using the new data from sound measurements collected on November 15, 2017 and from the results of sound modeling, transducer locations, numbers, and orientations for the 2018 study will be selected to minimize interference from air entrainment and optimize signal strength in an attempt to produce a continuous sound field spanning across the edge of the tailrace and with sound pressure levels (SPLs) greater than the 160 dB (Figure 1-1). As described later, for the 2018 study we are proposing to generate the sound signals at source SPLs greater 190 dB (reference SPL 1 m from the source. The objective of the 2018 study is to establish a *barrier region* of sufficiently high SPLS to deter adult shad from crossing through into the Cabot tailrace. Due to the air entrainment from the Cabot discharge, it is not practical to ensonify the entire tailrace.

The study is planned for a 4-week period encompassing the peak migration period- the month of May. In 2018, we are proposing to move the Ultrasound array outside the influence of the Cabot Station tailrace (to the extent possible depending on constraints associated with bathymetry and transducer deployment options) and make use of the same frequency, duration pulses, and transmission strength and time as the successful Hydro Quebec studies.

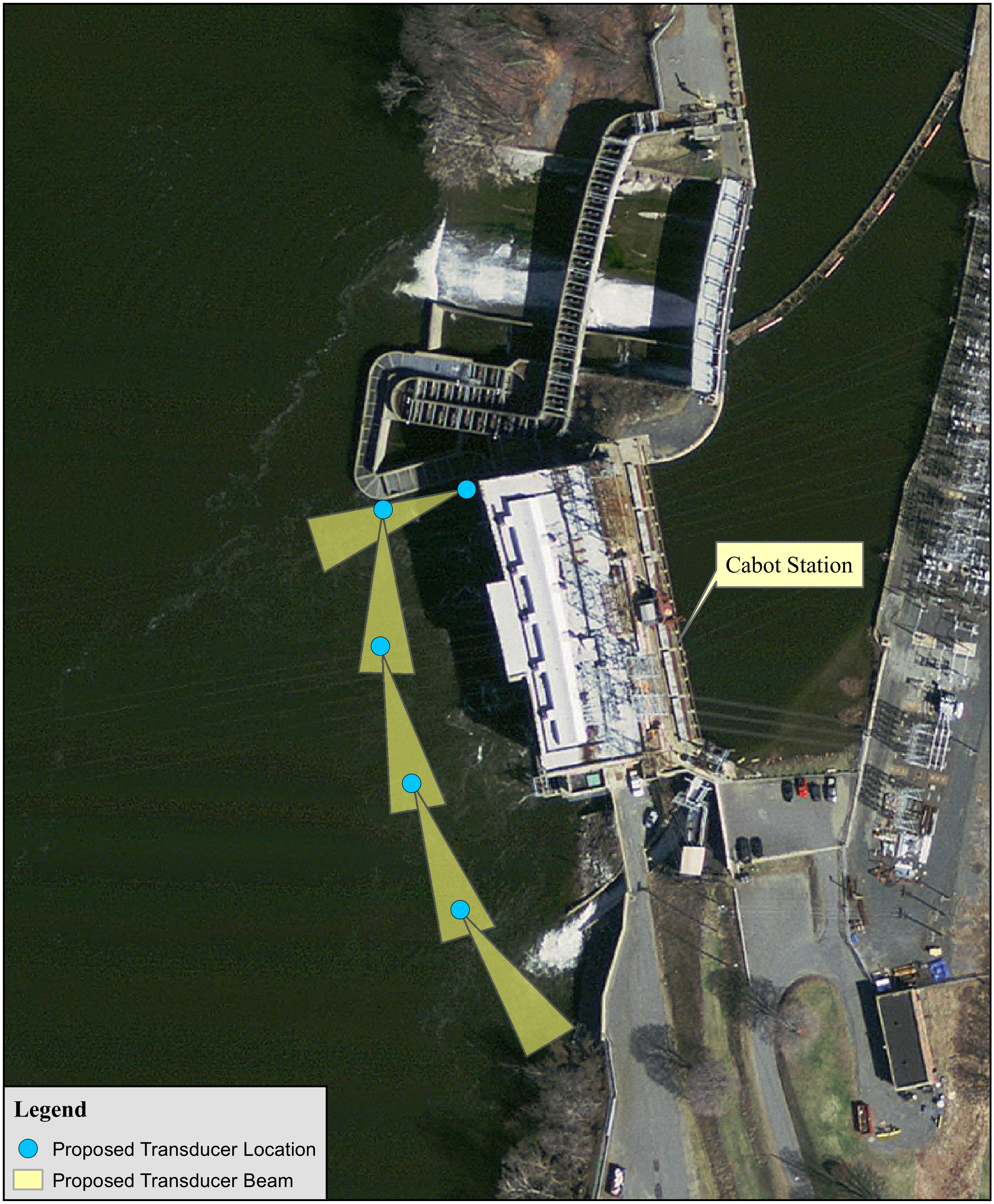
A total of 250 early migrating adult shad are proposed to be radio tagged. These radio tagged fish will be monitored with a combination of Orion and Lotek receivers (11). The monitoring equipment will be deployed and calibrated to inform on the effects of the ultrasound array on migration routes and behavior. Direct observation of shad behavior at the edge of the ensonified area will be achieved using a mobile DIDSON camera. Both radio telemetry data and shad counts at the Cabot and Spillway Fish Ladder will be used to determine the effectiveness of the ultrasound array in repelling shad away from the Cabot tailrace and Ladder.

The proposed location of the ultrasound array includes habitat known to be used by spawning Shortnose Sturgeon (SNS). For the purposes of this study, the array would need to be in operation during the overlapping SNS spawning and upstream shad migration season. As SNS are not capable of hearing sounds in the frequency proposed for this study, they will not be disturbed by the operation of the ultrasound array. Staff from NMFS Protected Resources Division agreed that the ultrasound array proposed for this study would not impact the Shortnose Sturgeon (Pers. Comm., J. Pruden, NMFS).

The goal of this study is to determine if an ultrasound arrary barrier could be used to repel adult shad from the Cabot Station tailrace and guide them into the bypass reach. The study objectives are:

- To establish a high frequency sound (ultrasound) array across the edge of the Cabot Station tailrace;
- To determine if migrating adult shad that experience the ultrasound array continue migrating upstream further up the bypass (to be determined using radio telemetry);

- To investigate if the magnitude of the bypass flow and magnitude of Cabot Station discharges affect how adult shad respond and specifically whether they migrate further up the bypass;
- To observe adult shad behavior as they approach the ultrasound array field using a DIDSON camera.



Northfield Mountain Pumped Storage Project (No. 2485)
and Turners Falls Hydroelectric Project (No. 1889)

Relicensing Study 3.3.19

Figure 1-1: Proposed locations of the transducers for the 2018 study

N

0 55 110 220 Feet

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2.0 MATERIALS AND METHODS

2.1 Sound System

Alden Research Laboratory, Inc. (Alden) and Scientific Solutions, Inc. (SSI) will provide all the equipment and services that are necessary for the configuration, modeling, installation, and operation of the ultrasonic deterrent system at Cabot Station. Initial planning, preparation, field measurements, and modeling occurred in the fall of 2017, to the extent possible. Field testing of the array was conducted on November 15, 2017. SSI will conduct modeling of the sound field to determine the number and most appropriate locations of transducers needed to produce an effective sound deterrent field without impeding upstream movement of shad into the bypass reach.

2.2 Sound Field Modeling

Iterative sound field modeling was conducted to optimize the number and locations of transducers, with the goal of achieving sound pressure levels (SPLs) greater than 160 dB (threshold for strong shad responses) in the vicinity of the tailrace. The modeling of the sound field includes up to three transducer configurations for the expected flow distributions during the study period (i.e., combination of bypass reach flows and Cabot generation flow). Alden and SSI will summarize results of the modeling and provide recommendations for a preferred transducer configuration (number of units and locations).

An important aspect of the sound system deployment is to locate transducers near or at the tailrace margins to avoid, to the extent possible, propagating sound through turbine discharge areas with high levels of air entrainment. The interaction of the sound transmissions with entrained air results in more rapid attenuation and scattering of the deterrent signal and reduces the ability of fish to detect a gradient in the sound pressure levels (i.e., no directional cue for escape responses). Sound field modeling does not have the capability to address the effects of aeration on signal transmission. The modeling will assume sound propagation in an ideal gas free fluid and will guide the selection of the number of transducers and their mounting locations and orientations to avoid "gaps" in the acoustic barrier.

2.3 Preliminary Baseline Sound Field Measurements

Baseline sound measurements were recorded with minimal generation (one Cabot unit) using an omnidirectional transducer deployed within the study area on November 15, 2017. These measurements provide empirical data regarding the attenuation of the sound field under relatively "quiet" conditions in the tailrace (i.e., minimal aeration) and will be used for validation of the model results and to optimize transducer locations and orientations.

2.4 Sound System Assembly and Calibration

SSI will assemble and optimize the amplification system and other electronic components for generating maximum SPLs (source levels > 190 dB. This effort will include acquisition and/or fabrication of additional components (including more transducers, if needed based on modeling results and recommended configuration). SSI will perform bench testing of the complete system at Alden to verify operation/output and make any necessary adjustments prior to deployment of the system for the field evaluation in 2018.

2.5 Installation and Field Measurements

Mounting systems will be designed and fabricated for deploying transducers at or near the margins of turbine discharge (i.e., in order to avoid entrained air to the extent possible). Equipment installation and shakedown testing of the sound system operation will be completed in mid to late April 2018. Sound field measurements will be recorded after installation to verify coverage and SPLs and to determine if any changes to transducer locations and/or orientation are needed to optimize the output and coverage.

