



Northfield Mountain Station
99 Millers Falls Road
Northfield, MA 01360
Ph.: (413) 659-4489
Fax: (413) 659-4459
Email: Douglas.Bennett@firstlightpower.com

Douglas Bennett
Director MA Hydro Operations
Northfield Mountain/Turners Falls Projects

April 15, 2019

VIA ELECTRONIC FILING

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

Re: FirstLight Hydro Generating Company, Turners Falls Hydroelectric Project (FERC No. 1889) and Northfield Mountain Pumped Storage Project (FERC No. 2485). March 29, 2019 Study Meeting Summary

Dear Secretary Bose:

Pursuant to the schedule set forth in the Federal Energy Regulatory Commission's (FERC or Commission) Revised Process Plan and Schedule (Revised Schedule) issued August 10, 2018 for relicensing the Turners Falls Hydroelectric Project and Northfield Mountain Pumped Storage Project, FirstLight Hydro Generating Company (FirstLight) filed the following documents on March 1, 2019.

- Study No. 3.3.9: Two-Dimensional Modeling of the Northfield Mountain Pumped Storage Project Intake/Tailrace Channel and Connecticut River Upstream and Downstream of the Intake/Tailrace. Note that the original report was filed on March 1, 2016, thus the March 1, 2019 did not include any additional information on this study.
- Study No. 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

In addition, on December 14, 2018, FirstLight filed its Phase IB Archaeology Survey reports for Massachusetts, Vermont and New Hampshire and the Phase II Archaeological Survey report for New Hampshire¹.

Pursuant to the Revised Schedule, on March 29, 2019, FirstLight held a meeting to discuss these previously filed reports. Attached as [Attachment A](#) is FirstLight's meeting summary.

In addition to the meeting summary, attached as [Attachment B](#) is the PowerPoint presentation made at the March 29, 2019 meeting. FirstLight is filing its meeting summary and PowerPoint presentation with the Commission electronically. To access the document on the FERC website (<http://www.ferc.gov>), go to the "eLibrary" link, and enter the docket number, P-1889 or P-2485. FirstLight is also making the same available for download at the following website: <http://www.northfieldrelicensing.com>.

¹ No Phase II archaeological surveys were required in Vermont.

If you have any questions, or need additional information, please feel free to contact me.

Sincerely,

A handwritten signature in blue ink that reads "Douglas P. Bennett". The signature is written in a cursive style with a long horizontal line extending from the end of the name.

Doug Bennett

Attachment A: Meeting Summary

Attachment B: PowerPoint Presentation

ATTACHMENT A: MEETING SUMMARY

Location: Northfield Mountain Visitors Center, 99 Millers Falls Road, Northfield, MA
Date: March 29, 2019
Attendance:

United States Fish and Wildlife Service

Melissa Grader
Ken Sprankle

Kleinschmidt Associates

Chris Tomichek
Kevin Nebiolo

National Marine Fisheries Service

Bill McDavitt (via phone)

Gomez and Sullivan Engineers

Marc Wamser
Tom Sullivan
Tim Sullivan

Connecticut River Conservancy

Andrea Donlon
Don Pugh

TRC

Tim Sara (via phone)
Karen Mack (via phone)
Pat Walters (via phone)
Jasmine Gollup (via phone)
Sarah Verville
Lauren Leclerc

Elnu Abenaki

Rich Holschuh

Windham Regional Commission and Franklin
Conservation District

John Bennett

Great River Hydro

John Ragonese (via phone)

Northfield Selectboard

Julia Blyth

Gill Selectboard

John Ward

New England FLOW

Tom Christopher

No Affiliation

Karl Meyer

FirstLight

Justin Trudell
James Donohue
Marc Silver
Donald Traester
Doug Bennett
Steve Leach
Carter Wall

Foley Hoag

Adam Kahn

Van Ness Feldman

Mike Swiger

Introduction, Meeting Purpose and Process Timeline

The slide presentation for this meeting is attached to these minutes.

Mark Wamser (Gomez and Sullivan) opened the meeting and welcomed everyone. He asked for people to introduce themselves including those calling in. Staff from the Federal Energy Regulatory Commission (FERC) were not in attendance or on the phone; however, Mark noted that he emailed FERC the previous day and the agenda/call-in number for this meeting was previously filed with FERC.

He explained that the morning will be a study plan update addendum meeting as required by FERC, and the afternoon will be a stakeholder meeting to discuss recreation and shoreline erosion interests. He reminded the attendees that the afternoon meeting is not a settlement meeting. Mark reviewed the agenda (Slide 2) and the overall FERC relicensing schedule (Slide 3). Mark noted that the 2018 Ultrasound Array and Archaeology Study Reports were filed with FERC on March 15, 2019 and this is the study report meeting to discuss the results. A summary of the study report meeting will be filed with the FERC by April 14, 2019. Stakeholders have until May 14, 2019 to file requests for study plan modifications. FERC will have until June 13, 2019 to issue a Determination Letter. The filing date of the Amended Final License Application is to be determined.

FERC issued a Study Plan Determination on January 22, 2019. The study process for Erosion Causation (3.1.2), Instream Flow (3.3.1), Upstream/Downstream Shad (3.3.2), Sea Lamprey (3.3.15), Ultrasound Array Study (3.3.19) and RTE Species (3.5.1) are complete; no additional study modification requests for these studies will be considered by FERC. FirstLight will file Yellow Lampmussel and Spawning Sea Lamprey Assessment in Reach 4 by April 22, 2019. FirstLight is required to file the Phase II Archaeological Study Report by May 14, 2019. FirstLight requested an extension until September 15, 2019, but FERC denied it.

In response to a question from Andrea Donlon, Mark indicated that the barrier net assessment will be filed in May 2019. FERC does not need to approve this.

Archaeological Studies

Sarah Verville gave an introductory background on cultural surveys that have been conducted for the Projects in New Hampshire, Vermont, and Massachusetts.

New Hampshire (NH) archaeological studies were started in July 2014 with Phase 1A archaeological reconnaissance field work (Slide 4). Phase 1B field work for any resources which needed to be further studied was completed from May 14-26, 2018. Archaeological field work was completed in NH with Phase II fieldwork conducted from June 14-18, 2018. Two sites were found where the NH State Historic Preservation Office (SHPO) required Phase II work; both sites were recommended not eligible for the National Register of Historic Places (NRHP). Results were filed with the NH SHPO and NH SHPO signed off on the results. The NH Phase IB and Phase II report were also filed with FERC (Slide 4).

In July of 2014, Phase 1A archaeological reconnaissance field work was completed in Vermont (VT) (Slide 5). A report of this field work was submitted to the VT SHPO on December 30, 2014. FirstLight didn't hear back from the VT SHPO so the report was deemed accepted via the 30-day expiration contained in Vermont's regulations. Almost 5,000 meters of shoreline were surveyed during Phase 1B fieldwork from May 14-26, 2018. No archaeological resources were found in VT and no Phase II surveys were recommended. The Phase 1B end of fieldwork letter and report was submitted to the VT SHPO on July 3, 2018 and was also accepted via 30-day expiration. The VT report was also filed with FERC (Slide 5).

Phase 1A archaeological reconnaissance field work was completed in Massachusetts (MA) in July of 2014 (Slides 6 and 7). Thirteen survey segments were recommended by TRC for Phase 1B excavation. In MA, permits from the following entities were required before beginning field work: a research permit from the MA SHPO, MA Natural Heritage and Endangered Species Protection Program, MA Division of Fisheries and Wildlife (FW), Conservation Commissions (Towns of Northfield and Gill), and MA Department of Conservation and Recreation (DCR). Phase 1B field work was conducted during the period August-October 2018). FirstLight consulted with the Historical Commissions and the Tribes and invited them to observe the field work efforts. The Phase IB report was filed with the MA SHPO in November 2018 and with FERC in December 2018. The MA SHPO requested revisions to the report. The revised Phase 1B report was filed with the MA SHPO in February 2019 and with FERC in March 2019.

The Phase IB report recommended fourteen sites as potentially eligible and needing Phase II surveys to determine eligibility. In its approval of the Phase IB report, the MA SHPO removed one site as it didn't agree that it needed Phase II investigation. The MA SHPO also added four sites needing Phase II investigations, resulting in a total of 17 sites requiring Phase II survey.

Don Pugh (CRC) asked what identifies a new site in the field and what Phase IB fieldwork consists of. Tim Sara (TRC) answered that a new site is one which has not yet been recorded, whereas a previously identified site has already been reported to SHPO in the past. Tim also noted that per MA SHPO requirements, field surveys were conducted along a linear transect placed every 7.5 meters, 10 meters wide from the top of the shoreline of the potential Area of Potential Effect (APE). Shovel tests are dug 50 centimeters-(cm) x-50 cm down to a meter and the soil material is screened through a ¼ inch cloth. Consecutive shovel test pits in which artifacts are found identify a site. A preliminary site boundary is based on positive shovel tests (i.e., shovel tests where artifacts are found). The Licensee is only permitted to study within the APE. Any site identified that extends beyond the APE would be considered a partial site.

The 17 potentially eligible sites recommended for Phase II study include: 14 sites in the Town of Northfield; 2 sites in the Town of Gill; and 1 site in the Town of Greenfield. Only site numbers and types were given at this meeting (see Slide 8) as the locations and names are filed privileged with the FERC and the MA SHPO.

Andrea Donlon (CRC) asked what the difference is between a "site" and a "find spot." Pat Walters (TRC) answered that a "site" is defined by consecutive positive shovel tests where a single or small number of artifacts were discovered. A "find spot" is a singular positive shovel test pit; this is also what is referred to as an "isolated find."

TRC next explained the Phase II survey methodology and its purpose, which is to determine eligibility and more narrowly define a site boundary within the APE. Proposed Phase II survey methods include (Slide 9):

- 50-x-50 cm shovel test pits;
- 1-x-1 m test units, including 1-x-2 m test units for deep testing;
- Soil is removed and screened through ¼ inch mesh, water flotation is done to find small artifacts;
- Artifacts are separated by provenance and are then sent to the lab, processed, analyzed, and entered into an inventory.

There was a question regarding what happens when the testing hits a big rock. Pat explained that in the Connecticut River generally the soil is comprised of gravel and big rocks are typically not hit. If something hard like a potential foundation is hit, it would be exposed during the survey. If a big rock is hit or massive tree roots, the test unit can be moved.

Karl Meyer asked if some landowners did not consent to Phase IB surveys. Karen Mack (TRC) confirmed that there were only a couple landowners that did not give permission for FirstLight to conduct Phase 1B surveys on their property but that these were generally small areas. There were also landowners who did not give TRC to permission to cross their property to access FirstLight owned property to conduct testing but TRC was still able to access the locations by gaining access through other property owners.

Julia Blyth (Northfield) stated that the Town of Northfield has a policy to report artifacts to the Town. Tim confirmed that the Phase IB report has been sent to the Towns of Northfield and Gill in accordance with their accountability policies and that the report contains an artifact inventory.

Rich Holschuh (Elnu Abenaki) asked which tribes had been consulted with. Sarah referred to Slide 5 and the list of tribes which were consulted. Some tribal representatives went in the field with the archaeologists during field surveys. Rich requested a copy of the revised Phase IB report, which Sarah confirmed would be provided to Rich.

Sarah explained the requirements for being able to proceed with Phase II field work (Slide 10). First, FirstLight is required to obtain a research permit from the MA SHPO. Permits from the MA NHESP and the Towns are required. The MA NHESP and the Towns cannot issue permits until the MA SHPO has issued its research permit. The research permit application was submitted to MA SHPO on March 25, 2019 (Slide 10). Sarah explained that based on prior experience with the MA SHPO on the FirstLight archaeological studies, FirstLight has built into the Phase II schedule the possibility of the MA SHPO requesting a revised research permit application before issuance of the research permit, thereby impacting the date on which other state and local permits can be issued and when Phase II fieldwork is anticipated to begin. Assuming commencement of Phase II fieldwork in July 2018, FirstLight expects to submit the Phase II technical report and the Revised Phase II report to the MA SHPO and FERC in October 2019 and January 2020, respectively.

Melissa Grader (USFWS) asked why Phase IB archaeological surveys didn't occur until 2018, when the majority of the other relicensing studies had occurred in prior years. Sarah explained that FirstLight had filed a request for rehearing of FERC's study plan determination that FirstLight should be required to survey all segments recommended for Phase IB survey. FirstLight made the argument to FERC that it should not have to do surveys on areas which are eroding due to non-Project causes. Due to the lack of a quorum at the Commission, FERC did not issue a ruling on FirstLight's request for rehearing until a year later. FERC denied FirstLight's request. In addition, FirstLight filed a request with FERC that it should not be required to survey segments that are located on the property of another FERC licensee and within the project boundary of that licensee's project, where the project is concurrently undergoing FERC relicensing (Great River Hydro's Vernon Hydroelectric Project has an overlapping Project boundary with the Northfield/Turners Falls project boundary from approximately Vernon Dam to Stebbins Island). This request delayed some of the Phase IB New Hampshire fieldwork.

