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
Plant General Manager

October 24, 2018

VIA ELECTRONIC FILING

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

Re: FirstLight Hydro Generating Company, FERC Project Nos. 2485 and 1889
October 9, 2018 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 various addendums to previously filed reports between April 3, 2017 and July 28, 2017. Pursuant to the Revised Schedule, on October 9, 2018, FirstLight held meetings to discuss the six addendums to 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 October 9, 2018 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, to access the document. FirstLight is also making the same available for download at the following website: http://www.northfieldrelicensing.com.

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

Sincerely,

Douglas P Bennett

Doug Bennett

Attachment A: Meeting Minutes
Attachment B: PowerPoint Presentation

<u>ATTACHMENT A: MEETING SUMMARY</u>

Location: Northfield Mountain Visitors Center, 99 Millers Falls Road, Northfield, MA
Date October 9, 2018
Attendance:

Federal Energy Regulatory Commission
Patrick Crile (via phone)
Steve Kartalia (via phone)
Bill Connelly (via phone)

United States Fish and Wildlife Service
Melissa Grader
Ken Sprankle

National Marine Fisheries Service
Bill McDavitt

Massachusetts Wildlife
Jessie Leddick

Massachusetts Department of Environmental Protection
Bob Kubit (via phone only for Study 3.1.2)
David Cameron (via phone only for Study 3.1.2)
Brian Harrington (via phone only for Study 3.1.2)

No Affiliation
Karl Meyer

Connecticut River Conservancy
Andrea Donlon
Don Pugh
Kathy Urffer

Van Ness Feldman
Mike Swiger

Franklin Regional Council of Governments (FRCOG)
Kimberly Noake McPhee (afternoon only)

Kleinschmidt Associates
Chris Tomichek
Kevin Nebiolo
Steve Knapp (via phone, only for Study 3.5.1)

Cardno
Andrew Simon (via phone, only for Study 3.1.2)

FirstLight
Doug Bennett
Marc Silver
Jim Donohue

Gomez and Sullivan Engineers
Tom Sullivan
John Hart
Tim Sullivan
Mark Wamser

Great River Hydro
John Ragonese (via phone)

Introductions, Meeting Purpose and Process Timeline

Mark Wamser (Gomez and Sullivan) opened the meeting and welcomed everyone. Mark asked everyone to introduce themselves and reviewed the agenda (Slide 2). Mark noted that between April 2017 and July 2018 several addendums were filed with FERC (Slide 3). He explained that on August 10, 2018, the Federal Energy Regulatory Commission (FERC) issued a revised process plan and schedule requiring FirstLight hold study report meetings on October 9, 2018 and March 30, 2019. For the October 9, 2018 meeting there were six addendums to review and on March 30, 2019 there were an additional two addendums and one report (archaeology). Mark noted that the emphasis on the two meetings was on the addendums; not reviewing the original studies. Mark reviewed FERC's revised process and schedule.

Study No. 3.3.1- Instream Flow Studies in Bypass Reach and below Cabot

<u>Addendum 1- Address Range of Comments Provided on Original Report</u>

Mark first reviewed Addendum 1, which addressed various comments filed on the original report.

Mark reviewed the overall schedule associated with the instream flow study (see Slide 5), indicating the original report was filed on October 14, 2016. He noted there were numerous comments filed on the original report and not all comments could be addressed in FirstLight's response to comments. Thus, FirstLight indicated it would file an addendum (Addendum 1) to address the comments. In FERC's Determination Letter (based on the original report), it required FirstLight to consult with the agencies in developing site-specific habitat suitability index curves for Sea Lamprey spawning, since data was collected at spawning sites during Study No. 3.3.15 (Sea Lamprey spawning study). In the end, FirstLight filed the following addendums:

- Addendum 1: Address comments on the original study report (filed 4/3/2017)
- Addendum 2: IFIM Study Results for Mussels in Reach 5
- Addendum 3: Yellow Lampmussel Assessment in Reach 3
- Addendum 4: Sea Lamprey Assessment with new habitat suitability index (HSI) curves

Slide 6- Mark noted that the stakeholders requested FirstLight develop habitat time series graphs for various species and life stages of fish in Reach 4 and 3. A period from June 28 to July 8, 2002 was selected for the habitat time series because it included a range of flows as follows:

- High bypass flows (over 10,000 cfs) and lower bypass flows in the 500 to 2,500 cfs range (entering Reach 3),
- Cabot peaking operations
- Based on Montague USGS gage flows ranging from over 30,000 cfs to ~2,000 cfs.

Karl Meyer asked about the upper extent of Reach 3. John Hart (Gomez and Sullivan) answered that the upper end of Reach 3 is Rock Dam and the upper part of the right channel around Rawson Island.

An example habitat time series graph was provided for various life stages of American shad in Reach 4 (Slide 7).

Slide 8- Another request was to provide habitat versus discharge relationships for state-listed mussels in Reach 3. An example weighted usable area (WUA) versus flow curve was provided for juvenile yellow lampmussel in Reach 3 for various combinations of bypass flow, Cabot flow and constant Deerfield River flow of 200 cfs.

Slide 9- Stakeholders requested that the WUA tables be updated to include flows of 6,500 cfs, 8,000 cfs and 10,000 cfs. Mark presented an example WUA table for various species and life stages of fish under the requested flows of 6,500 cfs, 8,000 cfs and 10,000 cfs.

Slide 10 and 11- Stakeholders requested habitat time series graphs for various species and life stages in Reach 3. Mark noted that the same June 28-July 8, 2002 period of record was used as it represented a range of flow conditions. An example habitat time series for spawning, juvenile and adult American shad was provided.

Slide 12- Stakeholders requested that the WUA versus flow curves be extended up to 20,000 cfs. An example was shown for all life stages of American shad in Reach 4, which went up to 20,000 cfs.

Slide 13-16- Stakeholders noted in their comments that the WUA versus flow curves in Reach 3 never had the habitat maximizing (or peaking) and requested that the hydraulic analysis be extended to higher flows. Mark noted that additional modeling was conducted for requested flows of 6,500, 8,000 and 10,000 cfs with the normal array of Cabot discharges. Mark noted that revised figures and diagrams were included as an Attachment to Addendum 1. Other attachments in Addendum 1 included combined suitability index habitat maps and persistent habitat maps. Mark explained that for some species and life stages, including American shad spawning and shortnose sturgeon, the WUA versus flow curves still show a slight upward slope with the higher flows. An example Reach 3 WUA versus flow curve was shown for American shad spawning under a range of bypass flows, Cabot flows and a constant Deerfield River flow of 200 cfs (Slide 14). An example combined suitability index map and persistent habitat map of Reach 3 was provided for American shad spawning (Slide 15 and 16, respectively).

Slide 17-18- Similar to a previous comment, stakeholders requested that higher flows be evaluated in Reach 3. An attachment to Addendum 1 included WUA versus flow tables that included flows of 2,500, 4,500, 7,000 and 14,000 cfs (Slide 17/18).

Addendum 2- Mussels in Reach 5

Mark provided background (Slide 19) on the assessment of mussels in Reach 5. In the October 14, 2016 report, FirstLight included a screening analysis for state-listed mussels. The stakeholders requested additional information beyond the screening analysis and requested that a revised study plan be developed. FirstLight provided stakeholders with a revised study plan (RSP) on May 19, 2017 and requested comments. The RSP included a full-scale instream flow and a meeting was held on June 1, 2017 to discuss the RSP. On August 8 and 9, 2017, Natural Heritage, US Fish and Wildlife Service and The Nature Conservancy expressed support for the final RSP, which was filed with FERC. On May 1, 2018, FirstLight filed Addendum 2- Reach 5 Mussels.

Mark noted that the study evaluated juvenile and adult life stages of Yellow Lampmussel, Eastern Pondmussel and Tidewater Mucket as well as host fish (deep slow guild, deep fast guild, shallow slow guild, shallow fast guild). A table of binary HSI classifications were developed for the mussels based on water depth, substrate, benthic velocity and sheer stress thresholds (see Slide 20).

Mark showed a plan map of Reach 5 (Slide 21) and how representative sub-reaches were selected. The reaches included Dry Brook (Run with gravel substrates, 3 transects), Hatfield (Run with sand and 3 transects) and Mitch's Island (Run with fine substrate and under low flows is influenced by Holyoke Dam elevations, 4 transects). The study included a total of 10 transects.

Mark explained the field data collection (Slide 22) included placing water level loggers at the 10 transects and at Holyoke Dam and collecting depth and mean column velocity data with the Acoustic Doppler Current Profiler (ADCP). Substrate was classified by visual means or probing, if the water depth was deep. A low and high flow calibration data sets (Slide 23) were collected in all three reaches. The existing HEC-RAS hydraulic model from Montague to Holyoke Dam was updated with the new 10 transects and the model was calibrated to the high flow data set and validated with the low flow data set. Habitat modeling was done in PHABSIM.

Mark showed an example WUA versus flow output for juvenile and adult Yellow Lampmussel (Slide 24) which varies pending the Holyoke Dam water surface elevation. An example dual flow table (Slide 25) was also included for Yellow Lampmussel based on 3 (velocity, depth, substrate) and 4 (velocity, depth, substrate and shear stress). A plan map (Slide 26) of the Hatfield subreach was provided to show where shear stress did, and did not, exceed the shear stress threshold. Mark noted that maps were developed for flows of 2,000, 5,000, 10,000, 15,000, 20,000 and 25,000 cfs.

A question was raised by a stakeholder about the shear stress threshold exceedance area changing from river right to river left between T-7 and T-6 on Slide 26. John Hart (Gomez and Sullivan) described the mapping as based on representative transects and the mapping was shown as the representative transect to the halfway point to the next transect. Melissa Grader (USFWS) asked if the coverages shown on Slide 26 are available in a GIS or Google Earth Format and John Hart stated that they are available. Jesse Leddick (NHESP) asked if individual habitat numbers were available for each representative reach, and John Hart answered that they are available. Jesse Leddick stated that these numbers could help indicate why no rare mussels were found at the Dry Brook Reach and farther upstream.

Mark noted that in summary (Slide 27) for adult Yellow Lampmussel and adult Tidewater Mucket, even after accounting for shear stress, there was no decrease in WUA up to, and including, flows of 25,000 cfs. For juvenile life stage and adult Eastern Pondmussel, about a 20% decrease in habitat occurred from 8,000 cfs to 16,000 cfs. A lower Holyoke Dam water surface elevation increases velocities slight, which is limited due to the hydraulic constriction at the Dinosaur Footprints. The study confirmed that flows in excess of the project is the largest limiting factor in mussel habitat.

Addendum 3- Yellow Lampmussels in Reach 3

Mark provided an example WUA versus flow curve for juvenile Yellow Lampmussel (Slide 28) in Reach 3 based on 4 variables (depth, velocity, substrate and shear stress) under various Cabot flows, bypass flows and a Deerfield River flow of 200 cfs. An example plan map showing the combined HSI for juvenile Yellow Lampmussel in Reach 3 under a Cabot discharge of 2,500 cfs, Bypass flow of 200 cfs and Deerfield River flow of 300 cfs was shown. Mark noted that composite HSI is binary.

Jesse Leddick stated that persistent habitat maps would also be useful to determine the change in available habitat during different flow combinations.

<u>Addendum 4- New Sea Lamprey Spawning HSI Curves</u>

FERC required FirstLight develop new Sea Lamprey spawning HSI curves based on the data collected at redd locations as part of Study No. 3.3.15. The new depth and velocity HSI curves were shown (Slide 30) and an example WUA versus flow curve was shown with the new (and old) Sea Lamprey HSI curves (Slide 31).

Study No. 3.3.2- Evaluate Upstream and Downstream Passage of Adult American Shad

Kevin Nebiolo reviewed the chronology of filings related to the Adult Shad Passage Study (Slide 32) including the requirements in the 02/17/17 Determination Letter from FERC.

On Slides 33 and 34 Kevin Nebiolo summarized how the data was reanalyzed due to comments on the study report.

On Slide 35, Don Pugh (CRC) asked about where for the Holyoke release site was the fallback location, and Kevin Nebiolo stated that that it was near the Redcliffe Canoe Club. Likewise Don Pugh asked about the fall back location for the canal and the TFI. Kevin Nebiolo (KA) stated that for the canal it was near the Conte intake and for the Turners Falls Impoundment (TFI), at Gill. Bill Connelly (FERC) asked if the fallback fish were used for the mortality calculations and Kevin Nebiolo stated that he was not sure and could get back with that information. Upon checking, fall back fish were not used in mortality calculations for Holyoke released fish on table 2.6-2, but could have been included in the emigration mortalities for Canal and Impoundment released fish.

On Slide 36, Bill Connelly asked if that table indicated that 8 fish died during emigration in the bypass reach. Kevin Nebiolo stated that is correct. Bill Connelly asked if there is a table in the report of the number of fish passed at each location and Kevin Nebiolo said yes.

On Slide 37, Don Pugh asked if all of the receivers allowed for mobile tracking of the fish and Kevin Nebiolo said yes.