A minimum of five transducer deployment locations has been assumed, from the north in the vicinity of the fishway wall to the south at or near the downstream end of the log sluice (*see* Figure 1-1). The north deployment location will likely consist of a beam anchored to the fish ladder wall vertically by divers and on which transducers will be mounted (either fixed or floating). Use of floating deployment methods are being considered for transducers away from the shore.

2.6 Sound Field Frequency and Pulse Rates

Hydro-Québec spent 10 years researching the best sound frequencies to deter adult American shad from their intake at their Rivière-des-Prairie Hydroelectric Facility (Guindon and Desrocher, 2016a). Based on their research we propose to use the same ultrasound pulse characteristics at Cabot Station tailrace in 2018.

Characteristics of Proposed Ultrasound Pulse:

- Frequency: 125 KHz
- Duration: 1.5 msec
- Number of pulses per second: 5
- Transmission time: 10s
- Break time: 1s

Unlike in the 2016 study where the ultrasound array was cycled "on" and "off" over a day, for 2018 the study the array will remain continuously on, but the signal will be pulsed and will incorporate a short, 1-second break time. The purpose of the pulsing and break time is to prevent the shad from becoming acclimated to the sound field. If signal transmission were cycled on and off, it would be difficult to determine if adult shad entering the tailrace area "behind" the sound field do so during a sound on or sound off period. This would also create a confounding factor for the assessment of Cabot fish ladder counts given the time it typically takes adult shad in the tailrace to locate and enter the ladder and eventually pass into the canal. Also, due to the expected sound field coverage (i.e., a perimeter barrier), adult shad already in the tailrace would not be expected to leave the area when sound is activated (in essence, they would be trapped between the sound field and the powerhouse).

3.0 FIELD STUDY

3.1 Proposed Bypass Flow during Ultrasound Array Study

Ultrasound array operation will be initiated immediately prior to the arrival of adult shad at Cabot Station. The ultrasound test is expected to be conducted during the month of May 2018, but the schedule may be adjusted based on river conditions and the timing of adult shad run in 2018. Shad passage at the Holyoke Dam, located downstream of the study area, will be monitored to determine the exact timing of the study.

As shown in May 2018 calendar (Figure 3.1-1), FirstLight proposes to release three bypass flows from the Turners Falls Dam, Spillway fishway/attraction flow, and Station No. 1 for three consecutive days throughout the month of May. The flow release schedule and plan is to ramp up the bypass flow April 30, with 6,500 cfs for 3 days, 4,400 cfs for 3 days, and 3,500 cfs for 3 days, followed by a ramp up day back to 6,500 cfs to begin the 3-day cycle for each of the 3 flows again. Similar to the 2015 ultrasound study, FirstLight will require a lead agency contact person as hydrologic conditions occurring in May 2018 may not match up with the schedule of releases below. Some flexibility is needed to make bypass flow changes "on-the-fly" based on the hydrologic conditions present, hence the reason for FirstLight needing a lead contact person from the agencies.

Figure 3.1-1: Proposed Bypass Release Schedule during Ultrasound Array Study

MAY						
S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

ramp day
6,500 cfs
4,400 cfs
3,500 cfs

Assuming flows are within the control of FirstLight's facilities (Cabot- 13,728 cfs, Station No. 1-2,210 cfs), there will be a flow split between the magnitude of flow passed "upstream of Station No. 1" and from Station No. 1 itself. Per current water use agreements, TF Hydro and PaperLogic currently only operate when the hydraulic capacities of Cabot and Station No. 1 (collectively 15,938 cfs) are exceeded. Consideration was given to having these two facilities provide a portion (approximately 402 cfs collectively) of any future bypass flows upstream of Station No. 1. However, for purposes of the 2018 ultrasound array study TF Hydro and PaperLogic will only operate after the Cabot and Station No. 1 discharge capacity is exceeded, thus they will not provide any portion of the flow above Station No 1. In addition, another source upstream of Station No. 1 is the Fall River. Because there currently is no United States Geological Survey (USGS) gage or equivalent on the Fall River, we have assumed for purposes of the 2018 ultrasound array study that it will not contribute to the flow upstream of Station No. 1. Thus, in summary, the main two sources of flow upstream of Station No. 1 will be provided from the Spillway Ladder fishway/attraction flow (equates to ~ 320 cfs) and from spill over bascule gate No. 1 when flows are in control of the Project. If flows are higher, any increased flow will be passed at bascule gate No. 1 and then other conveyance structures if the flows continue to rise.

Relative to the flow split --- the percentage of the total bypass flow provided by Station No. 1 versus the Spillway ladder fishway/attraction flow and spill from bascule gate no. 1--- it is assumed that approximately 33% of the flow will come from Station No. 1 and the remaining 67% will come from the Spillway ladder fishway/attraction flow and spill.

FirstLight will strive to maintain the 33-67% split for the range of flows. At the conclusion of the study, FirstLight will provide the following hourly data: total Naturally Routed Flow[2], TF Dam Spill, Bascule Gate 1 Spill, Station No. 1 generation (to be converted to cfs), and Cabot generation (to be converted to cfs). Having this information will inform parties if the 33-67% flow split is achieved when flows are within the operational capacity of the Projects.

As a frame of reference, the estimated May flows at the Turners Falls Dam over the period of record in 10% exceedance increments are shown in Table 3.1-1.

Table 3.1-1: Estimated May Turners Falls Dam Flows in 10% Exceedence Internals

Exceedence Interval	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**
Flow (cfs)	42,000	32,000	27,000	22,000	19,000	17,000	14,000	11,000	9,000

3.2 Radio Telemetry Study

The 2016 ultrasound array study resulted in less radio tagged shad reaching the Cabot tailrace study area than expected. To investigate reasons for these low numbers, a Mark Recapture assessment supported with Time-To-Event modeling was prepared using telemetry data from the large 2015 shad telemetry study (Appendix A). The analysis supported the conclusion that late-season shad have a low probability of reaching the Project; thus, radio tagging later in the season would result in low sample numbers. Since our intention is to assess the effectiveness of the Ultrasound array under three bypass flows, we will want as many fish as possible in the area. Thus, we are proposing to radio tag and release 250 migrating adult shad as early in the season as possible, depending on the number of shad available and the predicted river flow.

A total of 250 adult shad will be collected from the Holyoke Dam fish lift; tagged and released upstream of the Holyoke Dam. These 250 shad will be released in five batches of 50 fish in early May.

Each test shad will be tagged with a radio tag. The radio tags will be appropriate for esophageal impanation and sized approximately as follows: 26 mm length, 9.6 mm diameter, and 4 g weight.

Radio tags will transmit on several frequencies that are anticipated to range between 2 to 3 frequencies within the 148 to 151 megahertz band. The transmitters will employ a motion sensor and be configured such that the 2-second burst interval will shift randomly to minimize repeated collision of tags on the same

[2] Naturally routed flow includes: Vernon discharge + Ashuelot River USGS Gage Flow + Millers River USGS gage flow.

frequency. The tag life will be no less than 90 days. The total length, sex, and condition of each test shad will be recorded. Only those shad that are free from injury, with little to no descaling and exhibited vigor will be used in the study.

Tagged shad will be monitored using a combination of aerial Yagi antennas and in-water antennas (e.g. dipoles or stripped coaxial cable antennas). Antenna type and size will vary depending on site-specific constraints. Telemetry antennas will be deployed as either a singular antennae or grouped together. Prior to the anticipated tagging of American shad, monitoring equipment will be deployed at the Project and calibrated.

Data-logging receivers will be connected to either a single antenna or antenna arrays as necessary. Date, time of day, tag frequency (*i.e.*, channel), tag pulse code (unique to each tag), signal strength, and detection location (*i.e.*, antenna number) will be stored for each signal reception. Data will be downloaded from receivers periodically.

Eleven monitoring stations are proposed for this study (Table 3.1-1) as shown in Figures 3.2.-1 and 3.2-2.

Table 3.2-1. The proposed radio telemetry monitoring stations at the Turners Falls Project.