Rich Holschuh (Elnu Abenaki) asked that it be recorded that he considers the Traditional Cultural Properties (TCP) study substantially incomplete and would like to continue consultation on the TCP study.

2018 Ultrasound Array Study

Kevin Nebiolo from Kleinschmidt Associates (Kleinschmidt) presented the goals of the 2018 Ultrasound Array Study (Slide 11), which was to establish a high-frequency sound across the entire Cabot Station tailrace and determine the effect of the ensonified field on upstream migrating shad moving past Cabot Station. Study objectives (Slide 11) were to: establish an ultrasound array extending to the edge of the Cabot Station tailrace; determine if migrating adult shad that experience the ultrasound array continue

migrating further upstream in the bypass reach; and investigate if the magnitude of the bypass flow and magnitude of Cabot Station discharges affect how adult shad respond to the array and specifically whether they migrate further up the bypass reach.

Major conclusions of the study (Slide 12) are that the ultrasound array appears to deter shad. Historically, Cabot Ladder has always passed more shad than the Spillway, but in 2018 more fish passed via the Spillway than Cabot Ladder. A larger proportion of shad moved to the bypass reach entrance in 2018 (ultrasound) than in 2015 (no ultrasound). However, Cabot Ladder still provided attraction water and fish still passed (> 24,000 shad passed Cabot Ladder). A bottleneck to migration was detected in the Bypass Reach with potential velocity and physical barriers at the Rawson Island complex. Approximately only 35% of fish entering the Bypass Reach at Conte Discharge will arrive at the Spillway. Aggregated bypass movement analysis found that fish prefer flows in the 3,000 –6,000 cubic feet per second (cfs) range, however they prefer them to be stable over the length of their transit, and the later it gets in the season the longer those transits become.

A total of 250 adult American shad were collected and tagged at the Holyoke Dam in 2018 (Slide 13). Tagging and release dates were: May 14 (n=100); May 15 (n=75); and May 18 (n=75). There was a 50/50 split of males to females. Average length of females was 524 millimeters (mm) and males was 470 mm. Shad were tagged with TX-PSC-I-80-M Pisces transmitters manufactured by Sigma Eight (Slide 14). The tags measured 10 mm by 28 mm and were operated on two frequencies: 150.500 MegaHertz (MHz) and 150.560 MHz. Tags were programmed with a two-second burst and a mortality function, which defaulted to an eleven-second burst upon activation. Activation of mortality was based on relative motionlessness for six hours. Expected tag life was approximately 80 days. The study began on May 14 and continued to June 12, 2018. During that period flows of 6,500, 4,400, 3,500 and 2,100 cfs were released into the bypass reach below the Turners Falls Dam. Stationary telemetry receivers and weekly mobile tracking were established to track the tagged shad.

Calendars depicting bypass reach flows in May and June of 2018 were shown on Slide 15. The day between bypass flow changes included a “ramp” day for sturgeon, as requested by National Marine Fisheries Service (NMFS) request.

Information on shad detected per telemetry receiver are shown on Slide 16. Karl Meyer asked why there were no receivers at Rawson Island or Rock Dam. Mark answered that FirstLight will be looking at these locations for the proposed 2019 study.

Data analysis included: Kaplan-Meier estimator; Nelson-Aalen estimator; Cox Proportional Hazard Regression (Cox-PH); and Time Series Analysis. Kaplan-Meier is a non-parametric estimator for a survival function (Slide 17). In this case, the objective is to estimate the proportion of fish remaining in the tailrace after a certain number of hours (t). This curve gives us an idea of how long fish are present. The steeper the slope, the less delay.

The Nelson-Aalen is a non-parametric estimator of the hazard rate (Slide 18). The hazard rate is the probability of experiencing an event within the next unit of time conditional on being alive.

Cox-PH compares the hazard rate at two levels of an explanatory variable (Slide 19). We are always comparing the hazard rates at one level to the hazard rates at baseline.

Handling time series more effectively is shown on Slide 20. Moving windows (1, 2, 5 and 24 hours) calculated rolling average and volatility (aka variance). Cumulative measures over the entire exposure

included: average, variance; change in flow over exposure; absolute change in flow; and rate of change in flow.

Telemetry array and geometric network station locations are shown on Slide 21. Naïve Bayes retained 71% Orion and 91.7% Lotek detections. Data reduction is shown on Slide 22. Russian-Doll removed 421,090 overlapping detections. Overall 4,311,962 detections from 213 fish were used in the analysis.

Take home points of the tailrace movement include overall there were more movements towards ladder in 2018 than in 2015 (117 v 87). This is simply because there were more fish present in 2018 ($n = 112$ v $n = 66$). The median number of movements per fish towards the ladder is lower in 2018 than 2015 (2 v 3). Fish were more likely to move from the ladder to the tailrace when the ultrasound was present (HR 3.13); however, the effect reduces with time (HR = 0.62). It was concluded that the ultrasound effects fish movement, but the longer they are exposed to ultrasound, the less likely they are to move. The effect diminishes over time. Movement towards the bypass reach was affected by Cabot discharge and short term volatility. For every 1,000 cfs over baseline, fish are less likely to move (HR = 0.87). Short term volatility spurs movement (HR = 1.2) when operations change fish move.

Tailrace movement in the Nelson-Aalen Comparison is shown for 2015 and 2018 on Slide 24. There was no ultrasound in place in 2015 and only ultrasound in place in 2018. In 2018, the proportion of movements towards the bypass reach from the tailrace was higher than in 2015.

Ratio of Spillway ladder to Cabot Ladder (Spillway fish/Cabot fish) from 2008-2018 is shown in the table on Slide 25. The ratio was 1.36 in 2018, meaning far more fish were passed at the Spillway Ladder than historically. In 2015, a bypass flow was maintained but there was no ultrasound array in place. In 2018, Kevin noted that a bypass flow was maintained and the ultrasound array was present.

In regard to the probability of fish arrival at the Spillway, the study identified a bottleneck in the bypass reach—a large portion of the population drops off between the Conte Discharge and the Spillway (Slide 26). The study also showed that there is a potential velocity barrier at Rawson Island (Slide 27).

Aggregated bypass movement is depicted and discussed on Slides 28 and 29 for 2015, 2016, and 2018. In 2015, 20 of 54 fish (38%) made 23 movements. In 2016, 11 of 28 fish (39%) made 23 movements. In 2018, 30 of 85 fish (35%) made 38 movements. All results are comparable to the 2018 CJS model which concluded there is a 35% chance that a fish recaptured at the entrance to bypass reach will arrive at the Turners Falls Dam spillway. The best model incorporated: cumulative average flow (HR=6.92). Absolute change in Bypass flow while present (HR = 0.72). Day of year: cumulative average flow (HR = 0.99). Don Pugh (CRC) asked for an explanation of cumulative average. Kevin answered that it is the average over the time that fish are present.

Detailed bypass movement from Conte to Station No. 1 shows more fish moving downstream and from Station No. 1 to Spillway shows more fish moving upstream (Slide 30).

Results of the 2018 study indicated that of the 112 adult American Shad that arrived at the Cabot tailrace, 85 fish (76%) moved upstream into the bypass reach entrance before encountering a potential velocity and physical barrier around Rawson Island (Slide 32). These findings indicate that the Ultrasound Array may be keeping a proportion of the migrating shad out of the Cabot Station tailrace. Since additional flow in the bypass reach and the ultrasound array were both added as part the Ultrasound Array studies in 2016 and 2018, it is not possible to ascertain which contributed to the increased number of fish that moved upstream and entered the bypass reach. To determine the contribution of increased flow and/or the Ultrasound Array of the tagged fish moving upstream to the bypass reach, FirstLight will conduct a movement study in 2019 with test flows in the bypass reach but without an Ultrasound Array.

Bill McDavitt (NMFS) asked about Figure 20 in the report--- specifically if bypass flow versus Cabot flow could be incorporated into the analysis. Ken Sprankle (USFWS) noted that this analysis is included in the report and that the results were significant.

Don Pugh asked whether there was an esonfication receiver in the tailrace and how did you address in the analysis those instances when an array was out of alignment. There were several questions regarding the efficiency of entrance to the Cabot ladder. Kevin answered that Kleinschmidt did not quantify efficiencies of attempts of fishway entrance. Kevin said that he would email a table with the number of fish in the tailrace and the number of fish in the Cabot Ladder entrance to provide an idea of efficiency. Tom Sullivan (GSE) noted that an entrance efficiency under the ultrasound array study would be different than entrance efficiency if the ultrasound array wasn't present.

Melissa Grader (USFWS) asked whether attraction water at the ladder entry plays a role with respect to entry efficiency as opposed to Cabot operations. Kevin said somewhat yes. Melissa also asked that the spoke model be included in the report. Ken Sprankle stated that he thinks a compelling factor regarding duration of movement to ladder is that there are higher flows in the beginning of the month versus the end of the month. Tom Sullivan noted that a compelling factor regarding entrance efficiency could also be early season fish versus late season fish.

Karl Meyer asked whether the study looked at the effect of water levels at the naturally occurring Rock Dam. He noted that at certain levels, fish can go through the notches in Rock Dam. Tom Sullivan indicated that this could be evaluated as part of the River2D model of that area.

Tom Christopher (New England Flow) noted that during the 2014 whitewater controlled flow study, which assessed flows ranging from 2,500 cfs to 13,000 cfs, there was still a drop at Rock Dam at 8,000 cfs. It was asked whether Cabot was generating during the study. Kevin indicated that they would need to go back and look at data, but it probably was not generating during the whitewater study's higher flow releases as the water was provided to the bypass.

Melissa Grader noted that the report didn't discuss time of day factor. She asked whether a time of day component could be incorporated into the 2019 study to determine if it's a variable that should be included in the analysis.

2019 Ultrasound Array Control Study Plan

Kevin Nebiolo discussed study objectives of the 2019 ultrasound array control study plan (Slide 33) which include to:

- determine if a similar proportion of tagged migrating adult shad will migrate upstream of Cabot Station and into the bypass reach without the ultrasound array in place;
- investigate adult shad migration in the area of Rawson Island and Rock Dam;
- determine if adult shad migrate by the Station No. 1 tailrace under a flow split of 50% spill from the Turners Falls Dam and 50% from Station No. 1. [The 2018 study used a flow split of 67% spill from the Turners Falls Dam and 33% from Station No. 1, which appeared successful in terms of moving adult shad by Station No. 1 and toward the Turners Falls Dam. For the 2019 study both the 67%/33% and 50%/50% flow splits will be tested for two different total flow scenarios (4,400 and 6,500 cfs)]; and
- investigate the rates of immediate and latent survival for emigrating post-spawn shad that pass through the Cabot Station turbines as they move back downstream.

In 2019, a total of 250 early migrating adult shad will be collected, radio tagged at Holyoke Dam, and released upstream. Flows of 4,400 and 6,500 cfs will be released into the bypass reach during the study. The bypass flow release schedule is shown on Slide 34. A total of 24 stationary telemetry receivers will be installed to track the tagged shad (Slides 35-39).

In addition, downstream movement will be assessed (Slide 40). FirstLight will tag 200 shad at the exit of the Cabot Ladder and release them in the canal to determine downstream movements. Downstream movements of all tagged fish (Holyoke and Cabot releases) as they approach, and pass Cabot Station will be monitored and assessed with a combination of mark-recapture methods and time-to-event modeling. At least 20 euthanized fish will be tagged and released via the Cabot log sluice during a high and low Cabot operating scenario and their movements tracked downstream. FirstLight will track this specific cohort of dead fish to track their float downstream. Mobile tracking to recover all or most dead fish to assess immediate and latent mortality will occur in the stretch of river once per week between the Hatfield Waste Water Plant and the entrance of the bypass reach at the Cabot Station discharge. FirstLight will file the study results with FERC.

Don Pugh requested that the proposed flow release schedule be changed to provide the higher flow of 6,500 cfs during a period that historically has the most concentrated migration. Kevin asked Don to send him the proposed schedule and indicated a willingness to further consult on the proposed flow release schedule. Kevin also noted that the 2019 study will include monitoring at Rock Dam and Rawson Island, which wasn't done in the 2018 study.

In response to a question from Karl Meyer, Kevin agreed that the report for the 2019 study would include a discussion of Cabot generation during the study.