On Slide 38, Bill McDavitt (NMFS) asked how variable flows at Cabot were accounted for in the analysis. Kevin Nebiolo stated that the Cox proportional model looks backward in time (1,2, 6, 12, and 24 hours) and examines volatility in the flow. It is not in the addendum, but was done for the 2018 ultrasound study. Bill McDavitt also asked if the hazard rate is linear. Kevin stated that one of the assumptions of the Cox Proportional Hazard regressions are that hazard rates are linear, and that the hazard rate does not change with changes in levels of the covariate. In 2018, these assumptions were tested by examining the Schoenfeld Residuals as requested by the USFWS in comments on the study plan . Kevin Nebiolo stated that the 2018 study data will result in a substantially different table values. Don Pugh asked for more insight on the HR value of 0.94 for the Bypass: Cabot covariate. Don Pugh also asked if multiple movements by the fish could affect the shown Spoke relationship. Kevin replied that multiple movements made by a single fish are controlled in the model by using the cluster argument as described in the Addendum. Kevin Nebiolo described relationships shown in the Probability vs Days Since First Detection graphs on this page and others and how a higher slope in the first few days is desirable and indicates good passage efficiency.

On Slide 39, Kevin Nebiolo stated that only one or two fish moved during the Cabot shutdown. Bill McDavitt asked if the figures in the lower right were able to determine if fish moved at 2,000 cfs or 4,500 cfs or other values. Kevin Nebiolo stated that the model regresses on the value of the covariate in the instant before a fish moves.

On Slide 40, Don Pugh had questions about the bypass flow interval of 2,000 cfs and whether that is appropriate for the flows during the study. Kevin Nebiolo stated that for the bypass, the data shows about 20% passage from the Conte receiver to the Turners Falls Dam Spillway receiver and this is similar to what he is seeing in the 2018 data.

Karl Meyer asked how Station No. 1 affected the data. Kevin Nebiolo stated that only about 50% of the fish made it from the Conte receiver to the Station No. 1 receiver whereas 90% made if from the Station No. 1 receiver to the TFD Spillway d receiver. Kevin Nebiolo also stated that we believe there is a natural barrier to migration at Rock Dam.

Karl Meyer asked if the Station No. 1 bypass sluice was in operation during the study. Doug Bennett (FirstLight) stated probably not since it is very rarely used.

Ken Sprankle (USFWS) asked if the data showed that fish made multiple attempts to the spillway and if the data is over the entire period of the study. Kevin Nebiolo replied that the state table (2.8.3-2) lists all of the movement made by fish within the bypass reach. Examination of the state table shows 25 fish made 21 movements from the bypass reach towards the Turners Falls Spillway.

Karl Meyer asked about the flow split at Rawson Island and how much goes to Rock Dam or the right side of Rawson Island. John Hart (Gomez and Sullivan) stated that at low flows it is generally about a 50/50 split but more than 50% goes to the Rock Dam side of Rawson Island at high flows.

Tom Sullivan (Gomez and Sullivan) mentioned how the IFIM study results indicated shad spawning habitat between the Conte receiver and Station No. 1.

Don Pugh stated that the 2015 study indicated that 70% of the fish at the Conte receiver made it to Station No. 1.

On Slide 41, Kevin Nebiolo pointed out the limited number of fish that were available for this area. Melissa Grader asked for the location of the upper bypass receiver and Kevin Nebiolo stated that it was near the Turners Falls Dam.

On Slide 42, Kevin Nebiolo point out the bottleneck that occurs in the canal and how only 64% made it to the point where the canal narrows. Melissa Grader asked how the number of fish used in the data analysis could affect the results. Kevin Nebiolo commented that lower samples sizes would be reflected in the confidence intervals around our estimates.

On Slide 43, Don Pugh asked about how many fish moved at 5,000 cfs intervals as compared to the probability of the flow occurrence in the study period. Kevin Nebiolo stated that we did not account for flow availability and that perhaps there was an index that could be calculated. Andrea Donlon (CRC) asked how the flow was modeled at the NFM tailrace/intake area. Kevin Nebiolo stated that the flow used were from the 1D HEC-ResSim model which also accounted for NFM) operations. Bill Connelly asked how the migration model accounted for a 1,000 cfs change in NFM operations. Kevin Nebiolo stated that the Cox Proportional algorithm uses an instantaneous timestep. Don Pugh asked if the changes at Vernon and NFM are accurately determined with a 15 minute change in flows. Kevin Nebiolo stated that the change in flow noted was the change in flow during the 15 minute period prior to movement (dQ/dt) and should be treated as the instantaneous change in flow with respect to time. Kevin Nebiolo also stated that the 2018 study will account for other metrics of flow variability, including volatility over a 1, 2, 5 and 24 hour period and change in flow while present. Andrea asked if the 2018 telemetry study included receivers in the TFI and Kevin Nebiolo confirmed that it did not..

On Slide 44, Don Pugh stated that due to recapture effects, this slide could be of limited value. Kevin Nebiolo stated that Cohort 1 is the earliest group and Cohort 5 is the last group and that the confidence interval associated with each cohort and survival metric are found in the report. Don Pugh asked about movement to Vernon or Shear Farms and then back to NFM.

On Slide 46, Melissa Grader asked if the fish numbers in the "Did Not Pass" category probably meant that the majority of these fish died. Kevin Nebiolo stated that is probably right, but that we cannot confirm. Karl Meyer asked if the Cabot Emergency Spillway was used during the study period. Doug Bennett, stated that he believed the Cabot Emergency Spillways was very rarely used during this study period, but he would need to confirm. A FERC caller asked if these numbers included fish that were milling near Cabot. Kevin Nebiolo stated that milling fish would be stuck between receivers T8 and T9 used in the 2015 study. Melissa Grader asked about the differences between the solid and dashed lines show in the Probability vs Days Since First Detection graphs. Kevin Nebiolo stated that the dashed lines represented the 95th probability error distribution values.

Discussion occurred about how the mobile tracking telemetry distinguished between live recapture and dead recovery data points. Kevin Nebiolo stated that there is always some unknowns about deaths based on the telemetry data. With mobile tracking we are unsure of where and when they died, while assessment of mortality at Lotek receivers was difficult because of the nature of the receivers and that they switch frequencies.

On Slide 48, Kevin Nebiolo stated that the references shown in the x axis are defined in the addendum and that the error bars shown in the graph are representative of the normal approximation to the binomial. Don Pugh asked if the references shown on the X axis are in chronological order and Kevin Nebiolo stated that he did not think so, but he was not sure.

Melissa Grader asked if the Addendum changed much from the earlier study report and Kevin Nebiolo said no. Kevin Nebiolo stated that the primary difference between the multi-state markov (MSM) used in the original analysis and the Competing Risks framework used in the addendum was that with MSM modeling we can model movement back into the original location, while we will need at least two models to assess return movements using the competing risks framework. Both the MSM and CoxPH regression techniques assess movement with a hazard rate. The primary difference between the original assessment and the addendum was removal of fall back fish, which would affect the denominator when assessing with simple ratios.

Study No. 3.3.15- Assessment of Adult Sea Lamprey Spawning within the Tuners Falls Project and Northfield Mountain Project Area)

Mark noted that FirstLight filed the original report on October 14, 2016 (Slide 52). In FERC's February 17, 2017 Determination letter, it required FirstLight consult with the stakeholders and establish parameters for a low flow scenario to simulate in the hydraulic model to determine if previously located sea lamprey redds became exposed. Mark noted that there were four locations where information on Sea Lamprey spawning redds were gathered: Hatfield S Curve (below Cabot), Stebbins Island (just below Vernon) and three tributaries- Falls, Millers and Ashuelot Rivers (Slide 53). Mark explained that the three tributaries did not include a hydraulic model, thus it was not possible to conduct the analysis in these locations. He also noted that there was no transects located near the redd detected in the Hatfield S Curve, thus no analysis could be conducted; the only place where the hydraulic model could be used to assess redd exposure were the six redds located near Stebbins Island. Mark explained that HEC-RAS hydraulic model was run in an unsteady mode on an hourly time step to determine water surface elevations at the six redds for the period May 20-July 31 from 2000-2015 (not including 2010). The hydraulic model inputs included observed Vernon discharges, Ashuelot and Millers River flows from the USGS gages and the water surface elevation at the Turners Falls Dam (to set the downstream boundary). The hydraulic model was run and the output—specifically the water surface elevations at the six redds near Stebbins Island was developed (Slide 54). Mark showed an aerial map of the six redd spawning locations (Slide 55). Mark then showed the water surface elevation duration curves at the three locations (which covered the six redd locations) along with the elevation of the redd (Slides 56-58).

Don Pugh (CRC) asked if there is information available on the reason for the low water levels at the redds locations near Stebbins Island. Mark explained that water levels in this location are normally a function of Vernon discharges and Turners Falls Impoundment water levels. Andrea Donlon (CRC), Melissa Grader (USFWS), and John Ragonese (GRH) stated that information on this relationship and or the raw data would be useful.

Study No. 3.3.9- Two-Dimensional Modeling of the Northfield Mountain Pumped Storage Intake/Tailrace Channel and Connecticut River Upstream and Downstream of the Intake/Tailrace

Mark Wamser (Gomez and Sullivan) stated that FirstLight has been recommended by FERC to 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 NFM intake/tailrace may be affecting fish migration

Melissa Grader (USFWS) stated that they are interested in this relationship for the Ichthyoplankton Study and other studies and would be important for the design of possible structures in this area and the proposed expanded use of NFM Upper Reservoir.

Bill McDavitt (NMFS) stated that FirstLight has already run a lot of scenarios and additional scenarios might not be required.

-LUNCH BREAK-

Study No. 3.1.2- Northfield Mountain/Turners Falls Operations Impact on Existing and Potential Bank Instability (aka- Erosion Causation Study)

Tim Sullivan reviewed the chronology of filings related to the Erosion Causation Report (Slide 59). He explained that in FirstLight's draft and final license applications, it proposed to expand the use of the Upper

Reservoir from 100.5-938 (current) to 1004.5-920 (proposed). He noted that a method to assess streambank erosion along the TFI required the use of the three models (Slide 60) including:

- Operations Model (HEC-ResSim), which simulated current and proposed operations of the Upper Reservoir. Outputs from this model were then fed into the hydraulic model and included: TFI inflow, NFM pump/gen flow, and TFI elevation at TF Dam.
- Hydraulic model (HEC-RAS) to simulate hydraulics in the TFI. Outputs of the hydraulic model were fed into the erosion model and included: TFI water surface elevations at different locations along the TFI and energy grade line slope.
- Erosion model (BSTEM) to simulate bank-erosion rates at the 25 detailed study sites previously established throughout the TFI as part of Study No. 3.1.2

Tim explained that FirstLight used the hydrology from calendar year 2002 and the pump/gen schedule from 2009 (Slide 61). FirstLight was given the observed 2009 pump/gen schedule and asked to revise it assuming the additional Upper Reservoir storage was available. The operations model was run to reflect greater use of the Upper Reservoir storage.

Bill McDavitt (NMFS) asked a general question about how routing is handled in HEC-ResSim. John Hart briefly described the nodes within the model layout which generally has a time lag relationship between the nodes based on observed and/or calculated travel times which generally vary during different flow rates.

Andrea Donlon (CRC) asked for a sense of the error bars described in the reports. Andrew Simon (Cardno) noted that a 4% error bar as miniscule and well within the model error range.

A question was raised if the values on Slide 68 are based on the scenario with waves on or waves off. Tim Sullivan stated that the values represent the "waves on" option.

Kimberly McPhee (FRCOG) asked why elevation 184 feet was used as the break point between the upper bank and lower bank. Tim Sullivan stated that this break point was at different elevations for the individual cross sections and was based on site specific characteristics. Andrew Simon stated that the BSTEM model was not biased toward the lower or upper banks. Kimberly McPhee asked if the modeling of the banks occurred above elevation 184 feet, and Tim Sullivan stated that the modeling included the full range of bank elevations.

Karl Meyer asked if Northfield Mountain is being used for baseload generation yet. Doug Bennett (FirstLight) stated that it is a peaking facility.

Kimberly McPhee asked a question about the use of the detailed study sites. Tim Sullivan stated that the detailed study sites were generally from the Full River Reconnaissance Study and each site has detailed information on characteristics that are important to determine erosion rates.

Andrea Donlon said that she doubted the flow reversal modeling of the HEC-RAS model near the NFM tailrace. John Hart stated that during low river flow, the model indicated that pumping at NFM can create upstream flow below the tailrace and also during a combination of generation and low river flow, upstream flow can occur upstream of the NFM tailrace.

Study No. 3.3.20- Northfield Ichthyoplankton Study

Chris Tomichek (KA) reviewed the study chronology of the Northfield Mountain Ichthyoplankton Study Report. She noted that after the original study reports for the 2015, and 2016 studies, Addendum 1 was filed on July 28, 2017. The purpose of Addendum 1 was to estimate American shad ichthyoplankton entrainment under potential future expanded Upper Reservoir storage at NFM. Chris briefly explained that the HEC-ResSim model was used to create baseline and expanded operation conditions to determine the amount of water used for pumping.

Slide 71- Provided an exceedance curve of the pump flow for both baseline and expanded operations during the time of year when shad eggs and larvae would be present in the TFI. The exceedance curve indicted that slightly more pumping could occur during expanded operations condition.