Monitoring Station ID	Location
1	Entrance to the Deerfield River (Yagi)
2	Study Area Entrance Receiver (Yagi)
3	Downstream End of Smead Island (Yagi's)
4	Left Side of the Cabot Station Tailrace (Yagi, farfield)
5	Right Side of the Cabot Station Tailrace (Yagi, farfield)
6	Cabot Tailwater (Stripped Coaxial Antenna Array, nearfield)
7	Cabot Tailrace Far-field Antennae (Yagi)
8	Cabot Ladder Entrance (Dipole)
9	Conte discharge area (Yagi)
10	Bypass Reach, Downstream of Station 1 (Yagi)
11	Bypass Reach, Upstream of Station 1 (Yagi)
12	Spillway Ladder Entrance (Dipole)
13	Spillway Ladder Vicinity (Yagi)

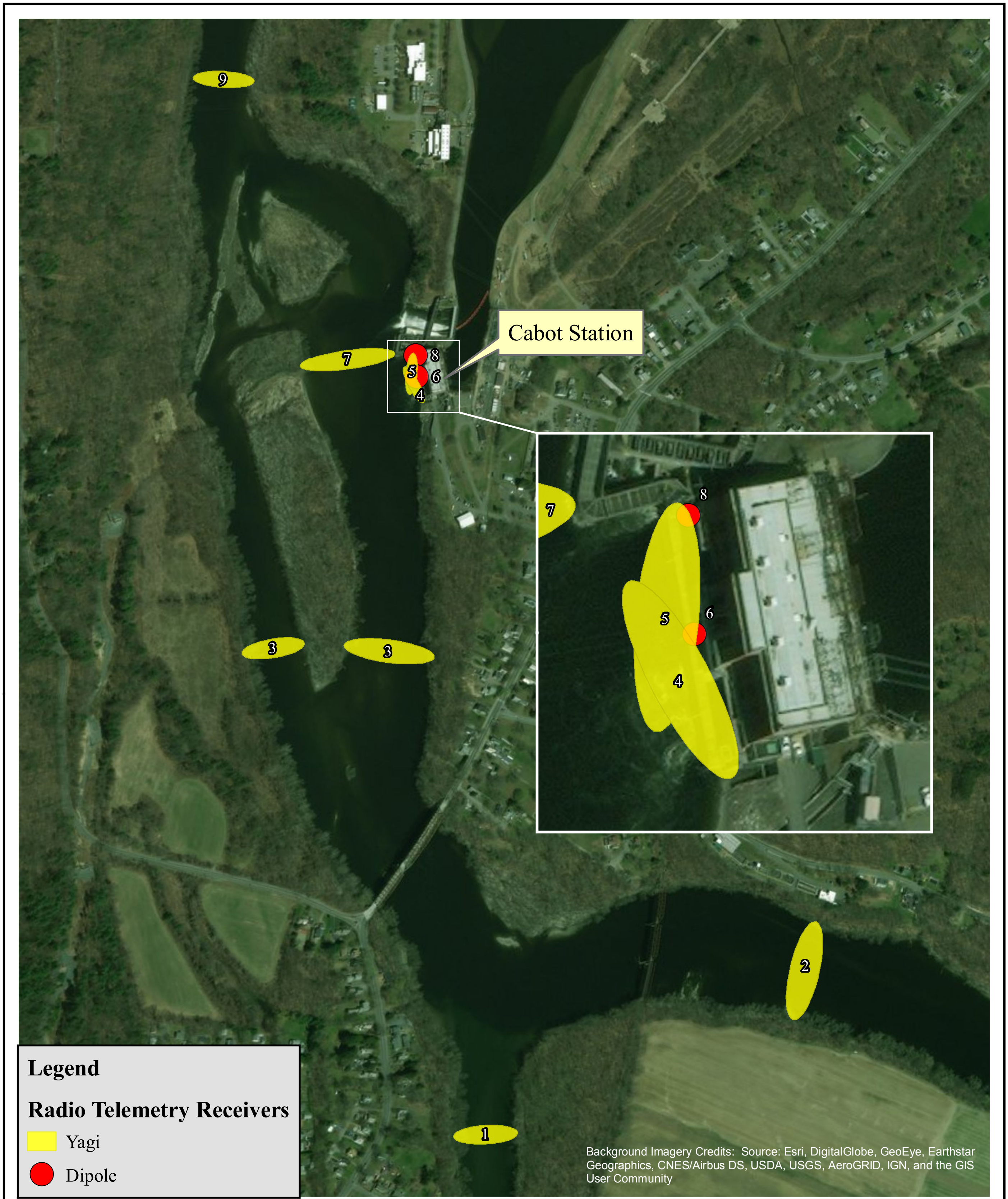
3.3 DIDSON Camera

A DIDSON camera (beam angle of 14˚ in the vertical and 29˚ in the horizontal) will be deployed from a stationary boat to collect data on the behavior of shad approaching and interacting with the Ultrasound field. The DIDSON camera will be angled downward from horizontal approximately 14º. This configuration will maximize the range in the upper water column, where shad are expected to be, while minimizing interference from the surface. Should interference from turbulence and entrained air in the study area make it difficult to effectively resolve images, an 8-degree concentrator lens may be used to confine the sonar beam to mitigate interference The DIDSON will operate in high frequency mode (1.8 MHz) to maximize resolution of targets. Data collection will employ GPS tracking to document the spatial extent of the survey. Acoustic data will be collected and analyzed using Sound Metrics Corporation DIDSON v. 5.26.06 software and will be written directly to a 3 terabyte (TB) external hard drive. The data will be backed up to a second external hard drive for redundancy and archiving. Data will be collected twice weekly during the study period for a total of eight survey events. Survey efforts are subject to safe environmental conductions at the discretion of the field crew leader and FirstLight liaison. Should flows exceed safe limits (~30,000 cfs), the survey will be postponed until flows recede.

3.4 Data Analysis and Reporting

Radio telemetry, fishway count and the DIDSON data will be analyzed to determine the effect of the ultrasound field on upstream migrating shad. It is not our intention to conduct a time series analysis of the fishway data. The intent of the DIDSON data is to evaluate the behavior of individual fish as they encounter the ensonified field, however the telemetry data will allow for a quantitative assessment on behavior of shad within the ensonified region. A series of in-water nearfield antennas will monitor the ensonified region. Recapture at any of these antennas indicates the fish is within the region affected by the ultrasonic transmitter. Movement to receivers upstream (bypass reach) or downstream of Smead Island indicates fish moving away from the ensonified region. We will perform a competing risks analysis using Cox Proportional Hazards (CoxPH) regression to understand why tagged fish transition from one state to the next. A series of simple, two state CoxPH models will assess movement within the Cabot Powerhouse tailrace. Those models are: 1) downstream end of Smead Island to ensonified region, 2) ensonified region to downstream end of Smead Island, 3) bypass reach to ensonified region, 4) ensonified region to bypass reach, 5) ensonified region to Cabot Fishway entrance, and 6) Cabot Fishway entrance to ensonified region. Time-dependent covariates include the bypass flow (sum of Station Number 1 discharge and spill over Turners Falls Dam, Spillway fishway flow, the Fall River and other discharges along the canal), Cabot discharge (cfs), diurnal (day/night), and water temperature.

A report will be prepared detailing methods, results, a discussion and conclusions. The report will be completed by October 15, 2018.



Northfield Mountain Pumped Storage Project (No. 2485) and Turners Falls Hydroelectric Project (No. 1889)

Relicensing Study 3.3.19

Figure 3.2-1: Proposed Telemetry Sites for Ultrasound Array Study

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Northfield Mountain Pumped Storage Project (No. 2485)
and Turners Falls Hydroelectric Project (No. 1889)

Relicensing Study 3.3.19

Figure 3.2-2: Proposed Telemetry Sites for Ultrasound Array Study

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Appendix A

Tagging Fish Late in the Season

As fish successfully pass Holyoke Dam, they have about 30 river miles until they reach the Turners Falls project. We believe that the likelihood of arrival at the Project for fish that have already been in the river for some time and arrive and pass late at Holyoke is lower than for fish that arrive and pass early in the season. A biological explanation for this phenomenon is that early fish are more motivated and fit to make that migration than fish that arrive and pass late in the season. Therefore, to assess the effectiveness of fish passage structures we should only target those individuals that are motivated to migrate into the Project area. Conversely, we should provide passing flows for fish early in the season and focus on maximizing spawning habitat for fish later in the season.

Mark Recapture assesses the ability of tagged fish to successfully migrate between telemetered reaches. Table 1 contains the probability that fish will migrate through telemetered reach by release cohort. To quantify the cumulative through-reach arrival probability, we simply multiply the reach specific independent probabilities together. For example, if we wish to calculate the probability that fish released at Holyoke on May 6th will migrate up to the Project we multiply the Release-Lower River (1.00) and Lower River-Project survival rates (0.79) together to obtain a 79% Project arrival rate for that cohort of fish. As evident in Table 1, the Project arrival probabilities for later cohorts is much less than earlier cohorts. Figure 1 displays the cumulative through-reach arrival rates. If our intention was to assess the effectiveness of fish passage structures or exclusion devices, we will want as many fish as possible in the area. Tagging late arrivals almost ensures low sample numbers.

Table 1 Mark recapture arrival rates

(ϕ) Reach	Release Cohort				
	6 – May	12 – May	19 – May	26 – May	8 - Jun
Release- Lower River	1.00 (1.00 – 1.00)	1.00 (1.00 – 1.00)	1.00 (1.00 – 1.00)	1.00 (1.00 – 1.00)	1.00 (1.00 – 1.00)
Lower River – Project	0.79 (0.66 – 0.87)	0.81 (0.65 – 0.90)	0.52 (0.35 – 0.68)	0.25 (0.25 – 0.25)	0.63 (0.55 – 0.70)
Project – Gatehouse Ladder	0.11 (0.05 -.025)	0.10 (0.03 – 0.28)	1.00 (1.00 – 1.00)	0.00 (0.00 – 0.00)	0.12 (0.07 – 0.20)
Gatehouse Ladder – Impoundment	1.00 (1.00 – 1.00)	0.67 (0.15 – 0.96)	0.06 (0.01 – 0.34)	0.00 (0.00 – 1.00)	0.78 (0.42 – 0.94)
Impoundment -Vernon	1.00 (1.00 – 1.00)	1.00 (1.00 – 1.00)	0.00 (0.00 – 0.00)	0.07 (0.00 – 1.00)	0.94 (0.00 – 1.00)