Melissa Grader requested that dead shad be released into the Cabot Station turbines instead of being released into the Cabot log sluice as proposed. Kevin answered that we cannot do that because it is a safety concern. Melissa and Ken Sprankle stated their belief that releasing fish via the sluiceway would not be predictive as to what happens if the fish are released through Cabot station.

Don Pugh asked if FirstLight would consider tracking dead fish movement for several hours on the day that they are released. Some immediate tracking could be done after they are released (maybe 6 hours on the day).

Melissa requested to increase the sample size of dead fish to at least 25 fish as opposed to 10 fish under each scenario.

Bill McDavitt requested that an additional yagi be deployed to cover the pool immediately downstream of the dam. Kevin answered that a massive yagi is already being proposed that is planned to monitor all the way across the pool. It will be located near the fishway entrance.

FirstLight stated that it will assess these requested changes to the study plan for the 2019 study.

NFM Tailrace River2D Study Chronology

Mark Wamser relayed that the FERC recommended that FirstLight consult with the fisheries agencies after the other fish migration studies have been completed to determine if additional analysis of the modeling results is necessary to describe how velocities and flow fields near the Northfield Mountain Project intake/tailrace may be affecting fish migration (Slide 41). Mark asked that if they had comments on the River 2D report that they submit comments by April 15th. There was no feedback.

ATTACHMENT B: POWERPOINT PRESENTATION
MADE AT THE MARCH 29, 2019 MEETING



Turners Falls Hydroelectric Project (FERC No. 1889)
Northfield Mountain Pumped Storage Project (FERC No. 2485)
March 2019 Study Addendum Meeting (morning)
Stakeholder Meeting (afternoon)

March 29, 2019



Time	Agenda Topic
FERC Meeting	
9:00-9:15 am	Introductions & Overall FERC Relicensing Schedule
9:15-10:00 am	Phase 1A, Phase 1B, and Phase II Archaeological Surveys Study (Study No. 3.7.1)
10:00-10:45 am	2018 Ultrasound Array Study (Study No. 3.3.19)
10:45-11:00 am	Break
11:00-11:30 am	2019 Ultrasound Array Concept Study Plan
11:30-Noon	Two-Dimensional Modeling of the Northfield Mountain Pumped Storage Project Intake/Tailrace Channel and Connecticut River Upstream and Downstream of the Intake/Tailrace (Study 3.3.9)
Noon-1:00 pm	Lunch (on your own)
Stakeholder Meeting	
1:00-2:30 pm	Discussion of Recreation Interests
2:30-2:45 pm	Break
2:45-4:15 pm	Discussion of Shoreline Erosion Interests
4:15-4:30 pm	Wrap-Up

Background- FERC Schedule

Party	Milestone	Date
FL	File Addendums on River2D of NFM Tailrace (nothing actually filed), 2018 Ultrasound Array and Archaeology	3/15/19
Stakeholders	Study Report Meeting	3/29/19
FL	File Study Report Meeting Summary	4/14/19
Stakeholders	File Requests for Study Plan Modifications	5/14/19
FL	File Responses to Disagreements/Amendment Requests	6/13/19
FERC	FERC issues Determination Letter	7/13/19
FL	File Amended Final License Application	TBD

Party	Milestone	Date
FERC	FERC issued Study Plan Determination	1/22/19
FERC	Study process for Erosion Causation (3.1.2), Instream Flow (3.3.1), Upstream/Downstream Shad (3.3.2), Sea Lamprey (3.3.15), Ultrasound (3.3.20) and RTE Species (3.5.1) are complete; no additional study modification requests for these studies will be considered by FERC	
FL	File Yellow Lampmussel and Spawning Sea Lamprey Assessment in Reach 4	4/22/19
FL	File Phase II Archaeological Study Results Due (FL requested extension until 9/15/19 due to frozen ground; FERC denied it)	5/14/19

Phase IA, Phase IB, and Phase II Archaeological Investigations - New Hampshire

Event	Date
Phase IA Archaeological Reconnaissance field work	July 2014
Results of Fieldwork: Survey Segments recommended for Phase IB excavation: 5	
Phase IA Archaeological Reconnaissance report	December 30, 2014 submitted to NHDHR February 5, 2015 approved by NHDHR
Phase IA Archaeological Reconnaissance report filed with FERC (privileged)	December 31, 2014
Phase IB Work Plan	April 16, 2018 submitted to NHDHR May 3, 2018 approved by NHDHR
Phase IB Notifications to Tribes and Towns	May 7, 2018
Phase IB fieldwork - 7,075 m of shoreline surveyed	May 14-26, 2018
Tribal Consultation: <ul style="list-style-type: none"> • Mashpee Wampanoag Tribe • Narragansett Indian Tribe • Nolumbeka Project • Stockbridge-Munsee Community • Wampanoag Tribe of Gay Head • Massachusetts Commission on Indian Affairs • Koasek Traditional Band of the Koas Abenaki Nation • Nulhegan Band of the Coosuk Abenaki Nation 	Tribal Consultation continued: <ul style="list-style-type: none"> • Elnu Abenaki Tribe • Abenaki Nation New Hampshire • Abenaki Nation of Missisquoi • Koasek Traditional Band of the Sover • Cowasuck Band of the Pennacook/Abenaki People • Vermont Commission on Native American Affairs • New Hampshire Commission on Native American Affairs
	Other Consultation: <ul style="list-style-type: none"> • New Hampshire Department of Historic Resources • USGS Conte Anadromous Fish Research Center • Town of Hinsdale, NH
Results of Fieldwork:	<ul style="list-style-type: none"> • Resources identified: 2 sites and 5 isolated finds • Phase II excavation recommended on both sites • No further work recommended on the isolated finds
Phase IB End of fieldwork letter and SOW for Phase II	June 4, 2018 submitted to NHDHR June 20, 2018 approved by NHDHR
Phase II fieldwork (sites 27CH244 and 27CH245)	June 14-18, 2018
Results of Fieldwork: Both sites recommended not eligible for the NRHP and no further work recommended	
Phase IB Archaeological Survey and Phase II Evaluation of Sites 27CH244 and 27CH245 report	July 30, 2018 submitted to NHDHR August 16, 2018 approved by NHDHR
Additional Phase IB Fieldwork on lands owned by Great River Hydro - 1,375 m of shoreline surveyed	October 13, 2018
Results of Fieldwork:	<ul style="list-style-type: none"> • Resources identified: 0 • No further work recommended
Fieldwork Visits: Mark Andrews, TCRM from the Wampanoag Tribe of Gay Head [Aquinnah]	
Phase IB Addendum Report	November 6, 2018 submitted to NHDHR November 26, 2018 approved by NHDHR
Phase IB Archaeological Survey Report and Addendum Report filed with FERC (privileged)	December 14, 2018

Phase IA and Phase IB Archaeological Investigations - Vermont

Event	Date
Phase IA Archaeological Reconnaissance field work	July 2014
Results of Fieldwork: Survey Segments recommended for Phase IB excavation: 4	
Phase IA Archaeological Reconnaissance report	December 30, 2014 submitted to VDHP Accepted by VDHP via 30-day expiration
Phase IA Archaeological Reconnaissance filed with FERC (privileged)	December 31, 2014
Phase IB Work Plan	April 16, 2018 submitted to VDHP May 11, 2018 approved by VDHP
Phase IB fieldwork – 4,950 m of shoreline surveyed	May 14-26, 2018
Tribal Consultation: <ul style="list-style-type: none"> • Mashpee Wampanoag Tribe • Narragansett Indian Tribe • Nolumbeka Project • Stockbridge-Munsee Community • Wampanoag Tribe of Gay Head • Massachusetts Commission on Indian Affairs • Koasek Traditional Band of the Koas Abenaki Nation • Nulhegan Band of the Coosuk Abenaki Nation 	Tribal Consultation: <ul style="list-style-type: none"> • Elnu Abenaki Tribe • Abenaki Nation New Hampshire • Abenaki Nation of Missisquoi • Koasek Traditional Band of the Sover • Cowasuck Band of the Pennacook/Abenaki People • Vermont Commission on Native American Affairs • New Hampshire Commission on Native American Affairs
Results of Fieldwork: <ul style="list-style-type: none"> • Resources identified: 0 	Other Consultation: <ul style="list-style-type: none"> • Vermont Division of Historic Preservation • USGS Conte Anadromous Fish Research Center
Phase IB End of fieldwork letter and report	July 3, 2018 submitted to VDHP Accepted by VDHP via 30-day expiration
Phase IB End of fieldwork letter and report filed with FERC (privileged)	December 14, 2018

Phase IA and Phase IB Archaeological Investigations - Massachusetts

Event	Date
Phase IA Archaeological Reconnaissance fieldwork	July 2014
Results of Fieldwork: Survey Segments recommended for Phase IB excavation: 13	
Phase IA Archaeological Reconnaissance report	December 30, 2014 submitted to MHC February 3, 2015 comments received from MHC May 12, 2015 revisions submitted to MHC Late May 2015 revisions accepted by MHC
Phase IA Archaeological Reconnaissance filed with FERC (privileged)	December 31, 2014
Phase IB Intensive survey permit application	November 8, 2016 submitted to MHC November 15, 2016 comments received from MHC April 19, 2017 revisions submitted to MHC April 27, 2017 comments received from MHC May 12, 2017 revisions submitted to MHC June 7, 2017 comments received from MHC
Resumed Consultation Phase IB Intensive survey permit application	May 7, 2018 submitted to MHC May 17, 2018 comments received from MHC July 9, 2018 revisions submitted to MHC
State Archaeologist Permit #3853	July 17, 2018 issued by MHC
Other State and Town Permitting	<ul style="list-style-type: none"> • NHESP - Endangered Species Protection Plan approved August 17, 2018 • MA DCR - Research access permit issued October 26, 2018 • MA FW - License issued August 13, 2018 • Town of Northfield Conservation Commission - Negative Determination issued August 1, 2018 • Town of Gill Conservation Commission - Negative Determination issued July 10, 2018 • Town of Greenfield Conservation Commission - No additional permitting required

Phase IA and Phase IB Archaeological Investigations – Massachusetts (continued)		
Event	Date	
Phase IB fieldwork Notification to Towns and Tribes	August 15, 2018	
Phase IB fieldwork – 13,700 m of shoreline surveyed	August 22 – Sept 18, October 9-14, and October 30, 2018	
Tribal Consultation: <ul style="list-style-type: none"> • Mashpee Wampanoag Tribe • Narragansett Indian Tribe • Nolumbeka Project • Stockbridge-Munsee Community • Wampanoag Tribe of Gay Head • Massachusetts Commission on Indian Affairs • Koasek Traditional Band of the Koas Abenaki Nation • Nulhegan Band of the Coosuk Abenaki Nation 	Tribal Consultation: <ul style="list-style-type: none"> • Elnu Abenaki Tribe • Abenaki Nation New Hampshire • Abenaki Nation of Missisquoi • Koasek Traditional Band of the Sover • Cowasuck Band of the Pennacook/Abenaki People • Vermont Commission on Native American Affairs • New Hampshire Commission on Native American Affairs 	Other Consultation: <ul style="list-style-type: none"> • Massachusetts Historical Commission • Dr. Kevin McBride • USGS Conte Anadromous Fish Research Center • Northfield Historical Commission • Town of Greenfield Historical Commission • Town of Gill Historical Commission
Fieldwork Visits: <ul style="list-style-type: none"> • Dr. Kevin McBride and David Naumec (Mashantucket Pequot Museum) 	<ul style="list-style-type: none"> • Mark Andrews, TCRM from the Wampanoag Tribe of Gay Head [Aquinnah] • Rich Holschuh and Chief Roger Longtoe, representatives of the Elnu Band of the Abenaki Tribe 	<ul style="list-style-type: none"> • Joe Graveline, NHC board member and Nolumbeka project member • Katherine Carpenter and Robert Perry, Gill Historical Commission
Results of Fieldwork:	<ul style="list-style-type: none"> • Resources identified: 27 newly recorded sites, 5 previously recorded sites, and 9 findspots 	<ul style="list-style-type: none"> • Phase II excavation recommended on 17 sites • No further work recommended on remaining 15 sites and 9 findspots.
Phase IB Intensive Survey report	November 30, 2018 submitted to MHC January 3, 2019 comments received from MHC February 8, 2019 revisions submitted to MHC March 7, 2019 received approval from MHC; MHC formally requests submittal of Phase II permit application	
Phase IB Intensive Survey filed with FERC (privileged)	December 14, 2018	

Archaeological Studies

Results of Phase IB Fieldwork Massachusetts

Number of Sites Identified	Number of Sites Recommended for Phase II Study
Town of Northfield	
28 sites, 8 findspots	14 sites
Town of Gill	
3 sites	2 sites
Town of Greenfield	
1 site, 1 findspot	1 site