Slide 72- Described that the changes in pump flow and the observed data collected in 2016 was used to estimate the increase in entrainment.

Slide 73- Provided the modeled daily percent change in the pump volume under expanded operations as compared to baseline conditions during the spawning season.

Slide 74- Provided a table of the weekly organism densities (org/m^3) at the 10th, 50th and 90th percentiles and the number of samples per week.

Slide 75- Provided graphs of the weekly extrapolation of entrained eggs and larvae using 2016 observed data adjusted based on week percent change in pump volumes under expanded operations versus baseline conditions.

Slide 76- Provided a table of equivalent adult estimates of all entrained eggs at the 10th, 50th, and 90th percentile using the weekly extrapolation method.

Slide 77- Chris described the conclusions of the Addendum including:

- Expanded operations will result in more pumping and an increase in the number of equivalent shad adults lost.
- Throughout the spawning season, both operating conditions and organism density will change.
- The 50th percentile should be considered the expected entrainment.
- Overall, it is predicted that about 600 additional juveniles and 81 adults may be affected by entrainment under expanded operations.

Andrea Donlon (CRC) stated that she would like the total change in MWs that were modeled under the expanded operations conditions. Melissa Grader (USFWS) stated that she would like information on the incremental increase in organism density between the baseline and expanded operations conditions. Melissa also stated that they have concerns about the entrainment model validation since the data only contained one sample when 4 pumps were running and had general concerns about how the 2016 data was applied. Melissa also stated that they are unclear about how the pump usage was determined in the expanded operations conditions. Mark Wamser (Gomez and Sullivan) and Doug Bennett (FirstLight) described how daily operations would probably not change much in the expanded operations condition. Melissa stated that they will ask for details on how the expanded operations conditions were developed by FirstLight in their comment letter.

Study No 3.5.1- Baseline Inventory of Wetland, Riparian and Littoral Habitat in the Turner Falls Impoundment, and Assessment of Operational Impacts on Special-Status Species

Mark reviewed the study chronology for the RTE report. He noted that after the original report filing in March 2016, FERC issued its first Determination letter on this study requiring FirstLight provide the following in an addendum (Addendum 1).

- copies of maps of historic and potentially suitable habitat for state listed plants,
- description of habitat suitability preferences used for each of the state listed plants,
- copies of data regarding plant health and vigor and
- information on how plant densities varied with WSELs.

These data were provided in Addendum 1 filed on October 14, 2016.

FERC issued its second Determination letter requiring FirstLight provide the following in another addendum (Addendum 2):

- Puritan Tiger Beetle: per the Determination Letter*: However, because the maximum, mean, and median monthly water surface elevations, as well as standard deviations, are available and may provide additional information useful for evaluating project effects on shoreline areas, we recommend that FirstLight prepare and file a table that includes this information with its proposed addendum to be filed by April 3, 2017.*
- Invasive Plants: per the Determination Letter: "*For the reasons described in staff's March 6, 2014, letter, FirstLight was required to survey for Salix exigua (not spp. interior), Alnus glutinosa, and Salix purpurea; therefore, we recommend requiring FirstLight to conduct surveys for these species and file an addendum to the study report by July 31, 2017*."

Addendum 2 also addressed numerous other comments provided on Addendum 1 (Slides 79-81). Mark noted that several of the comments were minor and were addressed in the either FirstLight's January 17, 2017 response matrix or addressed in the Addendums. Mark noted that the items shown in read on Slides 79-81 are ones that are addressed in today's presentation.

Slide 82- Relative to Cobblestone Tiger Beetle (CTB), FirstLight previously showed the percent of time potential CTB habitat was inundated for a period of 24 hours and 0 hours. Natural Heritage requested that figures be developed showing the percent of time potential CTB habitat (measured by elevation) was inundated for bins of 1-5, 6-9, 10-14, and 15+ hours. Mark showed example graphs for CTB for May and August (2008-2015, based on flows as measured at the Montague USGS gage).

Slide 83- Relative to Puritan Tiger Beetle (PTB), Natural Heritage asked for the same analysis as conducted for CTB- show the percent of time potential PTB habitat (measured by elevations) was inundated for bins of 1-5, 6-9, 10-14, and 15+ hours. Marked showed example graphs for PTB for May and August (again based on Montague flows from 2008-2015).

Slide 84- Relative to Rare, Threatened and Endangered Plants. Mark noted that figures were developed showing the range of elevations occupied by each plant at each transect, the flowering/seeding/fruiting period, average WSEL (from the hydraulic model) and the duration of time the RTE plant was inundated.

Mark noted that the range of plant base elevations was determined in the field resulting in a high and low base elevation (for all plants).

The hydraulic model was run on an hourly time step both in the TFI (2000-2015) and below Montague (2008-2015) to obtain WSELs at the RTE plants. Hourly WSEL data from the hydraulic model was used to compute average WSELs at the RTE plants and the duration of inundation (Slide 84). Mark presented a table (Slide 85) showing the timing of flowering/seeding/fruiting (months), the min, max and mean elevations of the plants, and the low flow. An example plot was shown for Sandbar Willow located below Cabot. The hydraulic model was run for the period May 15 to October 31, 2008-2015. From the hourly WSEL data, the average number of hours each day the plant was inundated was computed (shown as bars in Slide 86). The average daily WSEL was plotted as well as the high and low elevation of the plants. As the example shows there are many times when the plant remained inundated.

MA Natural Heritage requested that FirstLight develop rating curves for RTE plants located in the bypass reach- specifically Reach 3. WSELs in Reach 3 are a function of bypass flow, Cabot flow and Deerfield River flow. Using the hydraulic model various magnitudes of flow for the three variables were simulated in the hydraulic model and a best-fit curve was developed (Slide 87).of the three were simulated in the model under of flows to develop rough estimates.

Wrap Up

Mark Wamser stated that if the stakeholders have data requests, including those that might be briefly mentioned in the meeting notes, the data requests should be clearly defined in their subsequent and timely filings.

ATTACHMENT B: POWERPOINT PRESENTATION MADE AT THE OCTOBER 9, 2018 MEETING

Turners Falls Hydroelectric Project (FERC No. 1889)

Northfield Mountain Pumped Storage Project (FERC No. 2485)

October 2018 Study Addendum Meeting

October 9, 2018

Agenda

Time	Agenda Topic
9:00-9:15 am	Introductions, Agenda and Background
9:15-10:15 am	Instream Flow Study (Study No. 3.3.1)
10:15-11:15 am	Adult Shad Upstream and Downstream Fish Passage Study (Study No. 3.3.2)
11:15 am-Noon	Assessment of Sea Lamprey Spawning Sites (Study No.3.3.15)
Noon-1:00 pm	Lunch (on your own)
1:00-1:45 pm	Erosion Causation – Expanded Use of Upper Reservoir (Study No. 3.1.2)
1:45-2:30 pm	Northfield Ichthyoplankton Study (Study No. 3.3.20)
2:30-3:15 pm	Rare, Threatened and Endangered Species (Study No. 3.5.1)
3:15-3:45 pm	River2D of the Northfield Mountain Tailrace (Study No. 3.3.9)
3:45-4:00 pm	Wrap-Up

Background

- Between 4/3/2017 and 7/28/2018, FL filed various addendums with FERC.
- On 8/10/2018, FERC issued its Revised Process Plan and Schedule, requiring the following Study Report Meetings:
  - 10/9/2018 Studies: Erosion Causation, Instream Flow, Upstream/Downstream Adult Shad, Sea Lamprey, NFM Ichthyoplankton, and RTE Species.
  - 3/30/2019 Studies: River2D of NFM Tailrace, Ultrasound Array and Archaeology
- Emphasis of these meetings are on the Addendums; not reviewing the original studies.

Background- FERC Schedule

Party	Milestone	Date
FL	Filed Addendums on Erosion Causation, Instream Flow, Upstream/Downstream Adult Shad, Sea Lamprey, NFM Ichthyoplankton, and RTE Species	4/3/17 to 7/27/18
Stakeholders	Study Report Meeting	10/9/18
FL	File Study Report Meeting Summary	10/24/18
Stakeholders	File Requests for Study Plan Modifications	11/23/18
Stakeholders	File Responses to Disagreements/Amendment Requests	12/23/18
FERC	FERC issues Determination Letter	1/22/19
FL	File Addendums on River2D of NFM Tailrace, Ultrasound Array and Archaeology	3/15/19
Stakeholders	Study Report Meeting	3/30/19
FL	File Study Report Meeting Summary	4/14/19
Stakeholders	File Requests for Study Plan Modifications	5/14/19
Stakeholders	File Responses to Disagreements/Amendment Requests	6/13/19
FERC	FERC issues Determination Letter	7/13/19
FL	File Amended Final License Application	TBD

Instream Flow Study Chronology

Date	Milestone
10/14/16	FL filed Study Report
10/31/16 -11/01/16	Study Report Meetings
12/15/16	Deadline for Stakeholder Comments on Study Report
01/17/17	FL issued Response to Stakeholder Comments. FL agreed to file Addendum 1 on various questions asked by stakeholders
02/17/17	FERC issued Determination Letter: • Re: Sea Lamprey Spawning HSI Curves: *Because this site-specific habitat data is specific to the project area and would be useful for adjusting or verifying the HSI curves taken from the literature, we recommend that FirstLight consult with the agencies and use the data collected at documented sea lamprey spawning sites in study 3.3.15 to make adjustments to (or verify) the literature-based HSI curves.* (Addressed in Addendum 4)
04/03/17	FL filed Addendum 1
05/01/18	FL filed the following Addendums: • Addendum 2- IFIM Study Results for Mussels in Reach 5 • Addendum 3- Yellow Lampmussel Assessment in Reach 3 • Addendum 4- Sea Lamprey Assessment with new HSI curves

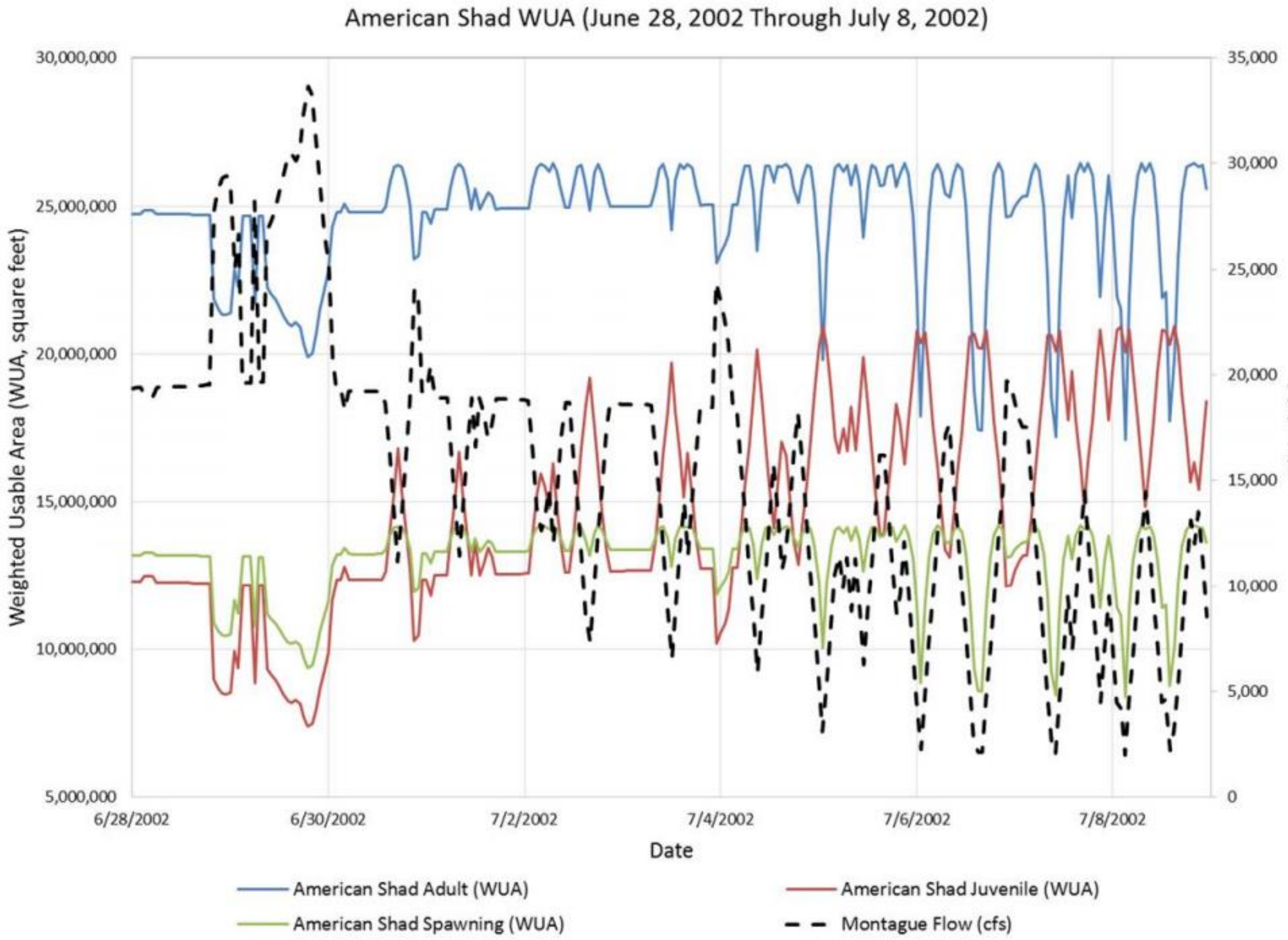
Instream Flow Study
ADDENDUM 1

Comment: USFWS-6 and 22 (and MADFW-12, MADFW-18) Requested additional habitat time series information for Reach 4

- FL provided habitat time series graphs for the species & lifestages for an 11-day period, Jun 28-Jul 8, 2002. This period included:
  - High bypass flows (over 10,000 cfs) and lower bypass flows in the 500 to 2,500 cfs range (entering Reach 3),
  - Cabot peaking operations
  - Used hourly output from the baseline HEC-ResSim operational model which was similar to the historical Montague USGS gage – flows range 30,000 cfs to ~2,000 cfs.