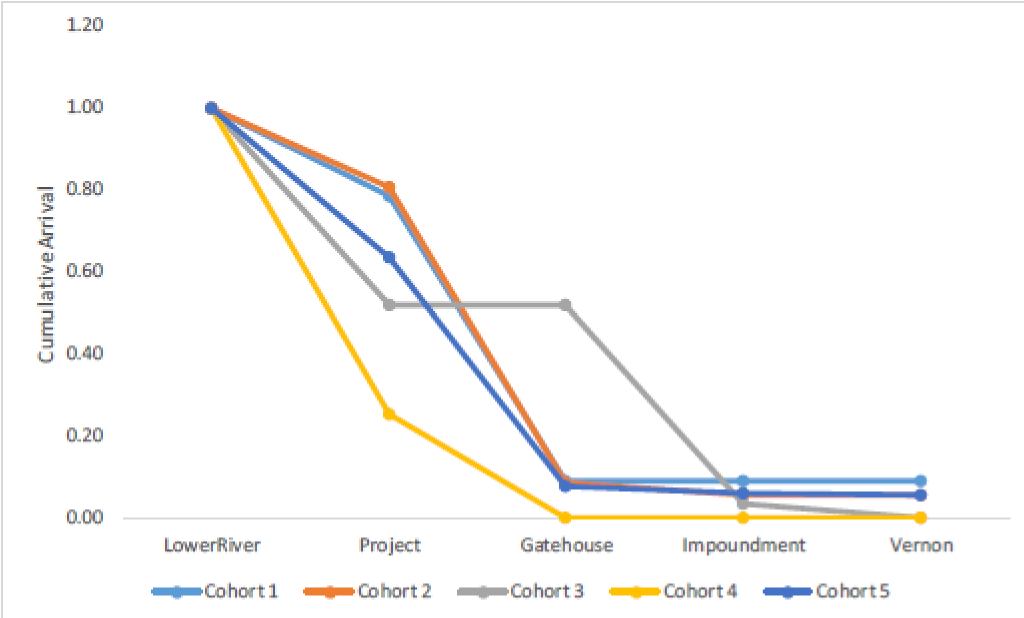

Figure 1 Mark recapture cumulative arrival rates, not that later releases do not perform as well as early releases.

This analysis was corroborated with Time-To-Event modeling, which assessed movement between Holyoke and Montague. The cumulative incidence plot (Figure 2) shows that approximately 79% of the fish that make it to Holyoke will arrive at the Project (fall back fish removed (47%)). Four models were fit (Table 2) that incorporated flow at Montague, release date and temperature and a saturated model. The flow model (Model 1) was significant, as flow increased by 1000 cfs, fish were more likely to move up and into the Project (arriving at Montague). Model 2, which incorporated release date as a covariate was also significant. The performance of fish arriving, were tagged and released on May 12 were not different from the fish released on May 6th, however, the fish that were captured, tagged and released on 5/19 and 5/26 were different from the May 12 release. The hazard ratios for these release cohorts were much less than 1.0, suggesting fish released on or after 5/19 were significantly less likely to approach the Project. Fish released on June 8 were not different from fish released on May 6, however only 3 of the 12 fish released on June 8 arrived at the Project. The third model incorporated temperature and was significant. As temperature increases fish are less likely to arrive at the Project. Given the AIC results, the best model is model 2, which incorporated release date. Figure 3 displays each tagged fish history overlayed on top of flow at Montague (cfs) and colored by release date. It is apparent from the figure that less fish from later releases arrive at the Project. Finally, Figure 5 displays the expected proportion of fish to arrive at the Project from releases on 5/6, 5/12, 5/19, and 5/26. The release on 5/12 was not different from 5/6, however it is apparent that releases on 5/19 and 5/26 have a much lower probability of arriving at the Project.

Table 2 Time to event model results

Model #	Akaike Information Criteria	Covariate	Likelihood Ratio	Standard Error	Probability	Hazzard Ratio	Confidence Interval
1	604.39	Flow (kcfs)	0.05	0.02	0.05	1.04	(0.99, 1.08)
2	600.38	5-12	0.008	0.28	0.35	0.76	(0.43, 1.34)
		5-19		0.36	0.007	0.38	(0.18, 0.78)
		5-26		0.60	0.02	0.24	(0.07, 0.79)
		6-8		0.62	0.91	0.93	(0.28, 3.14)
3	603.40	Temp (C)	0.03	0.09	0.04	0.82	(0.68, 0.99)
4	602.18	5-12	0.02	0.32	0.31	0.72	(0.39, 1.34)
		5-19		0.47	0.02	0.33	(0.13, 0.85)
		5-26		0.87	0.05	0.18	(0.03, 1.02)
		6-8		0.88	0.70	0.71	(0.13, 3.98)
		Temp (C)		0.17	0.65	1.08	(0.77, 1.51)

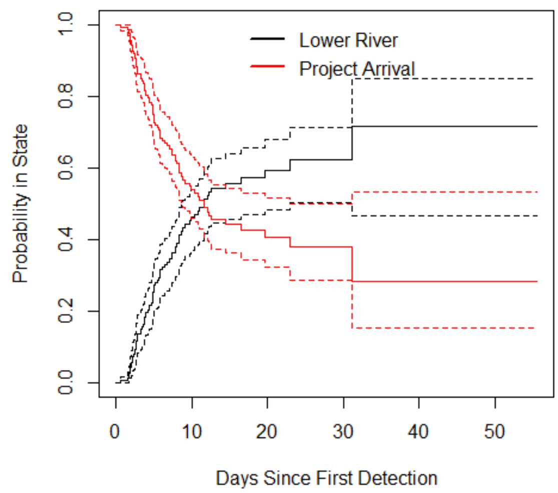

Figure 2 cumulative incident plot showing when fish arrive at the Project. The initial sill shows a delay of 1 – 2 days before fish arrive at the Project after arriving at Holyoke.

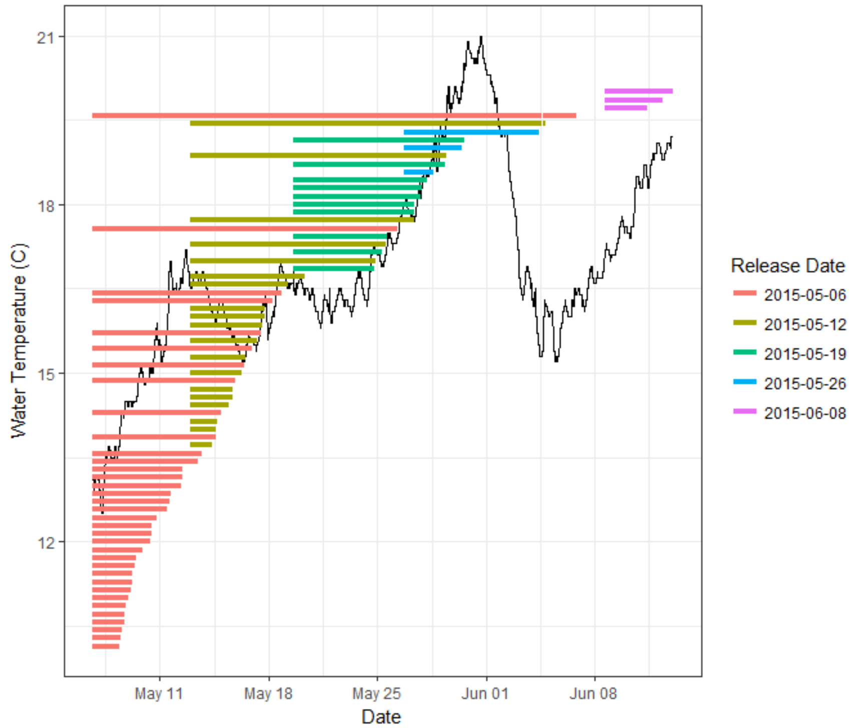

Figure 3 showing the time fish spent in the river between release at Holyoke and first arrival at Montague.

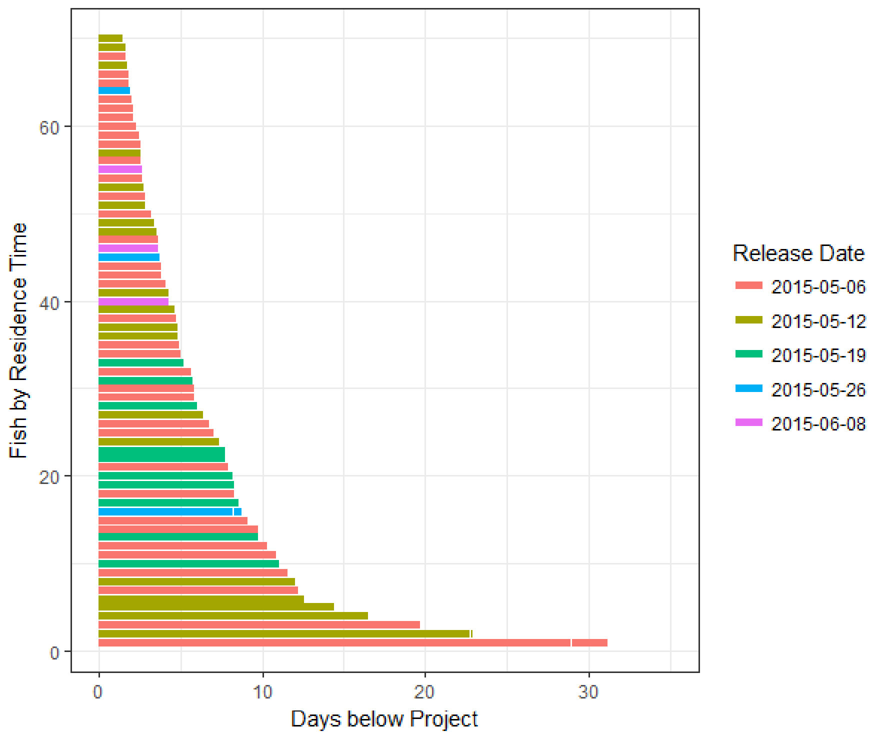

Figure 4 residence time by release date.