Phase II Archaeological Studies Recommended by SHPO (17 Sites) - Massachusetts

Site Number	Site Type
Town of Northfield	
MA5.2, 5.3, and 5.4	Multi-component (Precontact: Late Archaic-Woodland; Historic: 19 th -20 th Century)
MA6.1	Precontact (Late Archaic – Early Woodland Transitional)
MA6.4	Multi-component (Precontact: unknown; Historic: 19 th -20 th Century)
MA6.5	Precontact (unknown)
MA6.7	Multi-component (Precontact: unknown; Historic: 19 th -20 th Century)
MA6.8	Precontact (unknown)
MA6.3	Precontact (unknown)
MA19.1	Multi-component (Precontact: unknown; Historic: 19 th -20 th Century)
MA19.3	Multi-component (Precontact: unknown; Historic: 19 th -20 th Century)
MA19.4	Multi-component (Precontact: unknown; Historic: 19 th -20 th Century)
MA19.5	Multi-component (Precontact: unknown; Historic: 19 th -20 th Century)
MA19.6	Multi-component (Precontact: unknown; Historic: 19 th -20 th Century)
MA19.10	Multi-component (Precontact: unknown; Historic: 19 th -20 th Century)
MA19.17	Precontact (unknown)
Town of Gill	
MA14.1	Multi-component (Precontact: unknown; Historic: 18 th -19 th Century)
MA34.1	Multi-component (Precontact: unknown; Historic: unknown)
Town of Greenfield	
MA41.2	Historic (18 th -20 th Century: Industrial/Logging)

Proposed Phase II Field Methods

Proposed Methods	Purpose
50-x-50 cm Shovel Test Pits	Define site boundaries within the APE
1-x-1 m Test Units, including 1-x-2 m Test Units for deep testing	Gain an understanding of site stratigraphy, integrity, chronology, and activities
Screen through ¼ in mesh	Recovery of small materials: lithics, ceramics, faunal and floral remains, etc.
Collection of soil samples from cultural features for microanalysis	Identify site function, gain information on subsistence, seasonality, chronology, and specialized activity areas
Lab processing and analysis	
Reporting	
Artifact Curation	Curation agreement with Springfield Science Museum

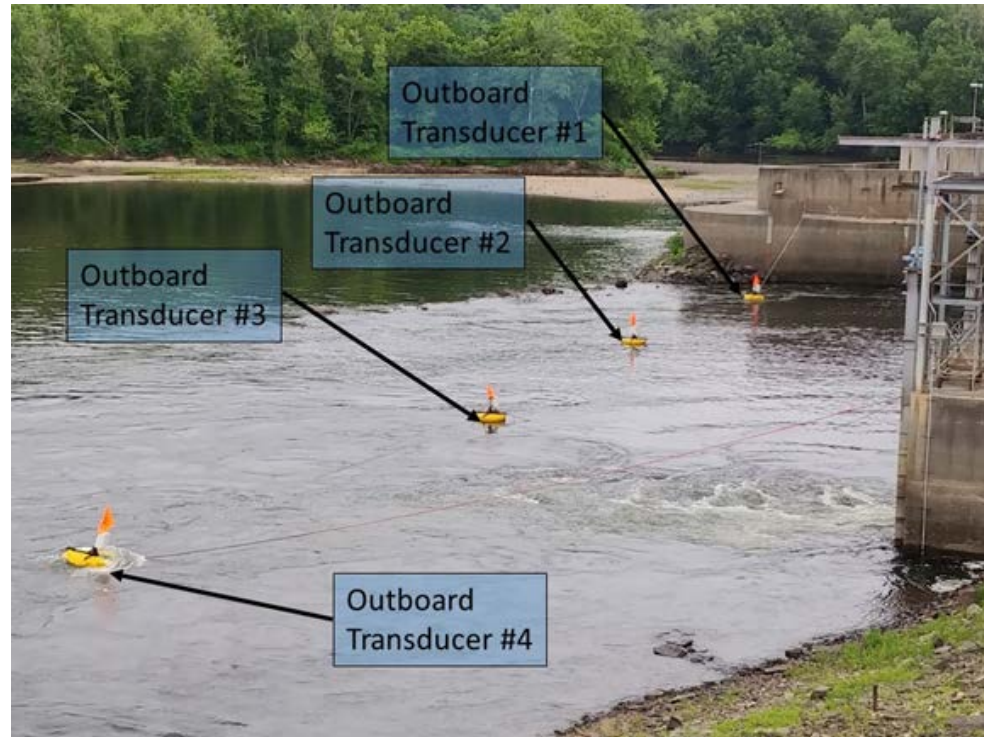
Project Element/Task	Anticipated Start	Anticipated End
Phase II Research Design/Permit Application		
TRC prepares Designs and Permit Application for 17 sites	March 11, 2019	March 22, 2019
➤ Submit Research Design and Permit Application to MHC	March 25, 2019	
MHC Reviews Research Designs	March 23, 2019	April 23, 2019
➤ MHC provides Research Design Comments, requests revisions	April 26, 2019	
TRC addresses MHC Research Design comments	April 29, 2019	May 10, 2019
➤ Submit Revised Research Designs and Permit Application to MHC	May 13, 2019	
MHC reviews and approves Revised Research Designs	May 14, 2019	June 14, 2019
➤ MHC Issues Phase II permit to TRC	June 17, 2019	
TRC obtains other permissions / prepares for Phase II fieldwork	June 18, 2019	June 28, 2019
➤ TRC mobilizes for Phase II Fieldwork	July 7, 2019	
Phase II Field Study, Analysis and Reporting		
➤ Begin Phase II Fieldwork	July 8, 2019	
TRC conducts Phase II Fieldwork	July 8, 2019	August 31, 2019
➤ TRC completes Phase II Fieldwork	August 31, 2019	
Lab Processing / Analysis	July 15, 2019	October 15, 2019
Phase II Report Development	July 15, 2019	October 15, 2019
➤ Submit Phase II Technical Report to FERC & MHC	October 24, 2019	
MHC Reviews Phase II Report	October 25, 2019	November 25, 2019
➤ Receive Phase II Report Comments from MHC	December 2, 2019	
Revised Phase II Report per MHC Comments	December 3, 2015	December 17, 2014
➤ Submit Phase II Revised Report to MHC and FERC	December 23, 2019	
MHC Reviews Revised Phase II Report	December 24, 2019	January 24, 2020
➤ MHC Accepts Revised and Phase II Report	January 24, 2020	
Curation Activities with Springfield Museums	January 24, 2020	April 30, 2020
➤ Submit MHPC acceptance of Revised Phase II Report to FERC	May 1, 2020	

Goal:

- To establish a high-frequency sound across the entire Cabot Station tailrace and determine the effect of the ensounded field on upstream migrating shad moving past Cabot Station.

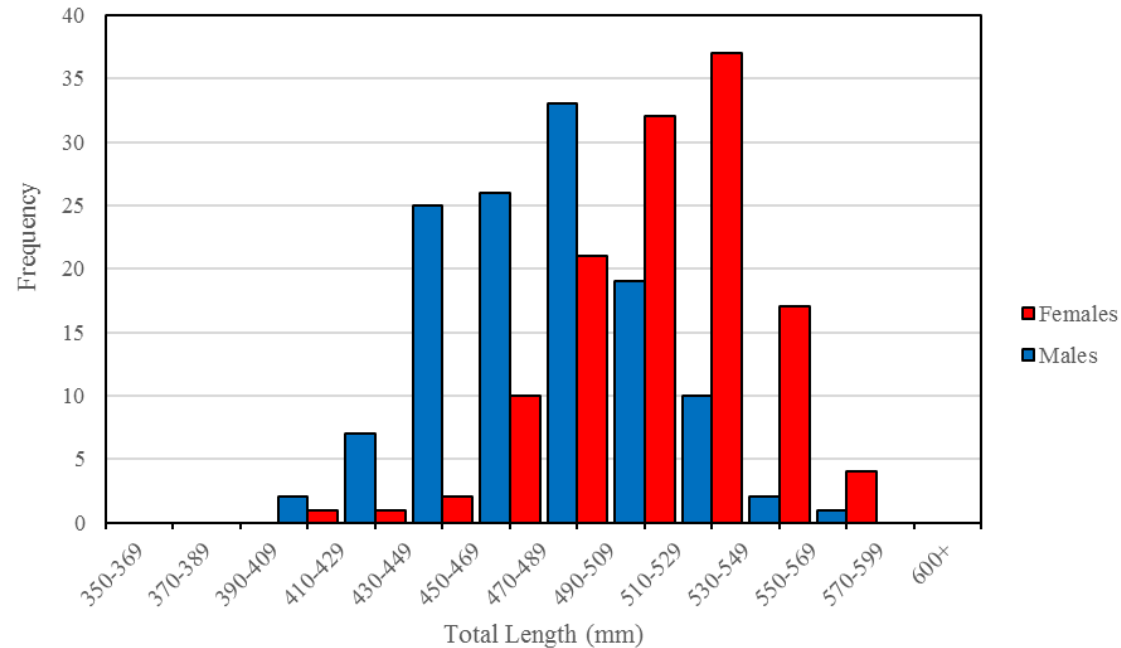
Study Objectives:

- To establish an ultrasound array extending to the edge of the Cabot Station tailrace.
- To determine if migrating adult shad that experience the ultrasound array continue migrating further upstream in the bypass reach.
- To investigate if the magnitude of the bypass flow and magnitude of Cabot Station discharges affect how adult shad respond to the array and specifically whether they migrate further up the bypass reach.



- Ultrasound Array appears to deter some shad
 - Historically, Cabot Ladder has always passed more shad than Spillway, but in 2018 more fish passed via Spillway than Cabot
 - A larger proportion of shad moved to the bypass reach entrance in 2018 (ultrasound) than in 2015 (no ultrasound)
 - However, Cabot Ladder still provided attraction water and fish still passed (> 24,000 shad passed Cabot Ladder)
- CJS modeling found a bottleneck in the Bypass Reach with potential velocity and physical barriers at the Rawson Island complex
 - ~ 35% of fish that enter the reach at Conte Discharge will arrive at the Spillway
- Aggregated bypass movement analysis found that fish prefer flows in the 3,000 – 6,000 cfs range, however they prefer them to be stable over the length of their transit, and the later it gets in the season the longer those transits become

- Total of 250 adult American Shad were collected & tagged at Holyoke Dam.
- Tagging and release dates:
 - May 14 (n=100)
 - May 15 (n=75)
 - May 18 (n=75)
- 50/50 split m-f
- F avg length: 524(428,576)
- M avg length: 470 (401,557)



- Shad were tagged with TX-PSC-I-80-M Pisces transmitters manufactured by Sigma Eight.
- The tags measured 10 mm by 28 mm; operated on two frequencies, 150.500 and 150.560 MHz.
- Tags programmed with a two-second burst and a mortality function, which defaulted to an eleven-second burst upon activation.
- Activation of mortality was based on relative motionlessness for six hours.
- Expected tag life ~ 80 days.