Instream Flow Study
ADDENDUM 1

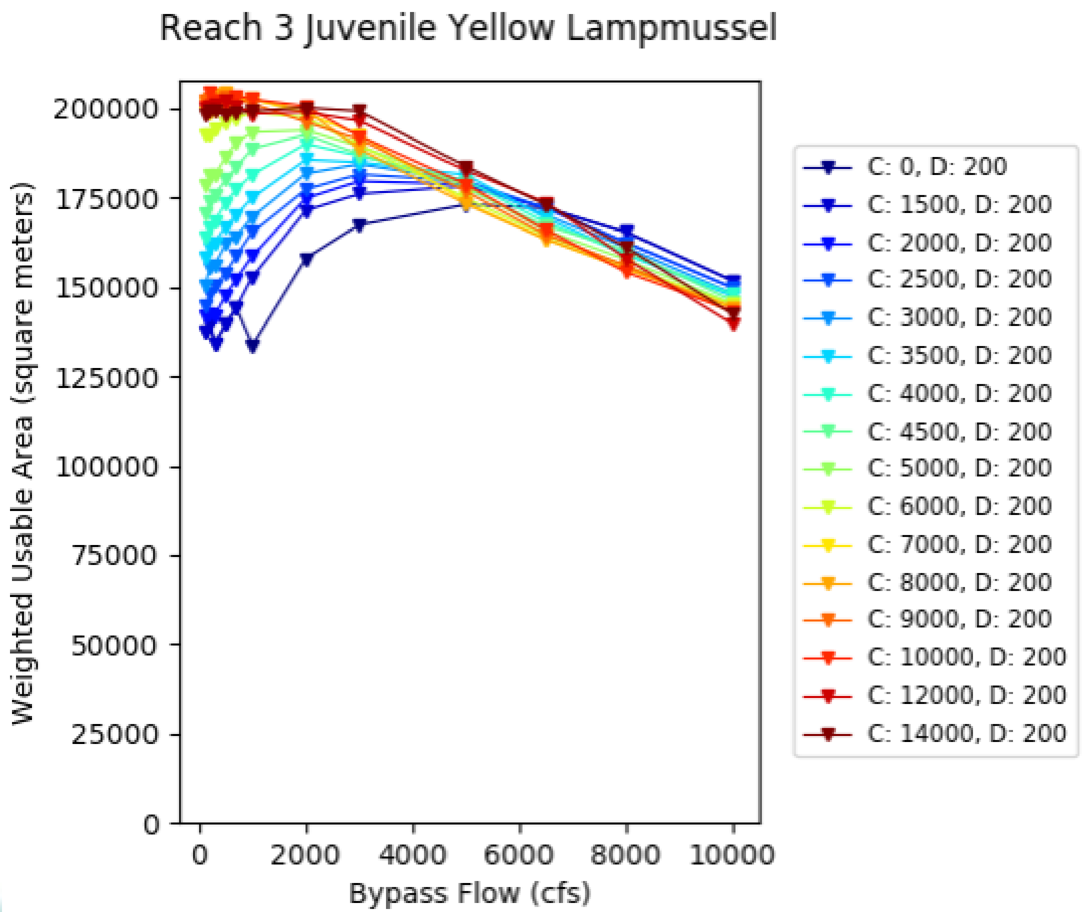
Reach 4: Habitat Time Series Graph for American Shad



Instream Flow Study ADDENDUM 1

Comment: USFWS-8 Requested habitat versus discharge relationships in Reach 3 for state-listed mussels.

- FL provided WUA Curves for yellow lampmussel habitat in Reach 3 in Appendix B of Addendum 1



C- Cabot Flow
D-Deerfield River Flow

Instream Flow Study
ADDENDUM 1

Comment: USFWS-9 Requested a clarification of the Maximum Weighted Usable Area tables.

- FL provided detailed clarification in the January 17, 2017 response matrix about the differences that USFWS noted.
- Updated tables with bypass flows of 6,500, 8,000, and 10,000 cfs in Addendum 1.

Table 2.3-1: Percentage of Peak WUA relative to Total Wetted Area for Reach 3 with Cabot Station Operating at 2,500 cfs and a Deerfield River Flow of 200 cfs

Species	Life stage	Maximum WUA Bypass Flow (cfs)	Maximum WUA (ft^2)	Total Wetted Area at Maximum WUA Flow (ft^2)	% of Available Habitat at Max WUA Flow
American Shad	Spawning/Incu	10,000 cfs	2,350,864	5,641,943	41.7%
American Shad	Juvenile	5,000 cfs	2,282,496	5,264,901	43.4%
American Shad	Adult	10,000 cfs	2,871,437	5,641,943	50.9%
Shortnose Sturgeon	Spawning	8,000 cfs	1,696,981	5,519,334	30.7%
Shortnose Sturgeon	Egg-Larvae	5,000 cfs	2,551,226	5,264,901	48.5%
Shortnose Sturgeon	Fry	5,000 cfs	1,444,448	5,264,901	27.4%
Shortnose Sturgeon	Juvenile	8,000 cfs	1,908,712	5,519,334	34.6%
Shortnose Sturgeon	Adult	6,500 cfs	1,964,490	5,403,672	36.4%

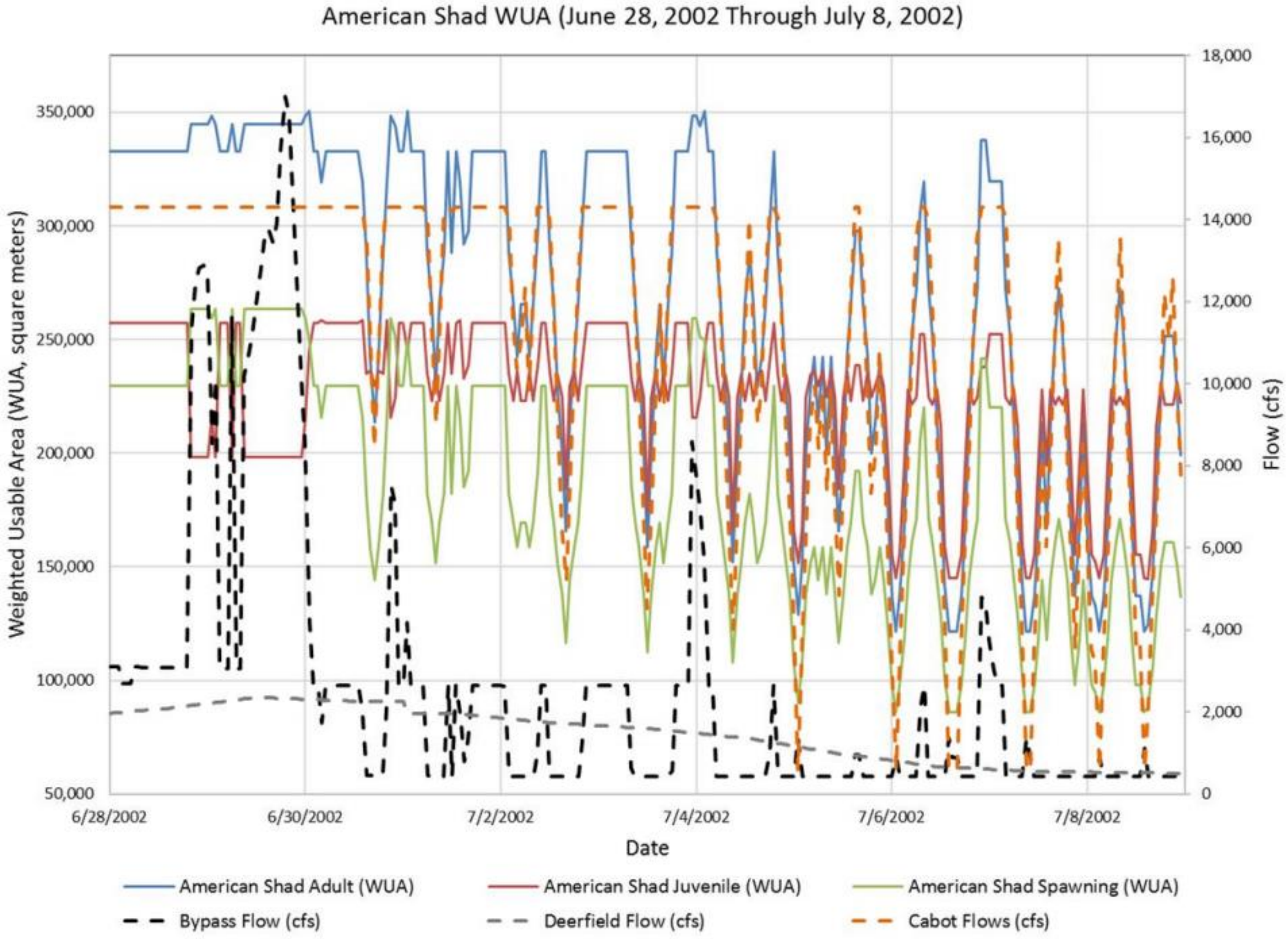
Instream Flow Study
ADDENDUM 1

Comment: USFWS-18 and MADFW-1, requested additional habitat time series information for Reach 3.

- FL provided habitat time series graphs for the species & lifestages for an 11-day period, Jun 28-Jul 8, 2002. This period included:
  - High bypass flows (over 10,000 cfs) and lower bypass flows in the 500 to 2,500 cfs range (entering Reach 3),
  - Cabot peaking operations
  - Used hourly output from the baseline HEC-ResSim operational model which was similar to the historical Montague USGS gage. Flow range 30,000 cfs to ~2,000 cfs.

Instream Flow Study
ADDENDUM 1

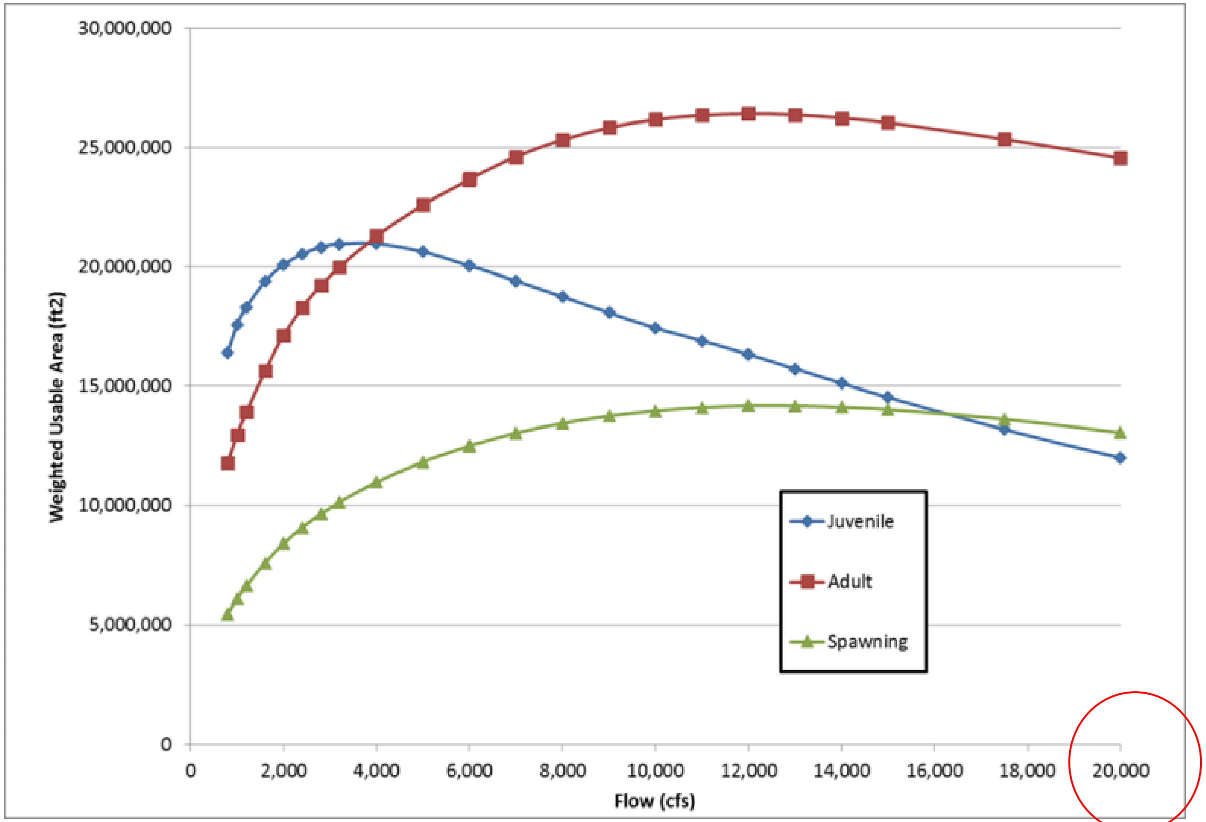
Reach 3: Habitat Time Series Graph for American Shad



Instream Flow Study
ADDENDUM 1

Comment: USFWS-21 and MADFW-17, requested that for Reach 4, the Habitat versus Discharge Relationships x-axis should have a maximum flow of 20,000 cfs.