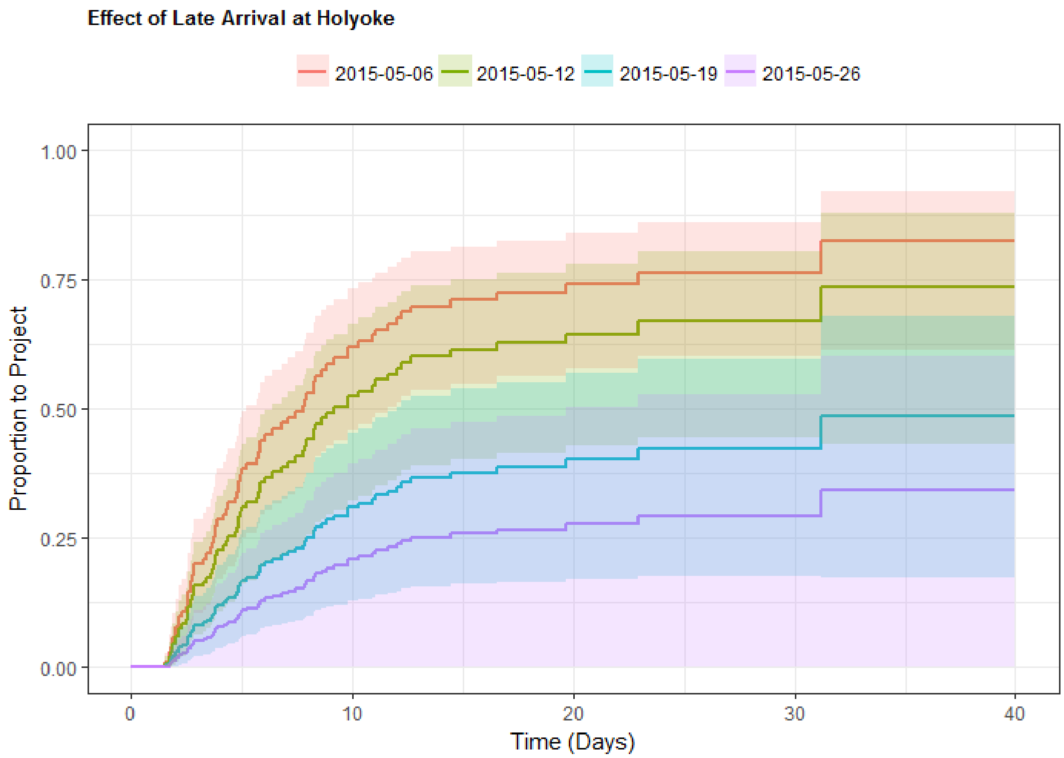

Figure 5 shows the effect of late arrivals at Holyoke on the Turners Falls Project arrival proportions.

Attachment B- Comments on Study Plan

Comments on First Light Proposed 2018 Ultrasound Shad Study

1.0 Introduction and Objectives-

1. The goal of the proposed study should be modified to include getting shad that are in the Cabot tailrace to the Turners Falls Dam (not only repelling them from Cabot tailrace or getting them into the bypass).

2. Objectives:
   a. To determine if operation of the ultrasound array affects entry into the bypassed reach (both quantity and rate of change) over time and in relation to varied operational and bypass discharges. The ratio of Cabot and Bypass discharge should also be examined for effect from interaction/relationship of two flow sources in combination with total flow.

   b. To determine if the operation of the ultrasound array affects the rate of rejection from the tailrace reach over time and in relation to discharge of Cabot, bypass flows and the ratio of discharges.

   c. To assess whether and to what extent shad habituate to operation of the ultrasound array. This can be measured as a change in the effect on rate over time. This is a complex problem that will require assessment of deviation from the proportional hazards assumption. Analysis of Shoenfeld residuals should address this question and it could be quite valuable.

   d. "*To investigate if the magnitude of the bypass flow and magnitude of Cabot Station discharges affect how shad respond and specifically whether they migrate further up the bypass*." This should be assessed in terms of penetration rate as well as rejection rate from the array nearfield and also from the tailrace reach (tailrace reach has competing risks of: penetration into the ladder and/or nearfield entry zone; penetration of the bypassed reach; and downstream rejection). The same goes for attraction up the bypass--we want to know that if they move up the bypass to avoid the ultrasound (as intended), and whether they successfully reach the dam. Do they expend similar effort at passage up the bypassed reach with and without insonification?

      Ultimately we care about shad arrivals at the dam. This can be viewed as passage rate out of the bypassed reach, but also as a single state transition from the tailrace reach to the dam (this can be done by simply combining occupancy of the tailrace and bypassed reaches).

   e. "*To observe adult shad behavior as they approach the ultrasound array using DIDSON camera*." With the DIDSON you cannot distinguish individuals which is a significant problem, because it raises the question of pseudoreplication. One approach to address this would be to quantify the rate at which telemetered fish approach the visual range of the DIDSON (you could do this with a short-range antenna). This would give you a sense of how frequently you are likely to detect a given individual which could help us understand whether and to what extent they might be deafened or otherwise habituated to the sound. This is one reason why the return rate to the insonified array is a key statistic that needs to be reported. However, we think that it would be far better to allocate the cost of the DIDSON portion of the study to an expansion of the radiotelemetry study by extending the period of monitoring, increase the number of tagged shad and increasing the number of receivers as discussed elsewhere in this memo.

2.0 Methods-

2. Installation and Field Measurements- Although it is implied that field tests for sound level output, under a range of operational (1-6 units) and field conditions (varied/bypass flow) this will occur in the set-up period, it is not explicitly stated in the methods section. The extent to which sound fields (described in hydrophone survey method for 2016) vary under those range of conditions should be measured and defined (figures and tables with associated data e.g., # units) to the maximum extent possible in the report and should be considered in the analyses. It is anticipated that modeled plots for sound wave distribution in the study area will be provided. The inclusion of in-situ point measure location, with separate table for measure and associated condition # units and bypass flow, may be useful in nearfield Cabot tailrace radio tagged fish movement/detection histories.

2.6 Sound Field Frequency and Pulse rate

3. The proposed constant "on" of the sound system was a point of discussion among Service and partner biologists. We have reached general consensus that having the equipment constantly "on" can serve to assess the primary goal and question for us – "<u>can we get shad that are in the Cabot tailrace to move into the bypass reach and reach the base of Turners Falls Dam</u>". This approach, without treatment and "control" does not, permit a proper experimental design for "response" to the sound treatment. We can, however, consider the larger question and ultimate goal of getting shad at the Cabot Station tailrace area to the base of the Turners Falls Dam and examine how that may occur relative to varied conditions over time.
4. There is a concern that the strength of the 190db ultrasound signal could have potential impact to shad that may be most directly exposed to the highest sound level. We suggest examining those shad that are detected as coming closest to the ultra sound array VS. those that have not (or not yet) – for example do "near sound field exposed fish" drop back at an elevated rate?

3.1 Field Study

5. Proposed bypass flows for this study, with the goal of attracting shad past Cabot and to the dam, should be based on several factors. The month of May falls within sturgeon spawning, shad spawning and shad passage season and the agencies/partners have strongly supported (in the context of settlement discussions) a bypass flow of 6,500 CFS

during this period. While we think this is the appropriate long-term spring flow, consideration of any other flow towards the end of the spring would need to be made with good data in hand about those flows. Therefore, it's appropriate to evaluate shad behavior at a lower bypass flow so that late season flows can be properly analyzed. Given that the previous adult shad telemetry study and ultrasound test study evaluated 4,400 cfs, testing this flow would provide data that can be directly compared to and potentially combined with prior data. Therefore, we see a benefit to assessing this flow under the 2018 array configuration.

E with just two bypass flows, however, getting enough replicates of those flows in combination with different Cabot operation and flow conditions around those flows will be challenging. Adding two more weeks to the study period would provide more time to work around unfavorable conditions and to increase the sample sizes of both treatments and responses of tagged fish. Given the investments being made to tag fish and monitor and analyze receiver signals, this extension of the test flow and monitoring period into early-mid June would be a worthwhile addition to the proposed study as it would increase the strength (power) of the analyses.

We understand that NMFS may have an additional flow it would like evaluated. In addition, we expect that FL may want to test a lower flow. While the Service has no objection to assessing other flows, the testing period would need to be expanded and the number of radiotagged fish increased, accordingly. We strongly recommend evaluating higher test flows earlier in the study period (i.e., May) and lower flows later in the period (i.e., June) to ensure sufficient flows are available.

We also recommend that treatment periods be no less than four days in duration. Initially we assumed a one day ramp in between flow changes, but have since reconsidered and do not believe ramping between test flows is necessary. The figures below show two hypothetical treatment schedules for the study; the first with three potential bypass test flows and the second with four test flows. It is the Service's recommendation that in no case should the number of test days for the 6,500 cfs and 4,400 cfs bypass flow treatments be less than 12.

May to June 15						
S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
(orange)	3500					
(green)	4400					
(blue)	6500					

(Colour coding: blue/6500 — May 1–5, 11–15, 21–25; green/4400 — May 6–10, 16–20, 26–30; orange/3500 — May 31–June 15.)

Figure 1. Hypothetical Schedule for three treatment flows, May and June.