Bypass Reach Flow

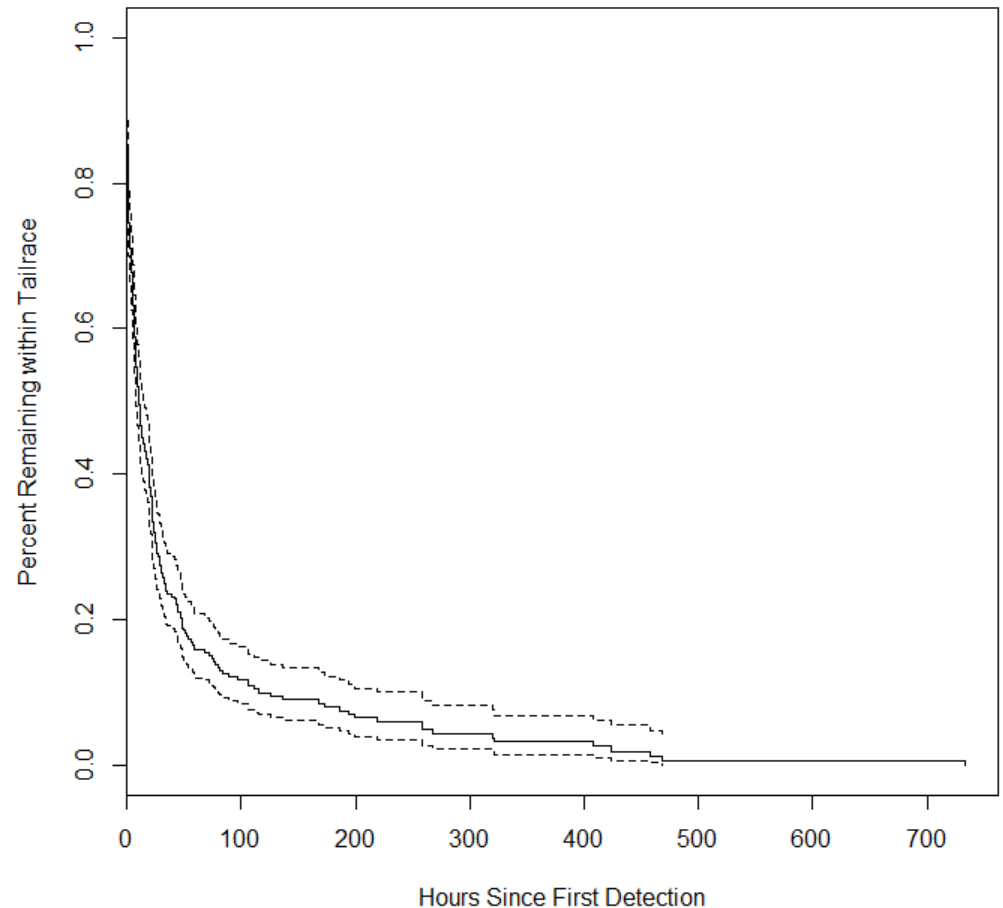
May						
S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		
June						
S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

	ramp day
	6,500 cfs
	4,400 cfs
	3,500 cfs
	2,100 cfs

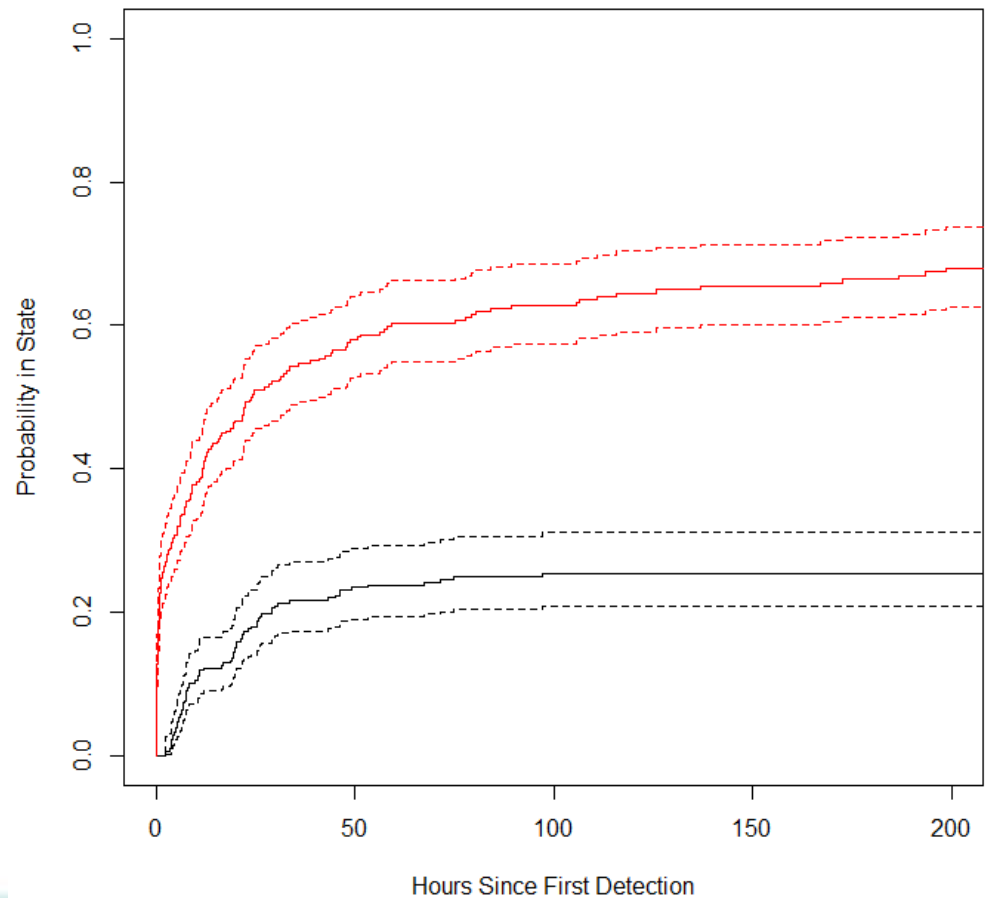
Shad Detected per Telemetry Receiver

Node	Receivers	Reach	Fish Per Node
S01	T02	Montague	135
S02	T01	Deerfield River	23
S03	T03O	Smead Island - West	15
S04	T03L	Smead Island - East	112
S05	T06	Cabot Farfield	115
S06	T04, T05	Cabot Tailrace (partially ensonified)	112
S07	T07	Nearfield (ensonified)	41
S08	T08	Cabot Ladder (ensonified)	55
S09	T09	Conte Discharge	85
S10	T10	D/S Station No. 1	36
S11	T11	U/S Station No. 1	18
S12	T13	Turners Spillway	33
S13	T12	Spillway Ladder	2
S00	T02Hol	Hadley Intake	74
S00	T03Hol	Gatehouse	81
S00	T04Hol	Surface Bypass	35
S00	T08Hol	Plunge Pool	115

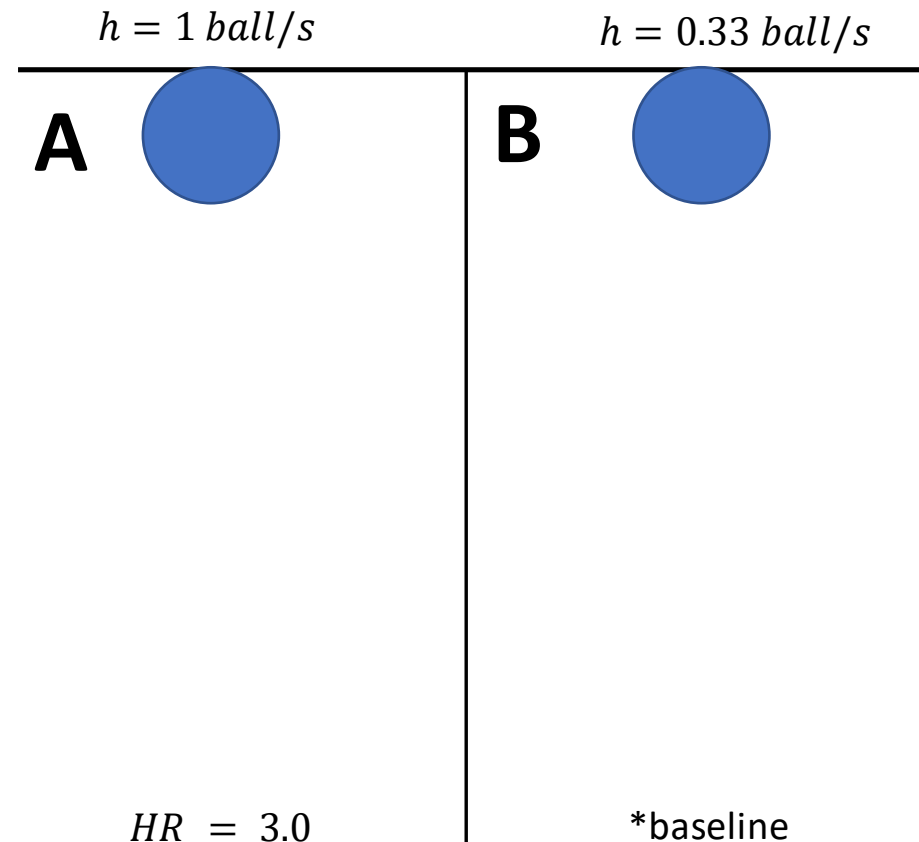
- Kaplan-Meier is a non-parametric estimator for a survival function
- In this case, we are estimating the proportion of fish remaining in the tailrace after a certain number of hours (t)
- This curve gives us an idea of how long fish are present
- ***The steeper the slope, the less delay***



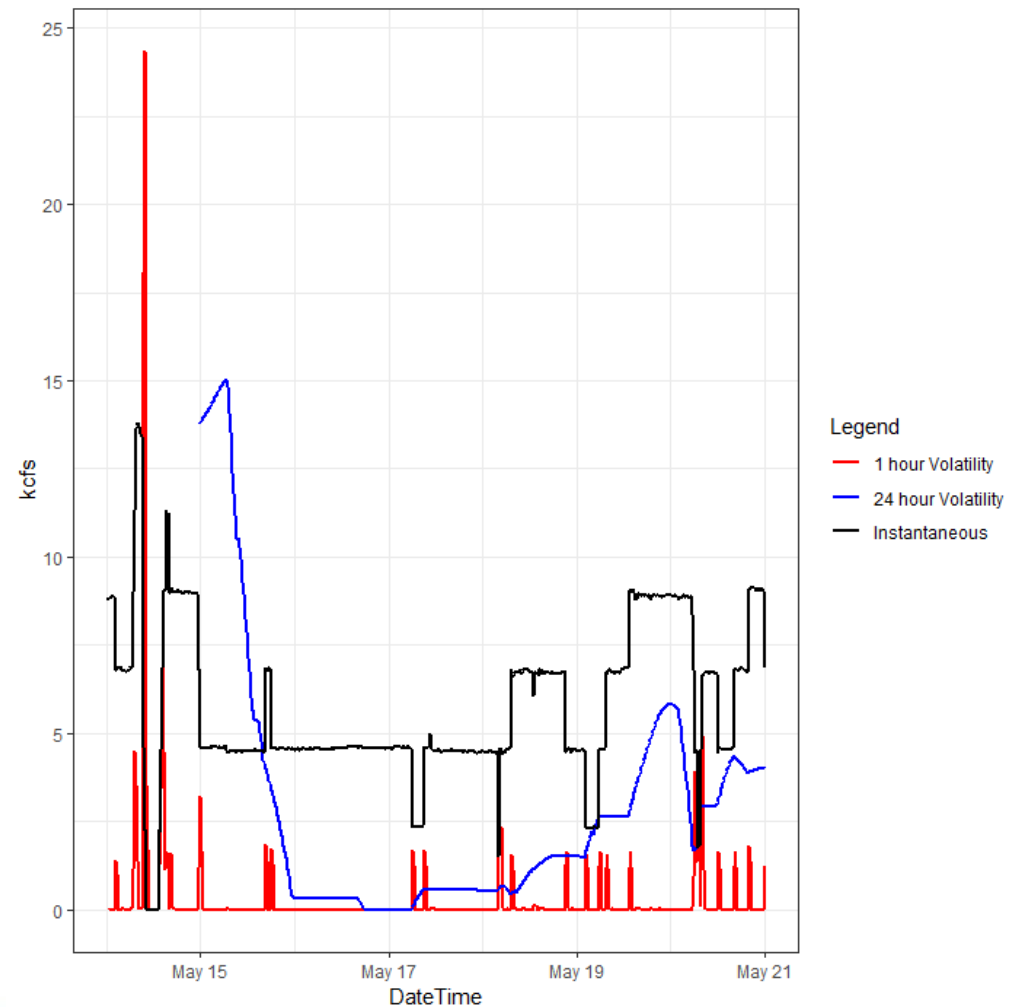
- The Nelson-Aalen is a non-parametric estimator of the hazard rate
- The hazard rate is the probability of experiencing an event within the next unit of time conditional on being alive