WUA Curve for American Shad in Reach 4



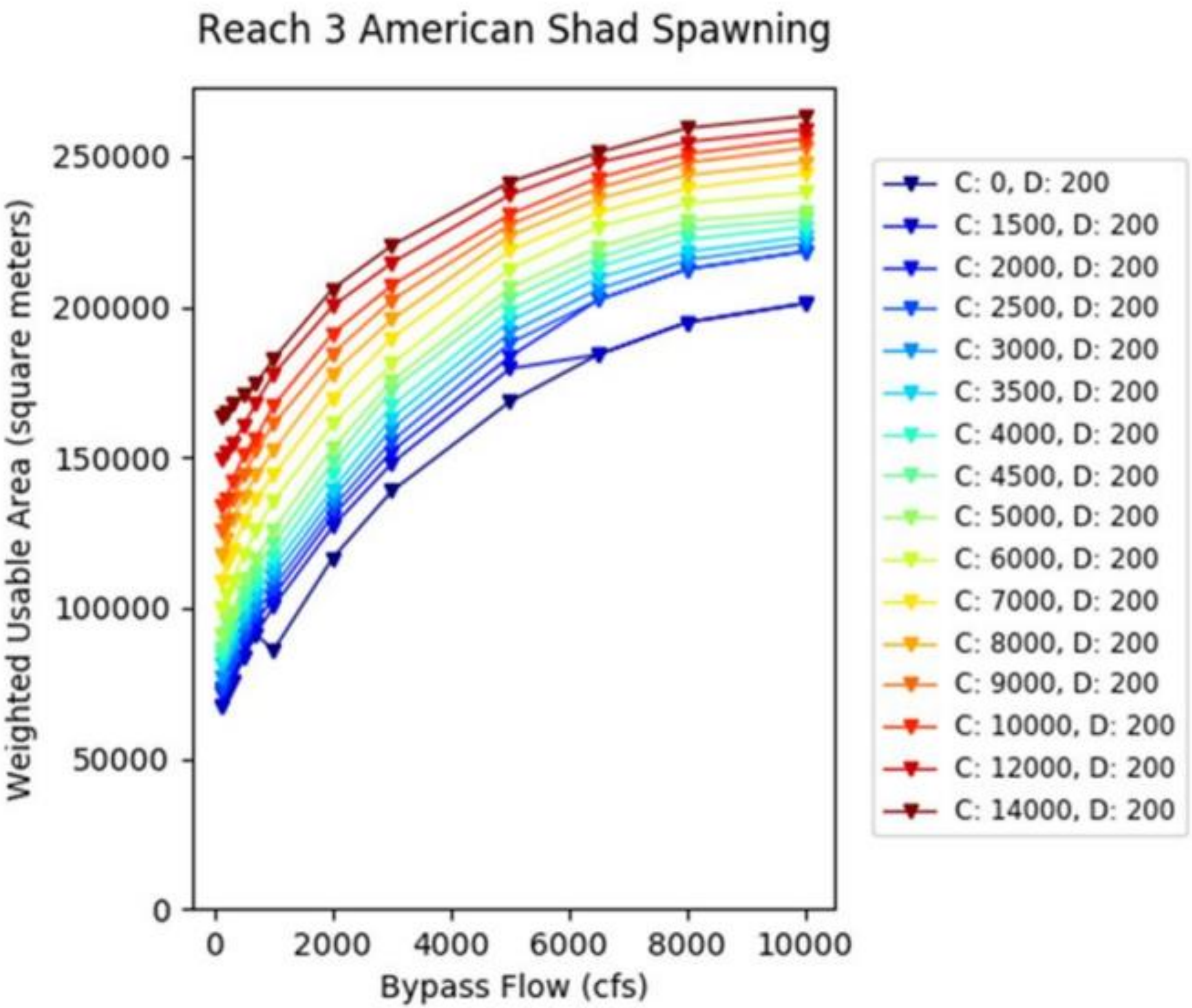
Instream Flow Study
ADDENDUM 1

Comment: NMFS-1, stated that the WUA figures for Reach 3 do not provide the flows at which the maximum WUA values would be achieved.

- FL performed additional hydraulic and habitat modeling for bypass flows of 6,500 8,000, and 10,000 cfs with the normal array of Cabot Station flows.
- Revised figures and diagrams were included in Attachment B.
- Revised combined suitability index habitat maps were included in Attachment D.
- Revised persistent habitat maps were included in Attachment E.
- For some species and lifestages including American shad spawning, shortnose sturgeon, the WUA curves still show a slight upward slope with the higher bypass flows.

Instream Flow Study
ADDENDUM 1

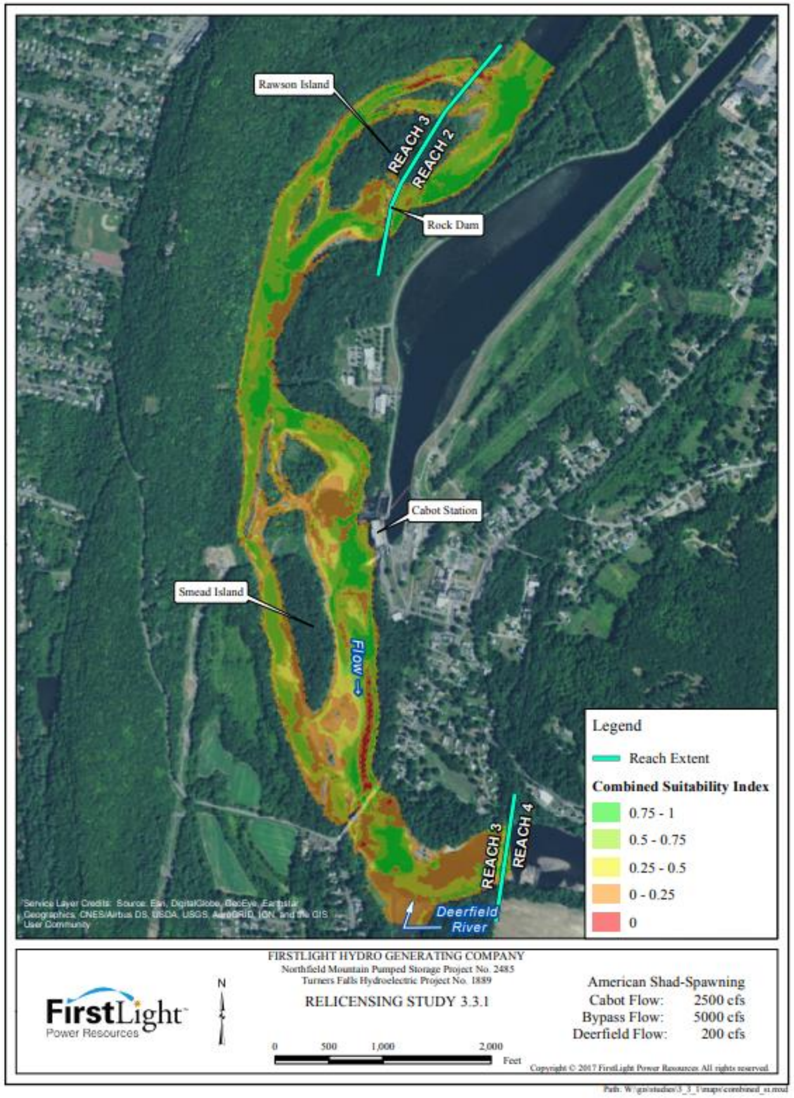
Reach 3 American Shad Spawning Weighted Usable Area

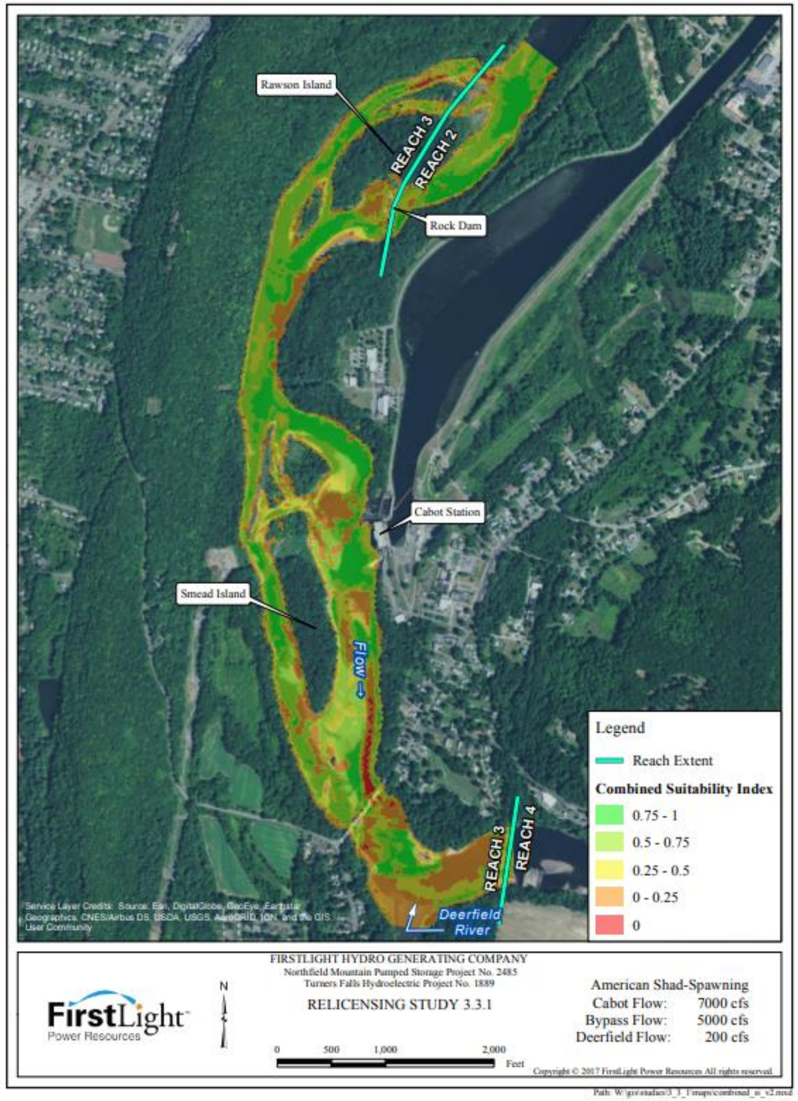


C- Cabot Flow
D-Deerfield River Flow

Instream Flow Study
ADDENDUM 1

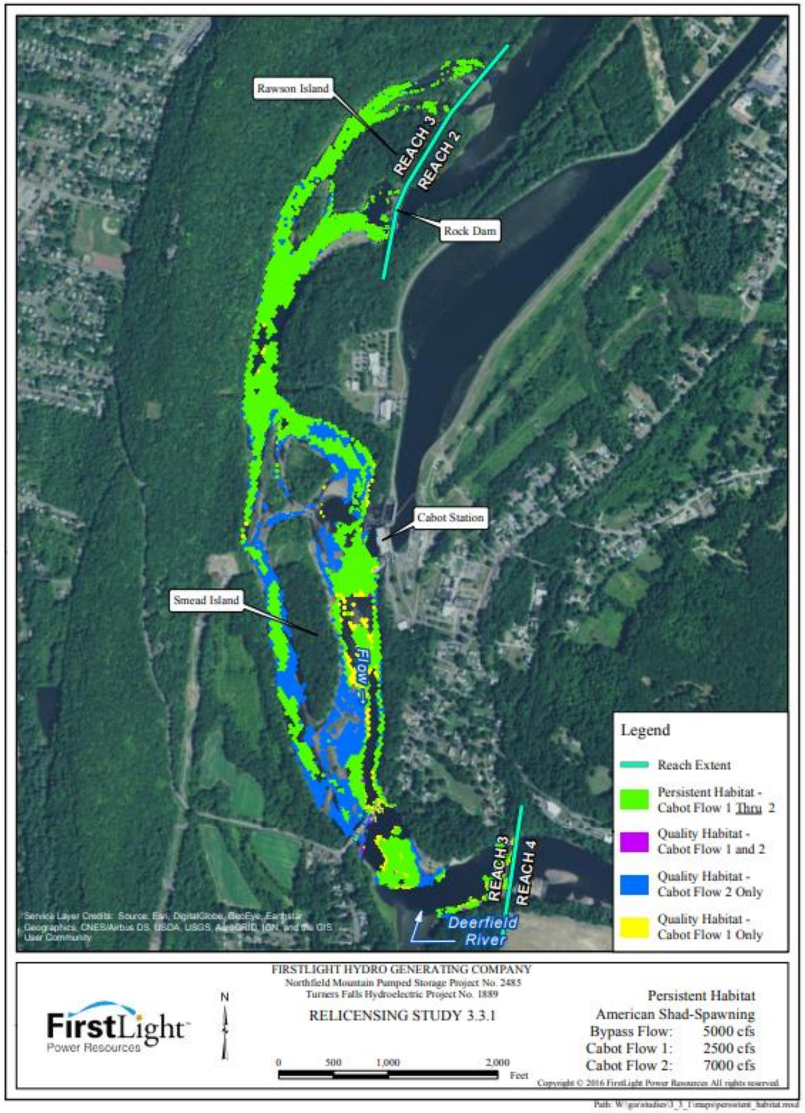
American Shad Spawning Combined Suitability Index Maps