May to June 15						
S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
(orange)	Low					
(green)	4400					
(blue)	6500					
(grey)	High					

(Colour coding: grey/High — May 1–4, 9–12; blue/6500 — May 5–8, 13–16, 21–24; green/4400 — May 17–20, 25–28, June 2–5; orange/Low — May 29–June 1, June 6–9; June 10–16 uncoloured.)

Figure 2. Hypothetical Schedule for four treatment flows, May and June.

6. We concur with the plan to ensure Station 1 discharge under bypass treatment flows does not exceed 33% of the total bypass flow

3.2 Radio Telemetry Study

7. A potentially significant problem is that downstream receiver arrays (between receivers 3 and 8, or perhaps even between 2 and 8) might fail to accurately place the fish within the 'tailrace reach'. Successful deflection by the array will minimize retention in this entire zone. Fish within this zone will comprise the denominator from which guidance up the bypassed reach must be measured. As designed, there will be considerable uncertainty as to whether fish are in this zone or elsewhere (downstream or in the Deerfield). This will boost the Type II error rate, and reduce the sensitivity of the design

with respect to the question being tested. In other words, it will make it more likely that one will conclude that the treatment is ineffective, even if it actually is effective.

It would be in FL's interest to ensure accurate detection of departures from the 2-8 zone. The confluence of the Deerfield is also a spawning area so we strongly suggest boosting the coverage just upstream of the Deerfield confluence as a way of better identifying those fish that are actually in the tailrace reach. Therefore, we recommend adding three more receiver arrays, basically doubling locations 1, 2, and 3. These arrays must have high probability of detection on each receiver to create reliable "gates" that describe directionality of movement.

8. The proposal calls for radio tagging 250 shad in five release groups of 50. As stated above, increasing the number of tagged fish over 250 will increase the power of the analysis. The timing of release groups should be done in the context of attempting to have the best sample sizes possible over the study period, for the variable treatment flows in order to examine treatment effects and on shad behavior/transitions among areas. We recommend releasing 50 fish batches (as proposed) at approximately weekly intervals, with initial release group fish expected to arrive at the project 2-3 days post release (as observed in the 2015 study).

   We would expect tagged shad to remain in the area for some time, moving among areas outside of Cabot tailrace and back again and provide additional observations, potentially improving data analyses results. In the 2016 study, tagged fish arrived and were present for a range of time periods post-release (median event time to transition upstream of array 9.5 days post-release; median time to transitions downstream of array 15.1 days post-release). These 2016 observations further justify extending monitoring to mid-June.

9. We have the following tagging/monitoring recommendations:
    a. Use a smaller size radio tag as a 90-day tag life is longer than needed for this application and tag size is a function of battery life/frequency
    b. The 2 second tag burst is too fast/frequent. Importantly, the short 2-second transmission time will prevent analyses of transmission intervals and identification of false positives. A tag burst of no less than 3 seconds is recommended, unless the proposed receivers have 0.1 second accuracy (and tag variance is less than that).
   c. Please clarify if antenna switching will be used.
   d. We recommend daily data downloads from receivers to avoid lost data should receiver/power issues occur.

10. We recommend that a field relationship be developed for the test of radio tag locations and associated power reading on receivers. In the Cabot tailrace, the assessment of the level of tag signal power for each receiver in relation to tag location in the detectable tailrace area should be done in a deliberate manner given the focus of the study on

detecting a behavior response. Tag detection records, among receivers and their design (near field, dipole, far field), are intended to help in determining the location of tagged fish. The additional tag power-to-distance and depth relationships, as suggested, may improve the ability to discern behavioral responses, and better support analyses of tag detection among the receivers for relative fish location. Signal strength may vary based on depth/flow etc. and would be better defined by taking measurements on several differing days/conditions which will allow for the evaluation of the degree of tag detection strength variability.

11. We also recommend the use of beacon tags to address any potential outages that may otherwise unknowingly impact tag detection ability, and possibly confound analyses.

12. We support using the statistically based review procedures for tag detections and analyses, including time-to-event analyses (Cox's proportional hazard) and mark/recap models (transitions) that were used in the 2016 study year report in addition to rates of movements. As we have stressed, the determination of under what conditions/variables over time shad move to the dam should be a primary goal of the study which would require analyses not specified in the proposal (noted model development) that was more focused on the tailrace area and movements into the bypass. We have included Figure 3 and its associated Table1, to clearly define zones and available transition rates to and from those zones that are necessary to more fully utilize the anticipated data and better quantify, describe and understand tagged fish movements (time-to-event).

13. In addition to utilizing the analytical approaches used for the 2016 study, we recommend that the report include figures that show for all tagged fish reaching the study area, the period of detection (hours or days) among all receivers and by receiver, with summary statistics for mean, median, range, min, max, variation measure for those plots. Those same plots should include Cabot operations (# units) and bypass discharge, on an additional axis (2^{nd} Y). It is understood that those plots have limitations for analytical purposes but they are helpful in relating tagged fish to the more complex/model data analyses. Plots for all tagged fish that reach the study area, showing their complete known detection history in either 2D or 3D individual figures for receiver detection and time are important.

14. We would also appreciate having copies of the raw and post processed data files, continuing with that existing agreement.

15. Radio receiver 12, at the Spillway Ladder is shown in the proposal as having a limited field detection distance. Unless there are issues with background noise, that receiver would be most beneficial in detecting fish that arrive (?) at the Dam and should be set as sensitive as possible (low noise floor). We know that entrance to the Spillway Ladder is not effective at higher spill conditions and the expected new spillway fishway entrance will be relocated. Therefore, detecting tagged fish entering the Spillway Ladder is of limited value given the primary questions and concerns of this study here.

A primary concern for this study is to determine, with a high degree of confidence, when tagged fish reach the Turners Falls Dam or spill pool and time spent there, relative to the study conditions. Consequently, more than one far field receiver should be set up at the Dam – we recommend at least one additional receiver unit on river right side and more if needed to fully cover the spill pool and access/egress routes. As with other receivers, a test tag ranging/detection figure, with power level of detections should be developed by field tests.

3.3 DIDSON Camera

16. It is unclear where the DIDSON will be deployed. Given the DIDSON field of vision, depth/distance, and extent to which the sound field presents a clear enough gradient (its width/area) in relation to the DIDSON detection field, it remains to be determined how informative those data will be. We disagree that shad will be most likely in the upper water column. Unless monitoring is to occur at the fishway entrance, we expect shad to be in the lower half of the water column (Boyd Kynard published study in Holyoke tailrace). Given our recommendations to increase the number of receivers, we recommend trading the costs of the DIDSON with the bolstered radio receiver coverage we identified and an increase in radio tag release sample sizes. We believe this will provide additional definitive data to answer the key study questions.

3.4 Data Analysis and Reporting

17. If the DIDSON is retained, it is not clear how fish behavior will be quantified or examined. It would be imperative to have the best possible understanding of the actual sound field propagation in the tailrace under a range of operational conditions, to relate to the observation field of the DIDSON. This is the same issue mentioned earlier regarding having a mapped range of radio tag receiver tag strengths on the various Cabot receivers, under a range of conditions. We are uncertain that placement of a DIDSON in the tailrace looking along some sound field isobar that may be subject to shifting due to changing flow conditions, with schooling shad that may likely exhibit milling behavior, will provide informative data.

18. On two state CoxPH models fish should be placed in zones. However, multi-state models are necessary for multiple competing risks (rates), time-to-event. That might be what is being proposed but it's not really clear in the study plan. We have include Figure 3 with Table 1, to more clearly define all possible transition rates among zones to better quantify and describe tagged fish movements (time-to-event). This includes a nested zone (Insonfication Zone) within the Tailrace Zone, nested also within the Approach Zone (for fish that may not enter tailrace). This study should not only be focused on what enters the Bypassed reach as Cox models development is shown but transitions and rates analyses for fish that reach the Dam. In addition to noted diurnal (day/night), the consideration of dawn and dusk diel periods has been noted as a factor.

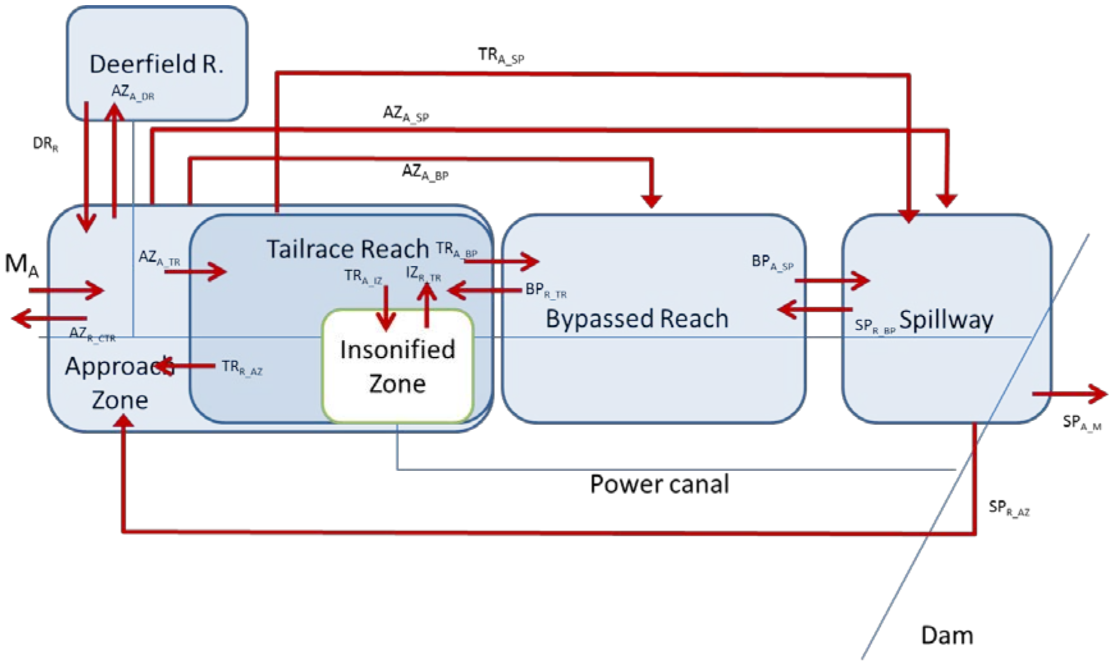

Figure 3. Framework for assigning fish to specific zones that relate to all possible transitions (detailed in Table 1, following page.) Variables are defined in following page, Table 1.