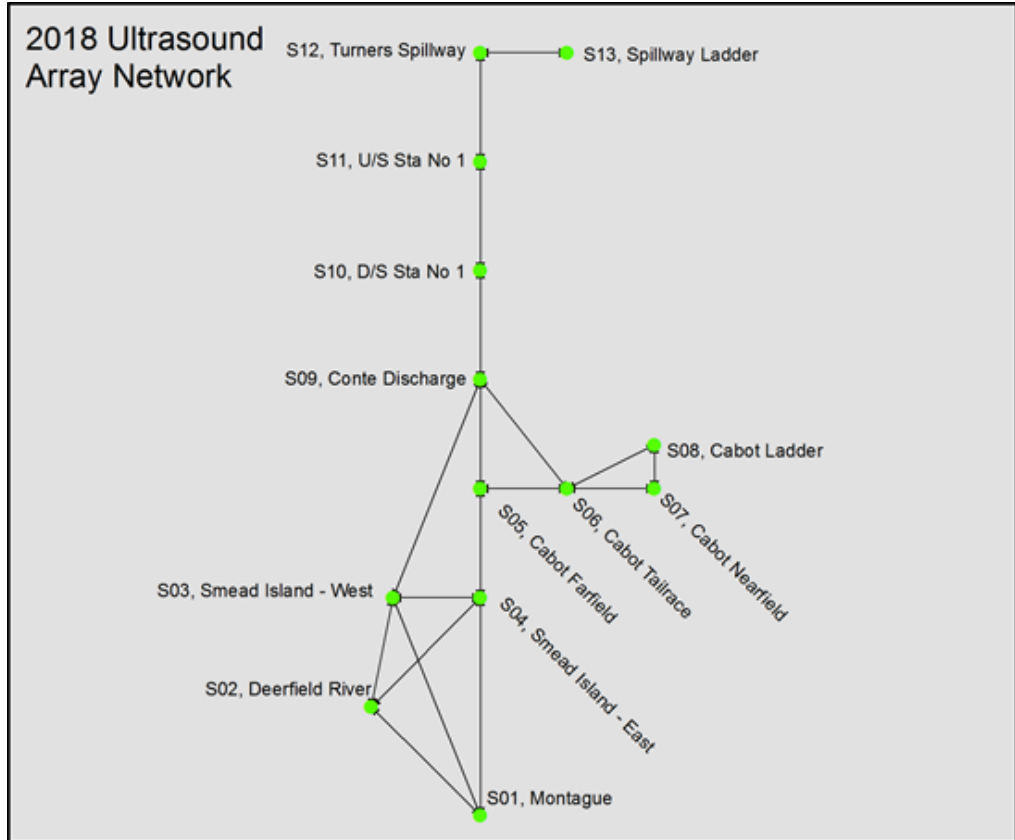
- Cox Proportional Hazard Regression (Cox-PH) compares the hazard rate at two levels of an explanatory variable
- We are always comparing the hazard rates at one level to the hazard rates at baseline
- In our experiment to the right, we visualize the hazard rates at different experimental levels with a ball drop



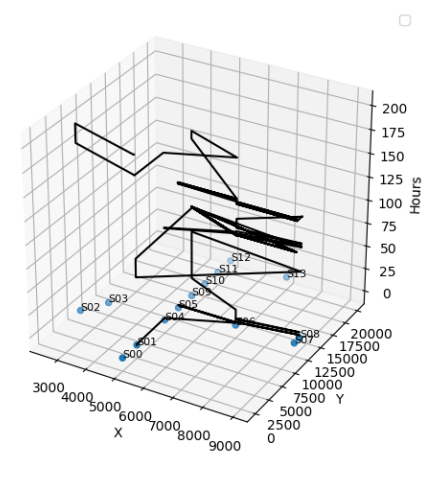
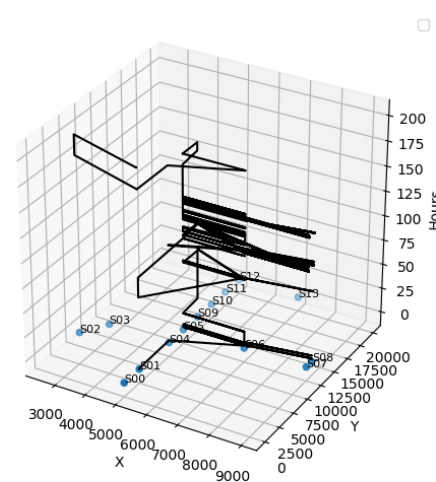
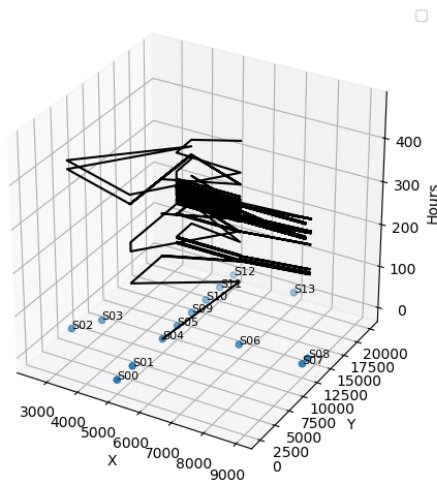
- Moving windows (1, 2, 5 and 24 hours) calculated rolling average and volatility (aka variance)
- Cumulative measures over the entire exposure
 - Average, variance
 - Change in flow over exposure $Q_{t1} - Q_{t0}: dQ$
 - Absolute change in flow: $|dQ|$
 - Rate of Change in Flow: dQ/dt



Station Location	Telemetry Receiver	Station ID	RM
Montague Wastewater Treatment Facility	T02	S01	118.3
Deerfield River	T01	S02	118.8
Smead Island West	T03O	S03	119.0
Smead Island East	T03L	S04	119.0
Cabot Tailwater (farfield)	T07	S05	119.3
Right Side of Cabot Tailrace	T05	S06	119.3
Left Side of Cabot Tailrace	T04	S06	119.3
Cabot Tailrace (nearfield)	T06	S07	119.3
Cabot Ladder Entrance	T08	S08	119.3
Conte Discharge Area	T09	S09	119.7
Bypassed Reach, D/S of Station No. 1	T10	S10	121.1
Bypassed Reach, Upstream of Station No. 1	T11	S11	121.2
Spillway Ladder Entrance	T12	S13	122.2
Spillway Ladder Vicinity	T13	S12	122.2

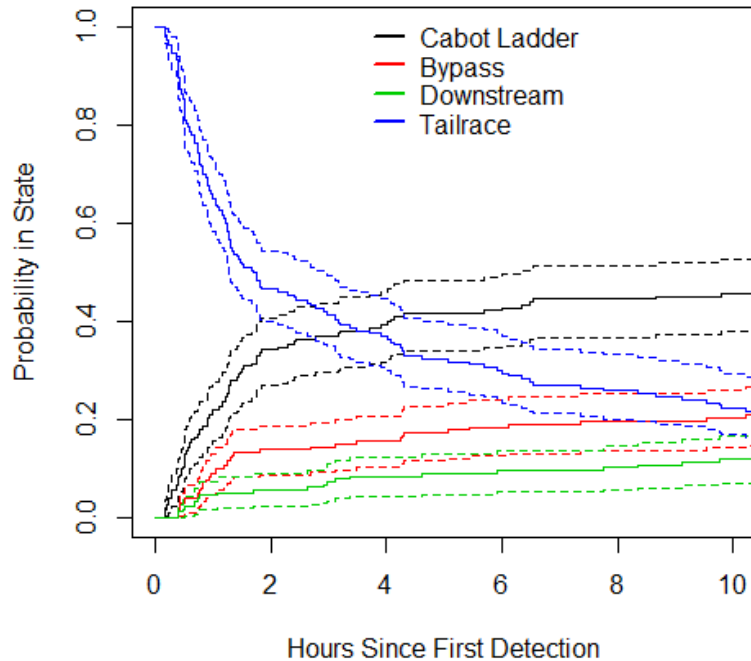


- Naïve Bayes retained 71% Orion and 91.7% Lotek detections
- Russian-Doll removed 421,090 overlapping detections
- 4,311,962 detections from 213 fish used in analysis

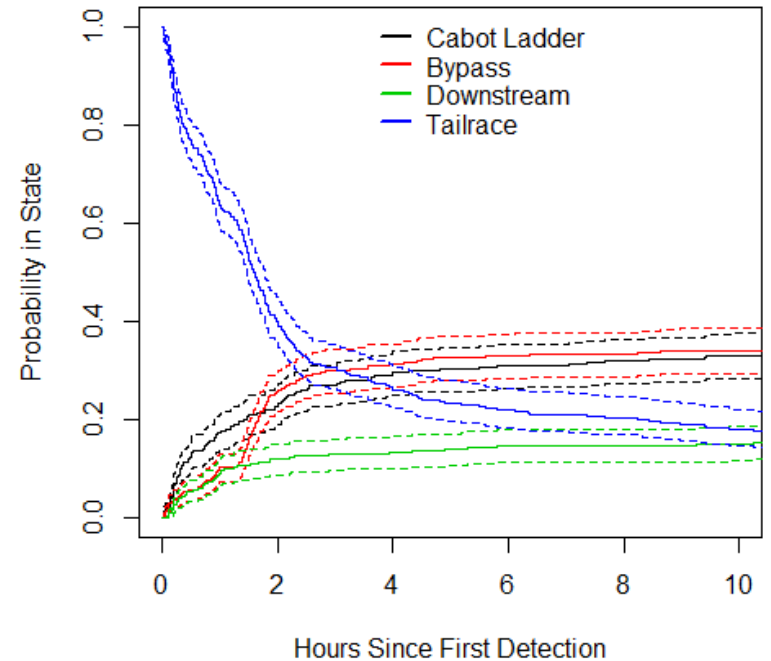


- Overall more movements towards ladder in 2018 than in 2015 (117 v 87) – simply because there were more fish present in 2018 (n = 112 v n = 66)
- Median number of movements per fish towards ladder lower in 2018 than 2015 (2 v 3)
- Fish more likely to move from the ladder to the tailrace when ultrasound present (HR 3.13); however, effect reduces with time (HR = 0.62)
 - We conclude that the longer fish are exposed to ultrasound, the less likely they are to move. This effect diminishes over time.
- Movement towards bypass reach affected by Cabot discharge and short term volatility
 - For every 1,000 cfs over baseline, fish are less likely to move (HR = 0.87)
 - Short term volatility spurs movement (HR = 1.2) – when operations change fish move

2015



2018



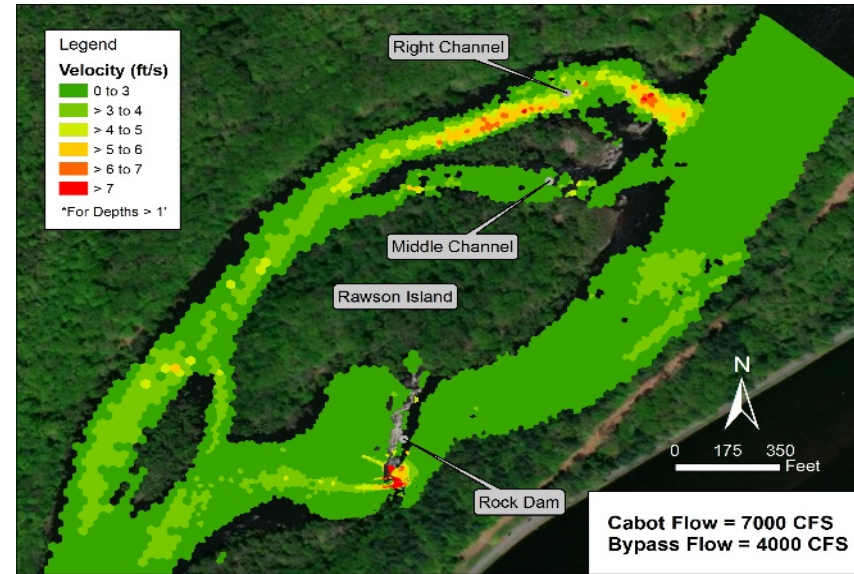
Ratio of Spillway Ladder to Cabot Ladder 2008-2018

Year	Spillway	Cabot	Ratio
2008	627	15,809	0.04
2009	928	13,360	0.07
2010	2,735	30,232	0.09
2011	1,966	27,077	0.07
2012	10,608	51,901	0.20
2013	10,571	46,886	0.23
2014	24,262	40,666	0.56
2015*	41,836	47,588	0.88
2016**	19,337	34,709	0.56
2017	16,741	43,269	0.39
2018**	32,593	24,031	1.36
*= Bypass flow maintained ** = Bypass flow maintained and ultrasound array present			

- With excellent recapture at all receivers, including Station Number 1 we identified a bottleneck in the bypass reach – large portion of the population drops off between Conte Discharge and the Spillway