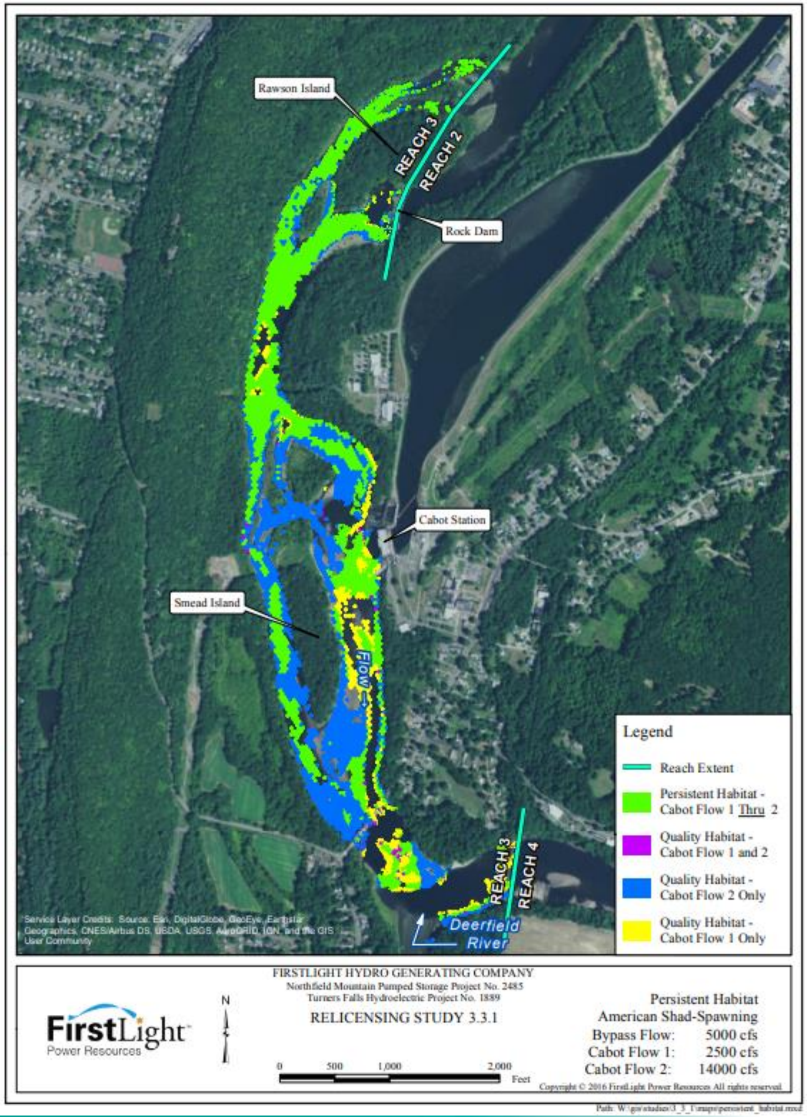




Instream Flow Study
ADDENDUM 1

American Shad Spawning Persistent Habitat Maps





Instream Flow Study
ADDENDUM 1

Comment: MADFW-14, stated that for Reach 3, a graph of maximum habitat should be provided as was done for Reach 4.

- FL noted where similar tables were provided in the Study Report.
- Due to the additional modeling and habitat analyses for higher bypass flows, the tables were updated and provided as Attachment F.
  - There are 4 tables with varying bypass flows and Cabot Station operating at 2,500, 4,500, 7,000, and 14,000 cfs
- WUA curves and plots showing the % of Maximum WUA were provided in Attachment B.

FirstLight Power Resources

Instream Flow Study ADDENDUM 1

Percentage of Maximum Habitat Table (Cabot at 2,500 cfs)

Percentage of the Maximum Weighted Usable Area (WUA) for Various Bypass Flows within Reach 3 with Cabot Station Operating at 2,500 cfs and a Deerfield flow of 200 cfs

Species	Lifestage	Months Present	Maximum WUA Bypass Flow (cfs)	Maximum WUA (ft^2)	120 (cfs)	200 (cfs)	300 (cfs)	500 (cfs)	700 (cfs)	1,000 (cfs)	2,000 (cfs)	3,000 (cfs)	5,000 (cfs)	6,500 (cfs)	8,000 (cfs)	10,000 (cfs)
					0.02 (cfsm)	0.03 (cfsm)	0.04 (cfsm)	0.07 (cfsm)	0.1 (cfsm)	0.14 (cfsm)	0.28 (cfsm)	0.42 (cfsm)	0.70 (cfsm)	0.91 (cfsm)	1.12 (cfsm)	1.40 (cfsm)
American Shad	Spawning/Incu	May-June	10,000 cfs	2,350,864	33.7%	35.9%	38.1%	41.8%	44.8%	48.9%	61.0%	71.1%	86.0%	92.6%	97.3%	100.0%
American Shad	Juvenile	June-Oct	5,000 cfs	2,282,496	55.4%	60.8%	64.9%	69.5%	72.6%	77.4%	90.5%	97.2%	100.0%	97.4%	93.7%	87.3%
American Shad	Adult	May-June	10,000 cfs	2,871,437	42.4%	43.9%	45.5%	48.1%	50.3%	53.5%	62.8%	71.1%	83.8%	90.3%	96.1%	100.0%
Shortnose Sturgeon	Spawning	April-May	8,000 cfs	1,696,981	25.8%	28.9%	32.9%	39.2%	44.2%	49.9%	64.9%	77.5%	94.5%	98.8%	100.0%	98.0%
Shortnose Sturgeon	Egg-Larvae	May	5,000 cfs	2,551,226	52.3%	56.4%	59.7%	63.8%	67.5%	73.2%	87.3%	95.0%	100.0%	99.1%	96.8%	92.3%
Shortnose Sturgeon	Fry	May	5,000 cfs	1,444,448	48.0%	52.9%	57.9%	63.9%	67.7%	73.0%	84.8%	93.3%	100.0%	99.0%	95.7%	88.4%
Shortnose Sturgeon	Juvenile	June	8,000 cfs	1,908,712	46.9%	51.2%	54.8%	59.3%	61.8%	65.5%	75.7%	83.7%	95.8%	99.5%	100.0%	95.2%
Shortnose Sturgeon	Adult	Year Round	6,500 cfs	1,964,490	48.4%	52.9%	56.7%	61.5%	64.1%	67.9%	78.9%	87.3%	97.7%	100.0%	99.4%	93.9%
Fall Fish	Spawning/Incu	May-June	3,000 cfs	576,656	53.1%	58.1%	61.3%	65.1%	68.9%	73.8%	93.1%	100.0%	91.9%	74.3%	52.6%	32.0%
Fall Fish	Fry	May-June	3,000 cfs	825,054	66.4%	69.9%	71.4%	74.6%	79.3%	85.2%	98.7%	100.0%	77.5%	57.3%	41.1%	29.5%
Fall Fish	Juvenile	Year Round	3,000 cfs	1,182,746	59.7%	65.8%	69.9%	72.9%	74.6%	78.6%	95.2%	100.0%	91.9%	78.6%	62.8%	47.1%
Fall Fish	Adult	Year Round	3,000 cfs	1,780,782	75.5%	81.5%	85.2%	87.9%	88.7%	90.3%	96.5%	100.0%	98.1%	93.7%	87.3%	80.3%
Longnose Dace	Juvenile	Year Round	2,000 cfs	307,054	76.7%	84.7%	85.1%	80.1%	77.5%	80.9%	100.0%	94.8%	69.3%	43.6%	25.9%	17.0%
Longnose Dace	Adult	Year Round	3,000 cfs	547,316	65.2%	74.8%	80.0%	82.6%	82.3%	82.8%	97.4%	100.0%	76.8%	52.9%	32.1%	19.9%
White Sucker	Spawning/Incu	April-May	3,000 cfs	162,255	71.8%	79.9%	83.2%	83.3%	84.2%	86.9%	99.0%	100.0%	82.9%	54.4%	28.9%	16.0%
White Sucker	Fry	May-June	120 cfs	2,032,500	100.0%	97.4%	94.5%	90.6%	89.8%	89.2%	86.4%	78.2%	61.2%	54.4%	49.4%	46.0%
White Sucker	Adult/Juvenile	Year Round	3,000 cfs	839,203	69.6%	76.6%	79.1%	77.3%	74.9%	76.5%	93.6%	100.0%	87.6%	76.7%	66.9%	58.2%
Walleye	Spawning	April-May	8,000 cfs	1,152,541	25.8%	27.0%	29.0%	33.9%	39.7%	47.7%	67.1%	80.2%	96.0%	99.9%	100.0%	91.5%
Walleye	Fry	April-May	10,000 cfs	166,471	96.7%	87.7%	83.0%	76.4%	76.6%	68.4%	72.1%	84.1%	77.8%	81.4%	82.1%	100.0%
Walleye	Juvenile	Year Round	10,000 cfs	145,400	83.4%	78.9%	73.4%	67.4%	66.6%	62.7%	66.1%	71.1%	81.7%	83.8%	85.7%	100.0%
Walleye	Adult	Year Round	120 cfs	495,345	100.0%	95.6%	88.2%	78.8%	72.6%	65.9%	64.1%	62.5%	63.1%	66.4%	68.4%	76.7%
Tessellated Darter	Adult/Juvenile	Year Round	2,000 cfs	203,018	78.6%	81.8%	77.0%	74.7%	75.7%	84.1%	100.0%	88.3%	58.3%	34.0%	21.5%	15.3%
Sea Lamprey	Spawning/Incu	May-June	3,000 cfs	134,295	58.1%	69.9%	82.3%	93.5%	96.1%	94.3%	94.3%	100.0%	98.8%	84.8%	53.5%	27.0%
Macroinvertebrates	Larva	Year Round	6,500 cfs	1,254,252	27.9%	32.6%	38.4%	46.9%	53.1%	59.5%	75.0%	85.6%	99.2%	100.0%	96.0%	86.0%
Habitat Guilds	Shallow Slow	Year Round	120 cfs	961,129	100.0%	96.3%	91.7%	90.5%	92.8%	96.9%	89.4%	77.4%	47.9%	33.7%	24.6%	19.2%
Habitat Guilds	Shallow Fast	Year Round	2,000 cfs	483,874	84.2%	87.4%	83.6%	78.6%	79.3%	86.9%	100.0%	94.5%	66.0%	43.0%	29.8%	23.1%
Habitat Guilds	Deep Slow	Year Round	200 cfs	1,699,409	98.7%	100.0%	99.9%	98.1%	95.4%	92.5%	94.0%	96.0%	85.2%	77.5%	68.7%	63.9%
Habitat Guilds	Deep Fast	Year Round	6,500 cfs	947,458	20.8%	23.5%	27.3%	34.3%	40.4%	47.8%	65.4%	79.1%	96.0%	100.0%	97.2%	77.9%
Tidewater Mucket	Juvenile	Year Round	3,000 (cfs)	181,579	79.7%	81.7%	82.8%	84.8%	87.4%	91.1%	97.7%	100.0%	99.0%	94.8%	89.4%	82.5%
Tidewater Mucket	Adult	Year Round	5,000 (cfs)	222,527	69.0%	70.7%	72.1%	74.6%	77.2%	82.1%	91.5%	97.1%	100.0%	99.6%	97.1%	94.0%
Eastern Pondmussel	Juvenile	Year Round	6,500 (cfs)	74,762	76.4%	77.5%	78.7%	81.1%	83.5%	87.9%	92.7%	95.6%	99.8%	100.0%	97.9%	96.6%
Eastern Pondmussel	Adult	Year Round	3,000 (cfs)	181,579	79.7%	81.7%	82.8%	84.8%	87.4%	91.1%	97.7%	100.0%	99.0%	94.8%	89.4%	82.5%
Yellow Lampmussel	Juvenile	Year Round	3,000 (cfs)	181,579	79.7%	81.7%	82.8%	84.8%	87.4%	91.1%	97.7%	100.0%	99.0%	94.8%	89.4%	82.5%
Yellow Lampmussel	Adult	Year Round	5,000 (cfs)	222,527	69.0%	70.7%	72.1%	74.6%	77.2%	82.1%	91.5%	97.1%	100.0%	99.6%	97.1%	94.0%