	Description	Competing Rates
M_{A}	Migratory Arrival, includes first arrival as well as return to Approach Zone for fish that moved downstream	Loss to follow-up; known downstream passage at Holyoke; Known mortality via mobile tracking
DR_{R}	Retreat from Deerfield River	Loss to follow-up
AZ_{R_CTR}	Retreat from Approach Zone to Connecticut River	AZ_{A_DR} AZ_{A_BP}
AZ_{A_DR}	Advance from Approach Zone to Deerfield River	AZ_{R_CTR} AZ_{A_BP}
AZ_{A_TR}	Advance from Approach Zone to Tailrace Reach (nested within Approach Zone)	AZ_{R_CTR} AZ_{A_DR} AZ_{A_BP}
AZ_{A_SP}	Advance from Approach Zone to Spillway	AZ_{R_CTR} AZ_{A_DR}
AZ_{A_BP}	Advance from Approach Zone to Bypassed Reach	AZ_{R_CTR} AZ_{A_DR}
TR_{A_BP}	Advance from Tailrace Reach to Bypassed Reach	TR_{R_AZ}
TR_{A_SP}	Advance from Tailrace Reach to Spillway	TR_{R_AZ}
TR_{A_IZ}	Enter Insonified Zone from Tailrace Reach	TR_{R_AZ} TR_{A_BP}
TR_{R_AZ}	Retreat from Tailrace Reach	TR_{A_BP} Also entry/passage at Cabot Fishway
IZ_{R_TR}	Retreat from Insonified zone	Entry into Fishway; If included, then you also must consider fishway rejection time and allow fish to return to the tailrace, via the insonified zone
BP_{A_SP}	Advance from Bypassed Reach to Spillway	BP_{R_TR}
BP_{R_TR}	Retreat from Bypassed Reach	BP_{A_SP}
SP_{A_M}	Advance from Spillway to migrating upstream (i.e. passage)	SP_{R_BP}
SP_{R_BP}	Retreat from Spillway to Bypassed Reach	SP_{A_M}
SP_{R_AZ}	Retreat from Spillway to Tailrace Reach	SP_{A_M}

Connecticut River
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February 27, 2018

Douglas Bennett
Plant General Manager, Massachusetts Hydro
FirstLight Power Resources, Inc.
99 Millers Falls Road
Northfield MA 01360

Re: Northfield Mountain Pumped Storage Project No. 2485-063
Turners Falls Project No. 1889-081
Connecticut River Conservancy Comments on FirstLight's Study Plan for 2018 addition to Study 3.3.19: Evaluate the Use of an Ultrasound Array to Facilitate Upstream Movement to Turners Falls Dam by Avoiding Cabot Station Tailrace

Dear Mr. Bennett,

The Connecticut River Conservancy (CRC) submits the comments below on the study plan for the 2018 Ultrasound Array study, posted by FirstLight in January 2018. Don Pugh assisted us in preparing these comments.

<u>2.2 Sound Field Modeling</u>
The plan should describe how the placement of transducers will consider the location and volume of entrained air so as to avoid entrained air.

<u>3.1 Proposed Bypass Flows during Ultrasound Array Study</u>
We propose that two flows (6300 and 4400 cfs) be tested during May, and one flow (3500 cfs) be tested in June, with longer periods for each flow. See recommended schedule below.

May to June 15						
S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
	Ramp					
	3500					
	4400					
	6300					

The flow schedule should start 3 days after the initial release of fish. In 2015, the first quartile arrived at the project 2.7 days after release and the median time to the project was 5.5 days (detection at Montague or tailrace). If the start of the flow schedule is delayed beyond May 1, we recommend that the first six flow periods remain in the above order.

3.2 Radio Telemetry Study

Attachment 1 shows additional bypass antennas and relocation of antenna 9. We recommend the following additional antennas/receivers:

- Near field antenna at St. 1 pointing at 45° down river (# 13).
- Antenna on river right below the dam to detect arrival at the dam (# 14). One of the study goals is assessing if fish reach the dam. The proposed configuration only assesses if fish are near the current spillway entrance and if they enter the ladder. An antenna on river right and possibly one in the center of the dam (# 15) is needed to determine if and when fish arrive at the dam.
- The range of antenna 12 should be extended to cover river left at the dam to increase likelihood of detection of fish at the dam.
- Detection efficiency at the Montague gage was 75 & 79% for 2015 and 2016 respectively[1]. In order to better determine if fish move downriver from the tailrace array, an additional antenna at the Montague gage should be located on river right.

Antenna #11 is superfluous. It is likely that the entrance to the spillway fishway will be relocated. Knowing if fish enter the current spillway ladder is not important for the study goals. The equipment will be better utilized at another location.

All detections should be logged individually – no CRTO.

The study plan should more clearly explain antenna #6's location and the number of droppers.

3.3 Didson Camera

The proposed location of the Didson camera from a boat in the tailrace would not provide a stable mount and the field of view would be restricted to the upper water column. While it is unknown where shad swim in the water column in the tailrace, shad generally swim lower in the water column (Witherell & Kynard). Depending on how many units are operating and the location of the Didson, there may be considerable entrained air that would degrade the quality of the image. A narrow and short field of view in an area as large as the tailrace would not be likely to provide data sufficient to understand the effect of the array.

The Didson camera would be better utilized at the entrance to the Cabot ladder. It would serve to identify fish at the ladder entrance when, if the array is working, none (or very few) should not be there. The mount would be stable, the field of view consistent throughout the study period, and entrained air would not obscure fish.

3.4 Data Analysis

Telemetry and operations data should be provided to the stakeholders.

Literature cited: Witherell, D.B and B. Kynard. 1990. Vertical distribution of adult American shad in the Connecticut River. Trans. Am. Fish. Soc. 119: 151-155.

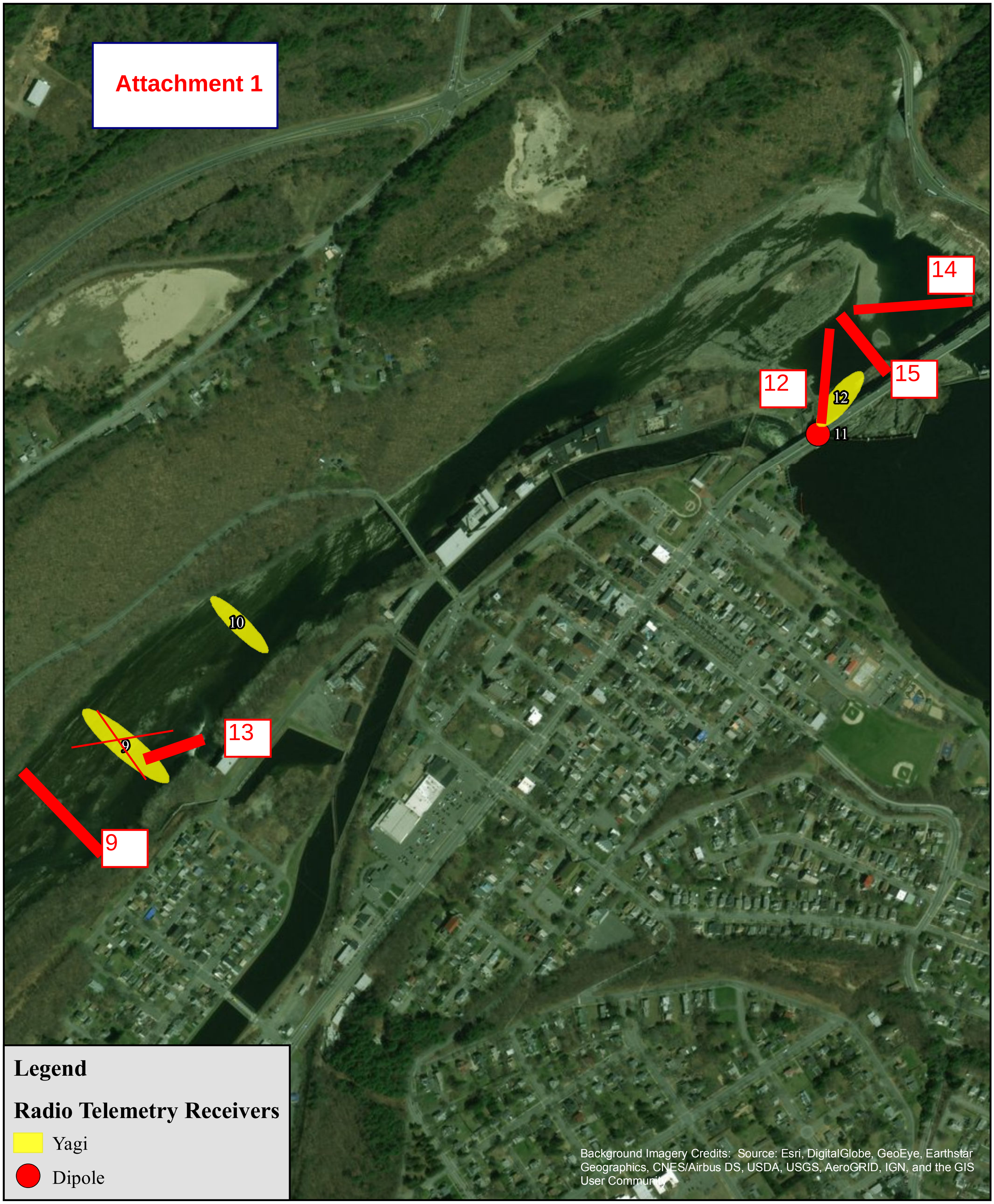
[1] Detection efficiency = # detected at Montague gage ÷ # detected at the project * 100

We appreciate the opportunity to provide comments on the study plan. I can be reached at adonlon@ctriver.org or (413) 772-2020 x.205.