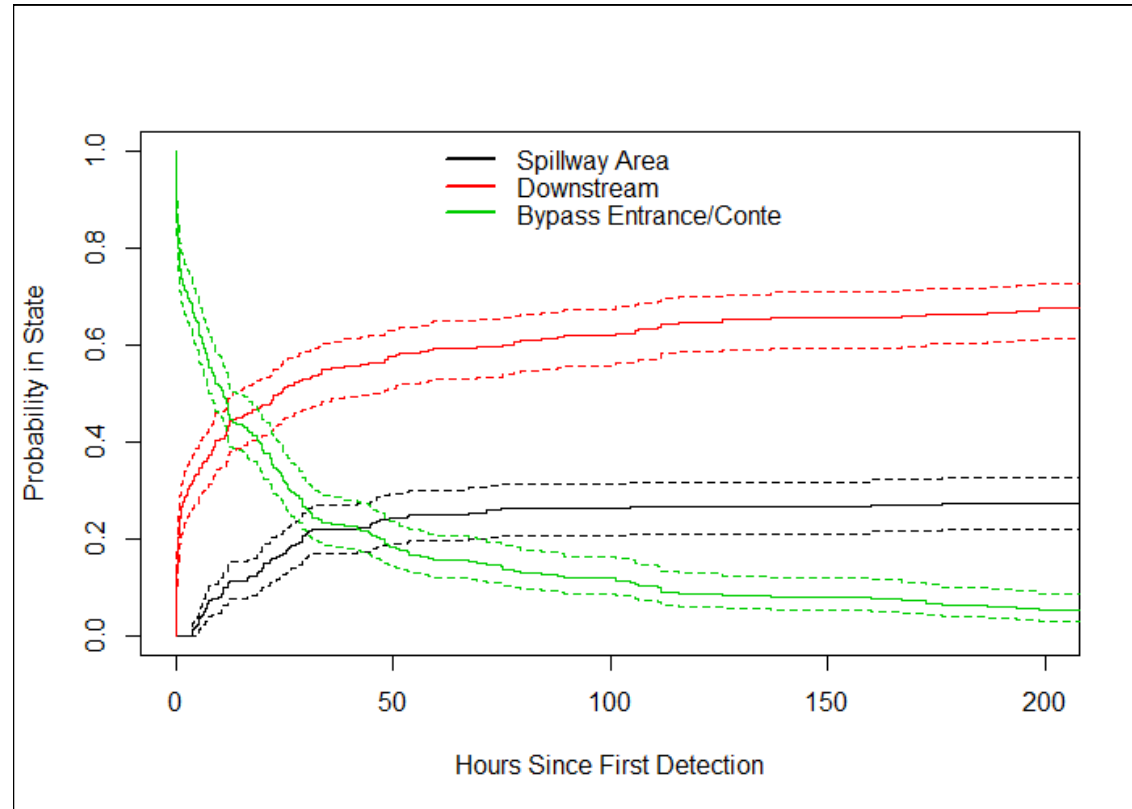
Parameter	Estimate	SE	Lower	Upper
(ϕ 1) Montague > D/S Tailrace	0.87	0.03	0.81	0.92
(ϕ 2) D/S Tailrace > Tailrace	0.98	0.01	0.95	0.99
(ϕ 3) Tailrace > Bypass	0.72	0.04	0.63	0.79
(ϕ 4) Bypass > Station No. 1	0.43	0.05	0.33	0.54
(ϕ 5) Station No. 1 > Spillway	0.94	28.69	0.75	1.00

Rawson Island Velocity Barrier



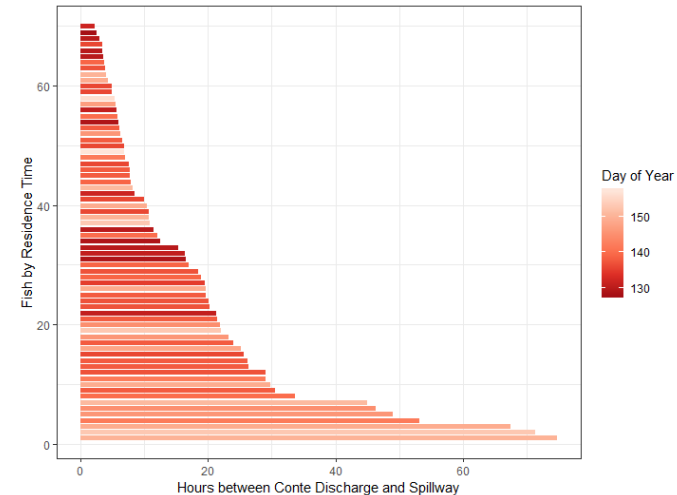
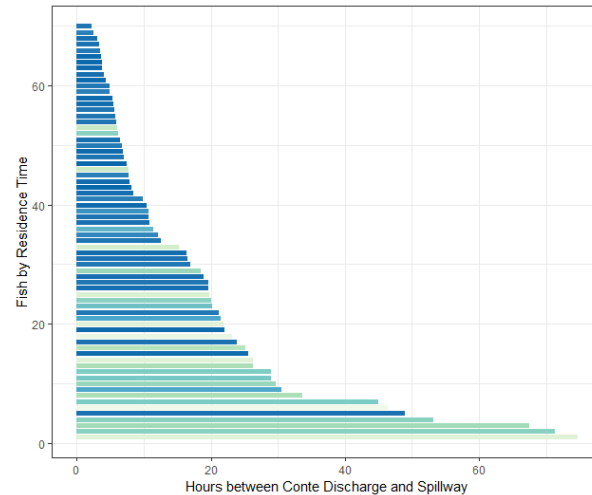
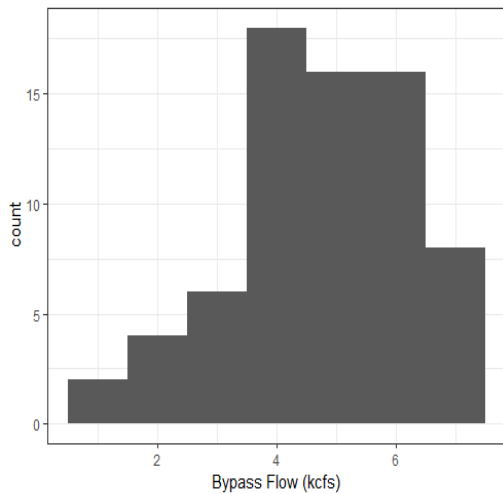
Aggregated Bypass Movement (2015, 2016, 2018)

- In 2015, 20 of 54 fish (38%) made 23 movements
- In 2016, 11 of 28 fish (39%) made 23 movements
- In 2018, 30 of 85 fish (35%) made 38 movements
- All results comparable to 2018 CJS which concluded there is a 35% chance that a fish recaptured at entrance to bypass reach will arrive at TFD spillway

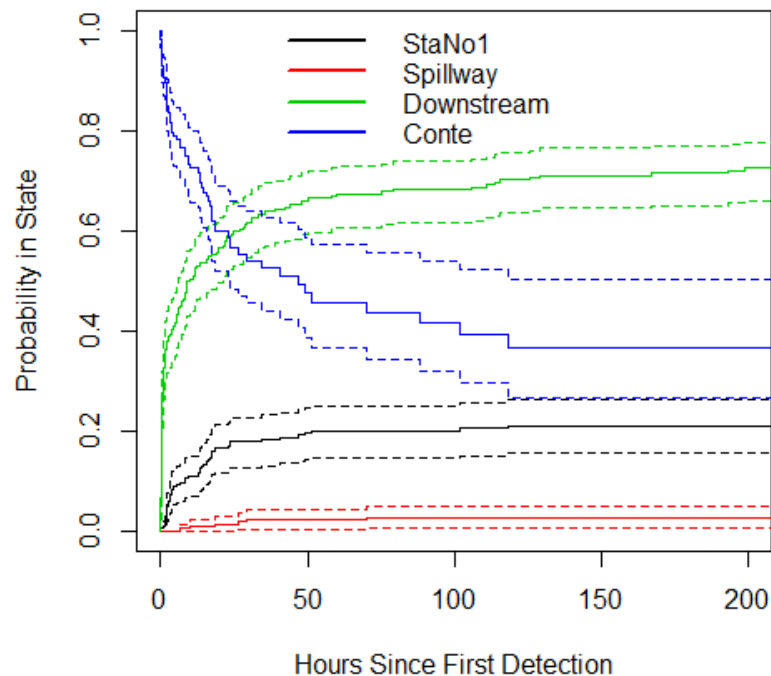


Aggregated Bypass Movement (2015, 2016, 2018)

- The best model incorporated:
 - Cumulative Avg Flow (HR = 6.92)
 - Absolute change in Bypass flow while present (HR = 0.72)
 - Day of Year:Cumulative Average Flow (HR = 0.99)

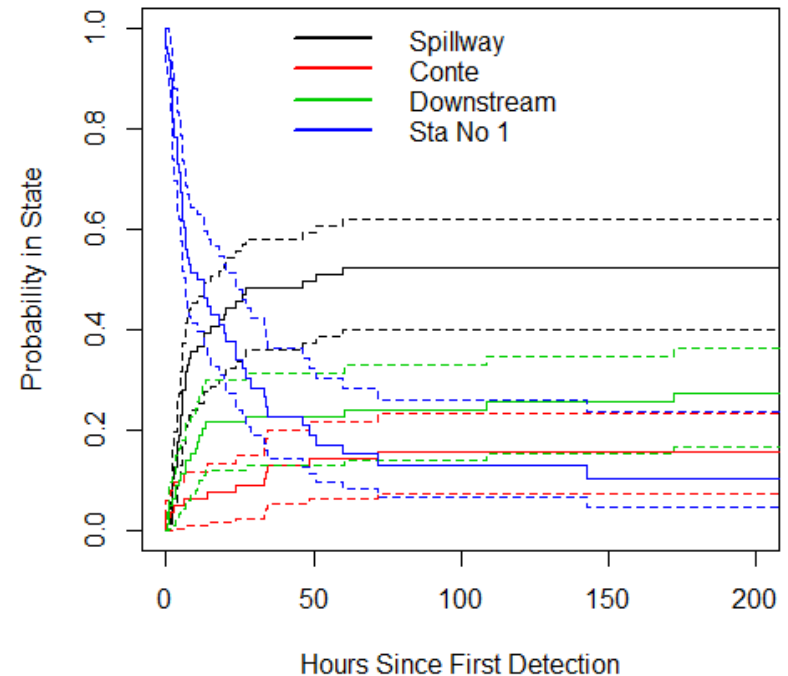


Conte to Station No. 1



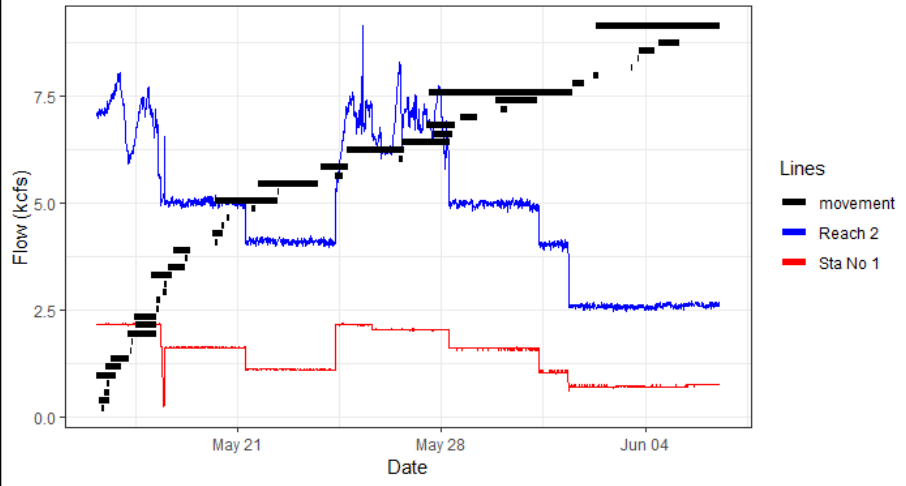
More fish moving downstream

Station No. 1 to Spillway

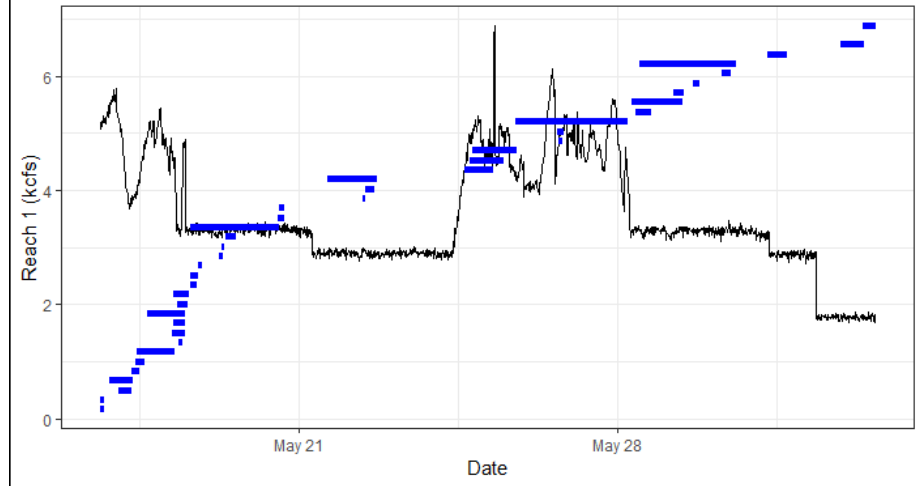


More fish moving upstream

Reach 2 Flow Conditions While Moving from Conte to Station Number 1



Reach 1 Conditions While Moving from Station Number 1 to Spillway



Results of the 2018 study indicated that of the 112 adult American Shad that arrived at the Cabot tailrace, 85 fish (76%) moved upstream into the bypass reach entrance before encountering a velocity and physical barrier around Rawson Island.