Instream Flow Study
ADDENDUM 2 Mussels Reach 5

Summary of Events Leading to the IFIM Study for Mussels in Reach 5

- Study Report 3.3.1 IFIM filed 10/14/2016
  - Included a screening level analysis for state listed mussels.
  - Agencies/NGOs indicated that additional analyses were required.
  - Some comments were addressed as part of Addendum 1 filed on 4/3/2017.
- FL emailed a Revised Study Plan to stakeholders on 5/19/2017 to conduct a full-scale IFIM study for state-listed mussels in Reach 5.
  - FL held a meeting on 6/1/2017 and consulted stakeholders on the RSP.
  - On 8/7-8/2017, NHESP, USFWS, and TNC expressed their support for the final RSP, which was filed with FERC.
- On 5/1/2018, FL filed Addendum 2 IFIM for Mussels in Reach 5

More details in Section 1.2 of the report

Instream Flow Study
ADDENDUM 2 Mussels Reach 5

Target Mussels and Host Fish

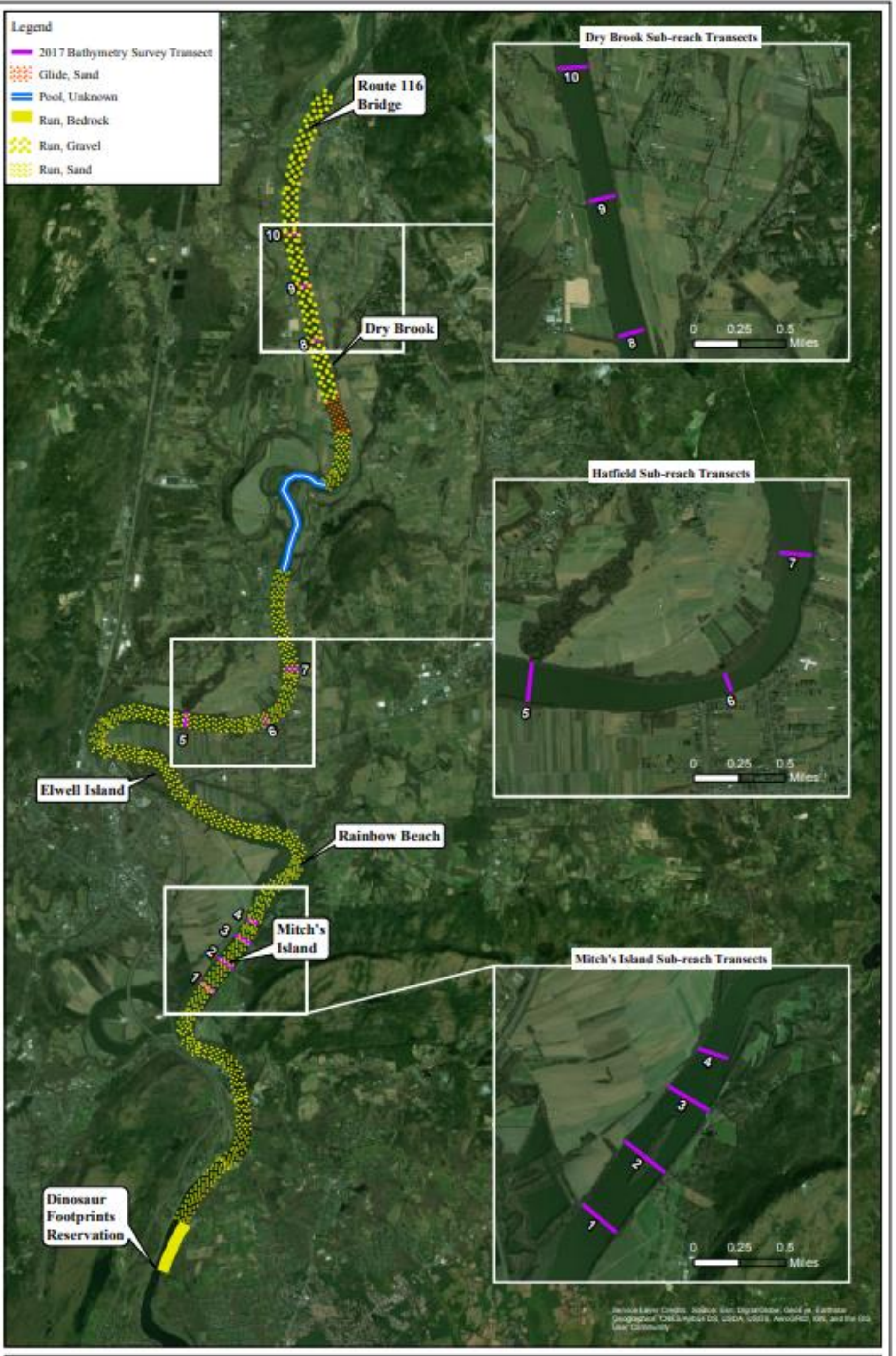
Species	Life Stages	Host Fish
Yellow Lampmussel	Juvenile, Adult	Deep Slow Guild, Deep Fast Guild
Eastern Pondmussel	Juvenile, Adult	Deep Slow Guild, Shallow Slow Guild
Tidewater Mucket	Juvenile, Adult	Deep Slow Guild, Deep Fast Guild, Shallow Slow Guild

Table of binary HSI classifications for the mussels and life stages (Table 2.3-1, page 2-4) for:

- Benthic Velocity
- Water Depth
- Substrate Size

Shear Stress Thresholds

Mussel Species	Adult Shear Stress Threshold	Juvenile Shear Stress Threshold
Yellow Lampmussel	150 dynes/cm^2	10 dynes/cm^2
Eastern Pondmussel	150 dynes/cm^2	10 dynes/cm^2
Tidewater Mucket	150 dynes/cm^2	10 dynes/cm^2



Instream Flow Study ADDENDUM 2 Mussels Reach 5

Representative Sub-Reaches and Transects in Reach 5

- Dry Brook. Run with gravel substrate (3 transects).
- Hatfield. Run with sand substrate (3 transects).
- Mitch's Island. Run with fine substrate and under low flows a greater influence from Holyoke operations (4 transects).
- Total of 10 transects.

Instream Flow Study
ADDENDUM 2 Mussels Reach 5

Field Data Collection

- WSEL loggers installed at the 10 transects and near Holyoke Dam.
- Depth and mean-column velocity measurements obtained with an Acoustic Doppler Current Profiler.
- Substrate classification at each transect by visual means or probing.

- High flow calibration for all 3 sub-reaches occurred 7/11/2017 ~10,000 cfs.
- Low flow calibration for Dry Brook on 8/3/2017 ~ 5,500 cfs.
- Low flow calibration at Hatfield & Mitch's Island occurred in 2016, ~ 5,500 and ~ 3,100 cfs respectively.

Modeling

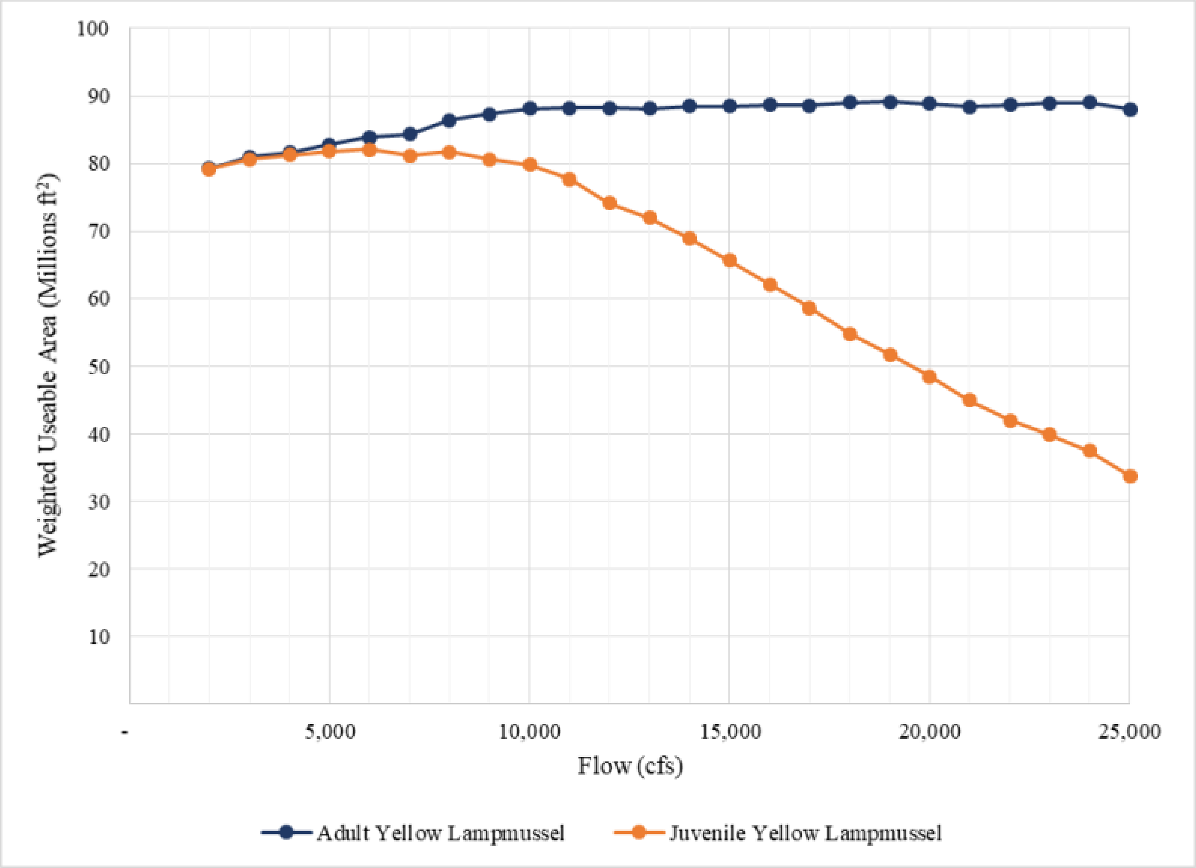
- Existing hydraulic model was updated with the 10 transects and calibrated to the measured WSELs and the ADCP measured flow.
  - Calibrated with the high flow data.
  - Validated with the low flow data.

- Cellular calibration and habitat modeling used the PHABSIM model.

Instream Flow Study
ADDENDUM 2 Mussels Reach 5

Results

- Weighted Usable Area figures developed for:
  - For 3 (substrate, depth, velocity) and 4 (shear stress) variables under both low and high Holyoke WSEL conditions for species/lifestages and guilds.



Example: 3 variable, low Holyoke downstream boundary

Instream Flow Study
ADDENDUM 2 Mussels Reach 5

Results

- Dual Flow (Appendix D)
  - For 3 and 4 (with shear stress) variables under both low and high Holyoke conditions for species/lifestages.

Table 4.2-6: Juvenile Yellow Lampmussel 4-Variable-WUA, Low Boundary Conditions Dual Flow Habitat Area Analysis (% max habitat), by Flow Pairs (cfs)

Flow (cfs)	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000	11,000	12,000	13,000	14,000	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000
2,000	96.4%	96.1%	96.1%	95.3%	94.3%	92.6%	90.6%	88.3%	86.4%	83.8%	79.6%	76.9%	72.9%	68.9%	64.6%	60.5%	55.3%	51.3%	47.5%	43.6%	39.5%	36.5%	33.3%	29.6%
3,000		98.2%	98.1%	97.2%	96.2%	94.6%	92.7%	90.3%	88.4%	85.7%	81.4%	78.7%	74.7%	70.7%	66.2%	62.0%	56.8%	52.7%	48.8%	44.9%	40.6%	37.7%	34.5%	30.7%
4,000			99.0%	97.9%	97.0%	95.3%	93.4%	91.1%	89.1%	86.5%	82.2%	79.5%	75.4%	71.4%	66.9%	62.7%	57.4%	53.2%	49.3%	45.2%	40.9%	37.9%	34.7%	30.8%
5,000				99.7%	98.6%	96.9%	95.0%	92.6%	90.6%	88.0%	83.7%	81.0%	76.9%	72.9%	68.3%	64.1%	58.8%	54.6%	50.6%	46.4%	42.0%	38.9%	35.6%	31.8%
6,000					100.0 %	98.3%	96.3%	93.9%	92.0%	89.4%	85.1%	82.4%	78.1%	74.1%	69.5%	65.3%	60.0%	55.8%	51.9%	47.6%	43.3%	40.1%	36.8%	32.9%
7,000						98.8%	96.9%	94.5%	92.5%	89.9%	85.6%	82.9%	78.6%	74.6%	70.0%	65.8%	60.5%	56.3%	52.4%	48.1%	43.7%	40.6%	37.3%	33.4%
8,000							99.5%	97.1%	95.1%	92.5%	88.2%	85.5%	81.2%	77.3%	72.6%	68.4%	63.1%	58.9%	55.0%	50.7%	46.4%	43.2%	39.9%	36.1%
9,000								98.1%	96.2%	93.6%	89.3%	86.6%	82.3%	78.3%	73.7%	69.5%	64.2%	60.0%	56.0%	51.8%	47.4%	44.3%	40.9%	36.6%
10,000									97.2%	94.6%	90.3%	87.6%	83.3%	79.3%	74.7%	70.5%	65.2%	61.0%	57.0%	52.8%	48.4%	45.3%	41.9%	37.5%
11,000										94.7%	90.4%	87.7%	83.4%	79.4%	74.8%	70.6%	65.3%	61.1%	57.1%	52.9%	48.5%	45.4%	42.0%	37.6%
12,000											90.4%	87.7%	83.4%	79.4%	74.8%	70.6%	65.3%	61.1%	57.1%	52.9%	48.5%	45.4%	42.0%	37.6%
13,000												87.7%	83.4%	79.4%	74.8%	70.6%	65.3%	61.1%	57.1%	52.9%	48.5%	45.4%	42.0%	37.6%
14,000													83.9%	79.9%	75.3%	71.0%	65.8%	61.6%	57.6%	53.4%	49.0%	45.8%	42.5%	38.0%
15,000														80.0%	75.3%	71.1%	65.8%	61.6%	57.7%	53.4%	49.1%	45.9%	42.6%	38.1%
16,000															75.6%	71.4%	66.1%	61.9%	58.0%	53.7%	49.3%	46.2%	42.8%	38.4%
17,000																71.4%	66.1%	61.9%	58.0%	53.7%	49.3%	46.2%	42.8%	38.4%
18,000																	66.8%	62.6%	58.7%	54.4%	50.0%	46.9%	43.5%	39.1%
19,000																		63.0%	59.0%	54.8%	50.4%	47.3%	43.9%	39.5%
20,000																			59.0%	54.8%	50.4%	47.3%	43.9%	39.5%
21,000																				54.8%	50.4%	47.3%	43.9%	39.5%
22,000																					51.1%	47.9%	44.6%	40.1%
23,000																						48.6%	45.3%	40.8%
24,000																							45.6%	41.2%
25,000																								41.2%