Sincerely,

Andrea F. Donlon
River Steward

Attachment 1: proposed changes to the antennas



FirstLight Power Resources

Northfield Mountain Pumped Storage Project (No. 2485) and Turners Falls Hydroelectric Project (No. 1889)

Relicensing Study 3.3.19

Figure 3.2-2: Proposed Telemetry Sites for Ultrasound Array Study

Path: W:\gis\studies\3_3_19\maps\Proposed Telemetry Sites2.mxd

From:	Sean McDermott - NOAA Federal
To:	Mark Wamser
Cc:	Norman Sims; Kristen Sykes; Bob Nasdor (bob@americanwhitewater.org); Andrea Donlon (adonlon@ctriver.org); Don Pugh; A. Fisk; Peggy Sloan; Kimberly Noake MacPhee (kmacphee@frcog.org); Bob Kubit (robert.kubit@state.ma.us); Frost, Karro (FWE); peter.hazelton@state.ma.us; Jesse Leddick (jesse.leddick@state.ma.us); Marold, Misty-Anne (FWE); Caleb Slater (caleb.slater@state.ma.us); mike.nelson@state.ma.us; robert.wernerhl@state.ma.us; Mendik, Kevin; Tom Christopher (tom.christopher@comcast.net); Julie Crocker (julie.crocker@noaa.gov); Bill McDavitt (William.McDavitt@noaa.gov); Christopher Boelke - NOAA Federal; Bjorn Lake - NOAA Federal; deirdre.l.casey@noaa.gov; erict@greenfield-ma.gov; John Ward (selectman.ward@gmail.com); philg@gmavt.net; Walter Ramsey - Montague Planner; StevenE - Montague Town Administrator; Julia Blyth; Bryan Smith; assessor.jacquelyn.boyden@erving-ma.org; kkennedy@tnc.org; Melissa Grader (melissa_grader@fws.gov); julianne_rosset@fws.gov; Ken Sprankle (ken_sprankle@fws.gov); brett_towler@fws.gov; Warner, John; charles.lynch@noaa.gov; Tittler, Andrew; Harrington, Brian D (DEP) (brian.d.harrington@state.ma.us); Foulis, David (DEP) (david.foulis@state.ma.us); David.Cameron@state.ma.us; James Donohue; Marc Silver - (marc.silver@firstlightpower.com); Tom Sullivan; Verville, Sarah; Doug Bennett (Douglas.bennett@firstlightpower.com); Don Traester (donald.traester@firstlightpower.com); Kahn, Adam; Wood, Julia; Swiger, Mike; Lana Khitrik; John Hart; Jim Ginnetti (Jim@jimginnetticonsultingllc.com); Shue, John; Rider, Peter; Stira, Robert; Kevin Miller; Ian Kiraly; Tomicheck, Chris; Hathaway, Edward; Kevin Nebiolo
Subject:	Re: Items from Yesterday"s Meeting
Date:	Tuesday, February 27, 2018 7:34:52 PM
Attachments:	image006.png image008.png

Mark,

We have reviewed the draft study plan for relicensing study 3.3.19 – Evaluate the Use of an Ultrasound Array to Facilitate Upstream Movement to Turners Falls Dam by Avoiding Cabot Station Tailrace (2018 Study). Below are our comments for the proposed study.

1. The proposed goals and objectives of the study should be refined. Our primary goal for this study is to determine if operation of the ultrasound array affects the rate of rejection from the tailrace reach. We support USFWS' comments on the goals and objective.

2. Our goal is to keep fish in the river and not subject them to the power canal. Therefore, upstream migrating shad will need to reach the Turner's Falls dam in a timely manner. While the ultrasound array might be option for deterring shad from being delayed at the Cabot Station tailrace, we are primarily interested in determining how best to get shad to the dam by providing either sufficient flow down the bypass channel or altering Cabot Station and Station 1 operations. As an agency, we are not supportive of creating a noisy environment in a river environment during the migration season for fish swimming to their spawning or rearing grounds. It is not entirely clear to us what the behavioral response it to a migrating American shad (not to mention other migratory and resident species) that is subjected to sound pressure levels of 190 db. For example, the sound may repel shad from the tailrace, which would be helpful, but it may result in shad moving downstream which wont be helpful. If the study results cannot demonstrate ultrasound array as a reliable method for repelling shad from the tailrace, other methods, including project operations, will need to be implemented and evaluate.

3. To the extent practicable, the study design should replicate foreseeable future conditions. Specifically, while the study plan does not define the flows to be tested, we would not support repeating the flow analyses of 2016. If FirstLight intends to evaluate three flow levels (high, mid, low), they should include 8000 cfs (the anticipated spring flow for shortnose sturgeon) and 6,500 cfs (representing flows for the remainder of the shad upstream migration season) as the high and mid, respectively. Flows below 6,500 cfs would not reflect future condition during the shortnose sturgeon spawning season or American shad passage migration season and would have marginal application.

4. If FirstLight chooses to test the ultrasound array with a bypass flow less than 6,500 cfs, than the Station 1 discharge should not exceed 33% of the total bypass flow. However, we consider 6,500 cfs and 8,000 cfs as the likely bypass flow condition for the sturgeon spawning season and American shad upstream migration season (April through June).
5. The ratio of Cabot Station discharge to bypass reach flow should be examined for an effect. Behavioral response may be binned by ratio blocks of these two flows to understand the relationship between project operations and shad use of the bypass reach.

6. Based on the 2016 results and other studies, shad habituate to the sound. Therefore, the proposed plan includes pulsing the sound in 1 second intervals. That short pulse rate may be inadequate to prevent habituation. We recommend considering longer pulse rates to allow fish to return to a naive condition, or leaving the system constantly on.
7. As proposed, fishway counts at Cabot Station Ladder and Spillway ladder would be used to evaluate the effectiveness of the ultrasound array at repelling shad from the Cabot tailrace. The fishway counts of untagged fish are not a good indication of the ultrasound array's success at repelling fish. It will not be possible to determine the total number of fish to at the top of either ladder and know what sound condition they encountered; it will not be possible to establish a ratio for counted fish vs those repelled.

8. We have clearly stated our interest in keeping American shad in the Connecticut River and having them swim to the dam to continue their migration. As such, we recommend more receivers being installed up at the dam. One receiver should be able to detect fish in the middle of river below the dam and another one should be on river right (facing downstream).

-Sean

On Mon, Feb 26, 2018 at 8:36 AM, Mark Wamser <mwamser@gomezandsullivan.com> wrote:

> Friendly reminder- please provide written comments on the ultrasound study plan to me by tomorrow. Much appreciated, Mark
>
> Mark Wamser, PE
>
> Senior Water Resource Engineer
>
> Gomez and Sullivan Engineers, DPC
>
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Karl Meyer, Greenfield, MA.
Karl Meyer, M.S. Environmental Science
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413-773-0006
February 27, 2018
karlmeyer1809@verizon.net

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

ILP Stakeholder COMMENTS re: spring 2018 Ultrasound Study Array, 3.3.19, in Turners Falls Hydroelectric Project P- 1889 and Northfield Mountain Pumped Storage Project P-2485.

Dear Secretary Bose,

I have been a participating Stakeholder in the FERC relicensing process for P-1889 and P-2485 since 2012. I serve on the Fish and Aquatics Studies Team for both projects. I submitted comments during FirstLight's initial Ultrasound Study Array, and submit the following broad comments centered on antenna coverage and placement in the effort to improve outcomes for a second study season in spring 2018.

1. Instead of alternating the sound signal, the array should be on at all times during the study.

2. Coverage at Station 1 should be encompass a larger area—and be able to see both the upstream and downstream sides of Station 1 outflow area. Anglers fish for shad on both sides of the Station, up and down, and during certain flow configurations when Station 1 is operating, shad are stacked up like cordwood in the outflow current there.

3. Additional coverage is needed on river-right, the tainter-gate side of TF Dam in Gill. Fish are drawn through this area by split flow dispersal that occurs when the bascules are open, and also via some of the additional flow added in when Falls River runs high.

4. Also at TF Dam, detection coverage should be comprehensive and take in the entire deep pool area adjacent and downstream of the Spillway Ladder entrance.

Thank you for your attention to these issues. It is hoped that a repetition of this study will improve prospects for a successful New England migratory fisheries restoration beyond Turners Falls and into Vermont and New Hampshire.

Sincerely,
Karl Meyer, M.S.