These findings indicate that the Ultrasound Array may be keeping a proportion of the migrating shad out of the Cabot Station tailrace.

Since additional flow in the bypass reach and the ultrasound array were both added as part of the previous Ultrasound Array studies in 2016 and 2018, it is not possible to ascertain which contributed to the increased number of fish that moved upstream and entered the bypass reach.

To determine the contribution of increased flow and/or the Ultrasound Array of the tagged fish moving upstream to the bypass reach, FL will conduct a movement study in 2019 with test flows in the bypass reach but without an Ultrasound Array.

Study Objectives

- To determine if a similar proportion of tagged migrating adult shad will migrate upstream of Cabot Station and into the bypass reach without the ultrasound array in place;
- To investigate adult shad migration in the area of Rawson Island and Rock Dam.
- To determine if adult shad migrate by the Station No. 1 tailrace under a flow split of 50% spill from the TFD and 50% from Station No. 1. The 2018 study used a flow split of 67% spill from the TFD and 33% from Station No. 1, which appeared successful in terms of moving adult shad by Station No. 1 and toward the TFD. For the 2019 study both the 67%/33% and 50%/50% flow splits will be tested for two different total flow scenarios (4,400 and 6,500 cfs).
- To investigate the rates of immediate and latent survival for emigrating post-spawn shad that pass through the Cabot Station turbines as they move back downstream.

Material & Methods

- Collect and radio tag a total of 250 early migrating adult shad at Holyoke Dam
- Bypass flow release schedule:

MAY

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
28	29	30	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

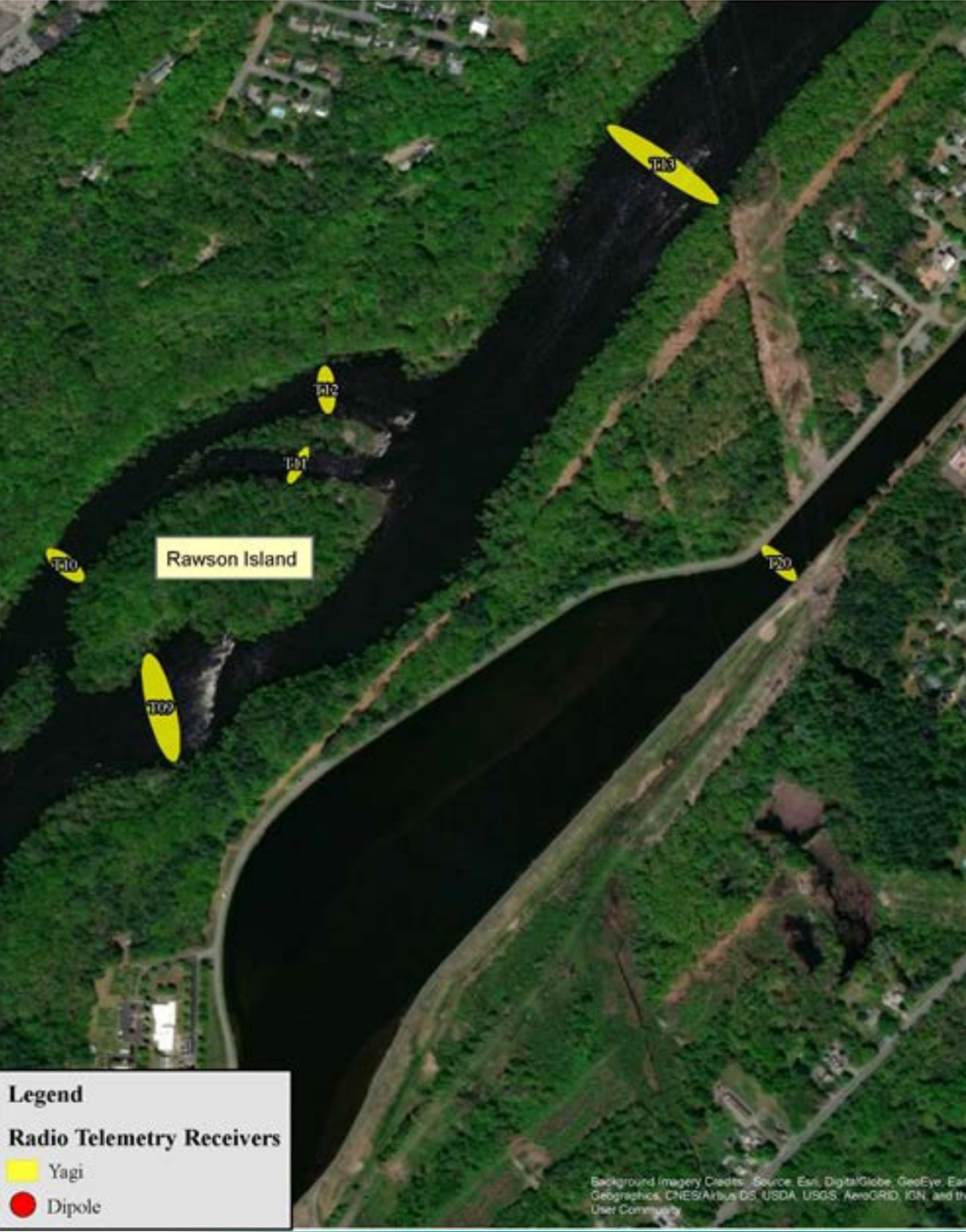
	ramp day
	4,400 cfs with 3,000 cfs (68%) from TFD and 1,400 cfs (32%) via Station No. 1
	4,400 cfs with 2,190 cfs (50%) from TFD and 2,210 cfs (50%) via Station No. 1
	6,500 cfs with 4,290 cfs (66%) from TFD and 2,210 cfs (34%) via Station No. 1

Monitoring ID	Location
T01	Montague Wastewater Treatment Plant (Yagi)
T02	Entrance to the Deerfield River (Yagi)
T03E	Downstream End, East Channel of Smead Island (Yagi)
T03W	Downstream End, West Channel of Smead Island (Yagi)
T04	Left Side of the Cabot Station Tailrace (Yagi)
T05	Right Side of the Cabot Station Tailrace (Yagi)
T06	Cabot Ladder Entrance (Dipole)
T07	Cabot Station Far Field (Yagi)
T08	Conte Discharge Area (Yagi)
T09	Rock Dam (Dipole)
T10	Lower Left Channel Rawson Island (Yagi)
T11	Middle Channel at Rawson Island (Dipole)
T12	Left Channel at Rawson Island (Dipole)
T13	Bypass Reach, Upstream of Rawson Island (Yagi)
T14	Bypass Reach, Downstream of Station No. 1 (Yagi)
T15	Bypass Reach Upstream of Station 1 (Yagi)
T16	Spillway Ladder Entrance (Dipole)
T17	Spillway Ladder Vicinity (Yagi)
T18	Cabot Station Forebay (Yagi)
T19	Log Sluice (Dipole)
T20	Copley Tunnel (where canal widens – Yagi)
T21	Nourse Farms Greenfield (Yagi)
T22	Hatfield Wastewater Treatment Plant (Yagi)
T23	Route 202 Bridge Holyoke, MA (Yagi)

2019 Ultrasound Array Control Study Plan



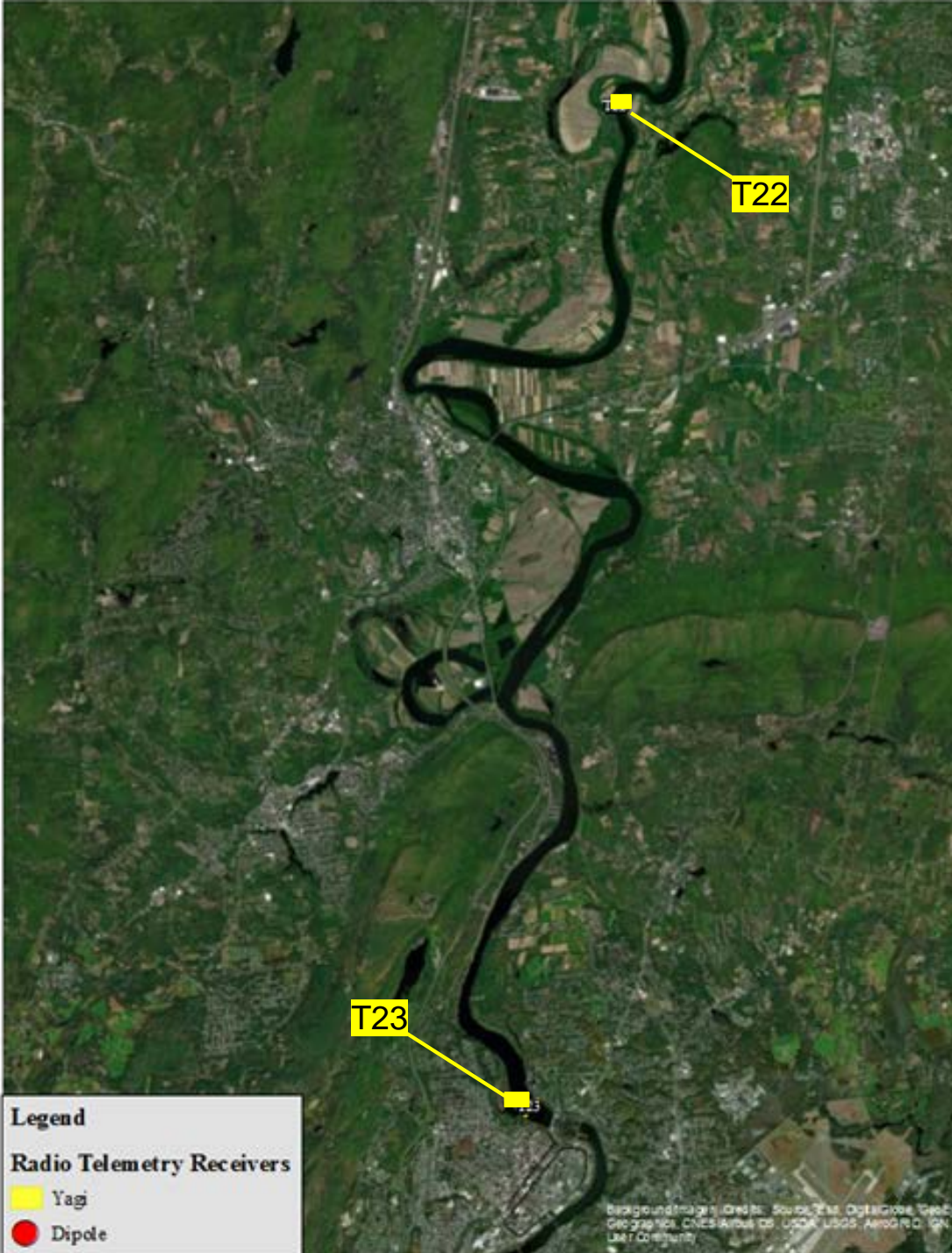
2019 Ultrasound Array Control Study Plan



2019 Ultrasound Array Control Study Plan



2019 Ultrasound Array Control Study Plan



Downstream Movement Assessment

- FL will tag 200 shad at the exit of the Cabot ladder and release them in the canal.
- Downstream movements of all tagged fish (Holyoke and Cabot releases) as they approach, and pass Cabot Station will be monitored and assessed with a combination of mark-recapture methods and time-to-event modeling.
- At least 20 euthanized fish will be tagged and released via the Cabot log sluice during a high and low Cabot operating scenario and their movements tracked downstream.
- FL will track this specific cohort of dead fish to track their float downstream.
- Mobile tracking to recover all or most dead fish to assess immediate and latent mortality will occur in the stretch of river once per week between the Hatfield WWP and the entrance of the bypass reach at the Cabot Station discharge.
- FL will file the study results with FERC.

NFM Tailrace River2D Study Chronology

Date	Milestone
03/01/16	FL filed Study Report
03/16/16	Study Report Meeting
04/30/16	Deadline for Stakeholder Comments on Study Report
05/31/16	FL issued Stakeholder Response to Comments
06/29/16	FERC issued Determination Letter. FERC required: <ul style="list-style-type: none"> • <i>We recommend that FirstLight consult with the fisheries agencies after the other fish migration studies have been completed to determine if additional analysis of the modeling results is necessary to describe how velocities and flow fields near the Northfield Mountain Project intake/tailrace may be affecting fish migration.</i>
10/23/18	Raised the River2D report at the 10/23/18 FERC meeting No comments received at meeting; no comments filed