Instream Flow Study
ADDENDUM 2 Mussels Reach 5

Results

- Shear Stress Mapping (Appendix E)
  - Maps of each sub-reach were developed to determine at what flows and locations shear stress becomes a limiting factor.
  - Conducted for flows of 2,000; 5,000; 10,000; 15,000; 20,000; and 25,000 cfs.

Instream Flow Study
ADDENDUM 2 Mussels Reach 5

Summary

- For adult Yellow Lampmussels and adult Tidewater Mucket, even accounting for shear stress, there is no decrease in WUA up to and including flows of 25,000 cfs.
- For the juvenile lifestages and Adult Eastern Pondmussel, about a 20% decrease in habitat from 8,000 cfs to 16,000 cfs.
  - However a very large amount of habitat is still available.

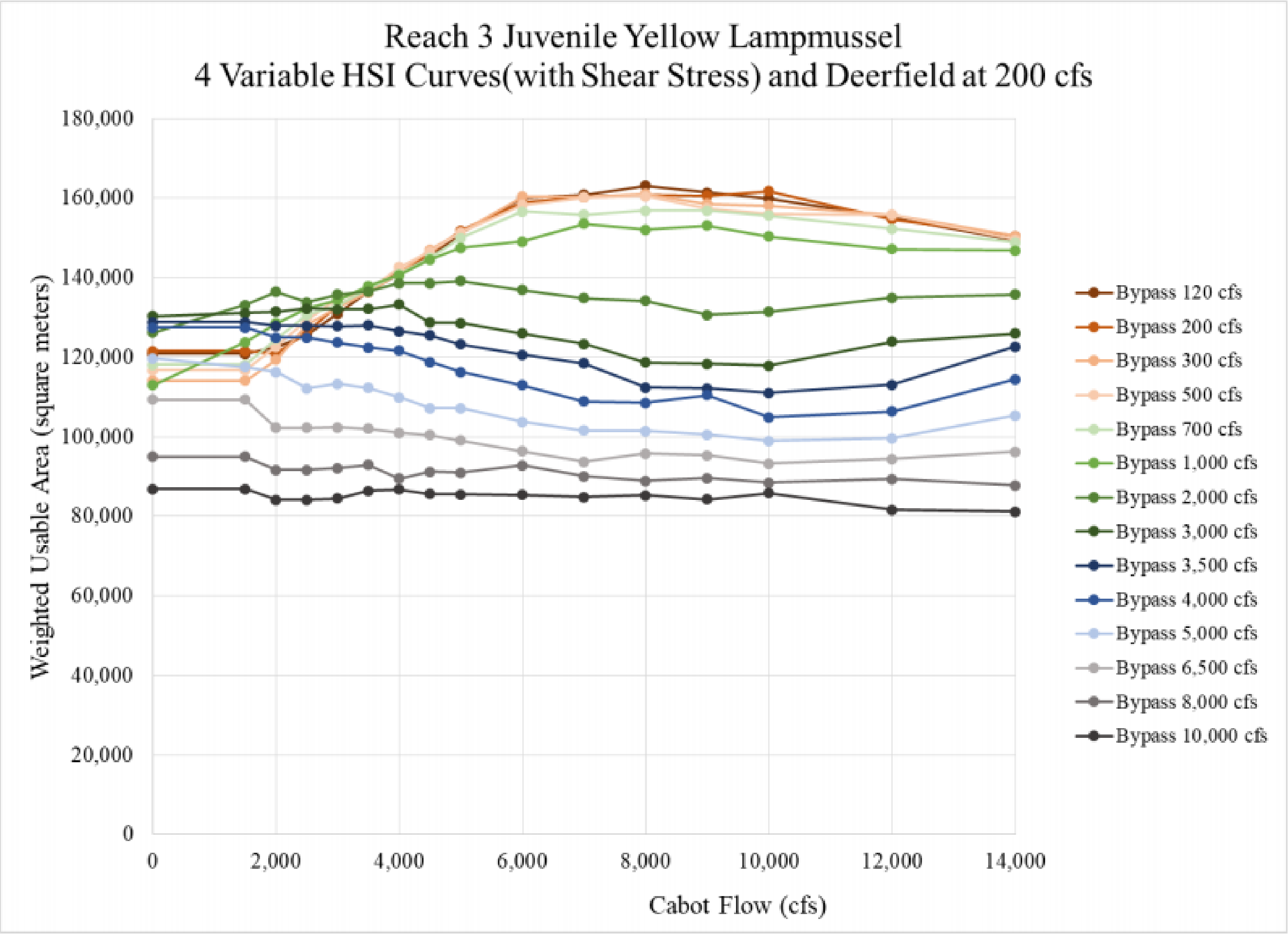
- Low boundary conditions at Holyoke increase the velocities slightly, but this is limited by the effect of the hydraulic constriction near Dinosaur Footprint at higher flows.
- As described in Study Report 3.2.2, peaking flows are attenuated in Reach 5.

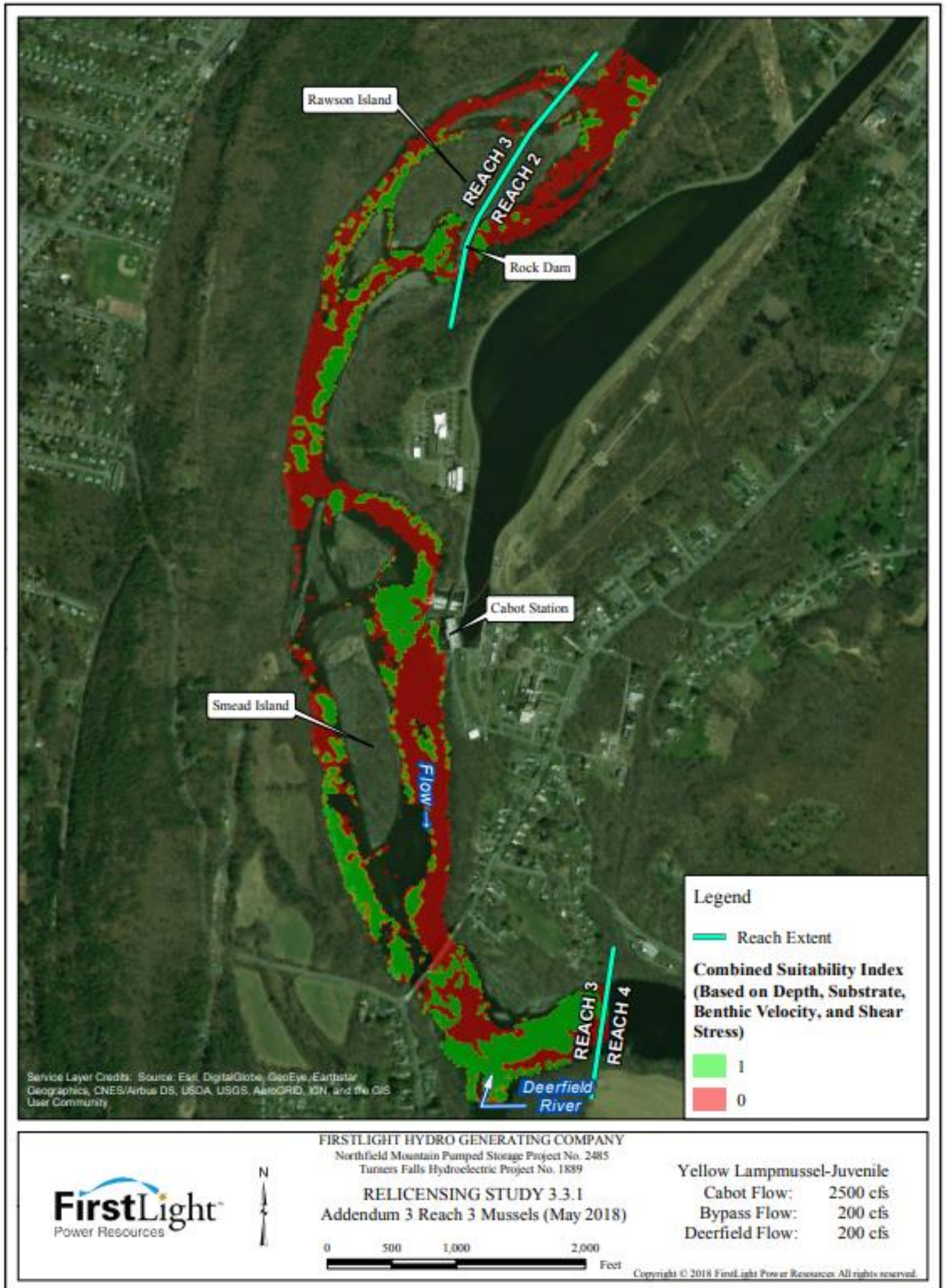
- **The IFIM analysis confirmed that high flows in excess of project control are likely the largest limiting factor in mussel habitat.**

FirstLight Power Resources

Instream Flow Study
ADDENDUM 3 Mussels Reach 3

Provide WUA vs Flow figures for adult and juvenile Yellow Lampmussel in Reach 3





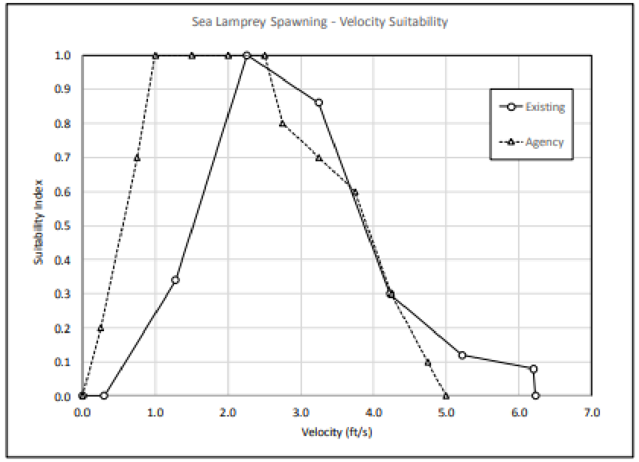
Instream Flow Study ADDENDUM 3 Mussels Reach 3

Provide combined HSI maps for juvenile and adult Yellow Lampmussels

Example: Juvenile Yellow Lampmussel, Cabot = 2,500 cfs, Bypass= 200 cfs, Deerfield River= 200 cfs
Based on 4 variables

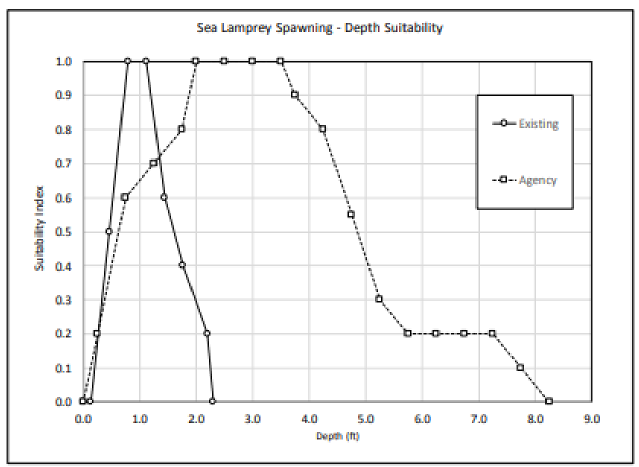
Instream Flow Study ADDENDUM 4
New Sea Lamprey HSI Curves

Develop new Sea Lamprey Spawning HSI curves, based on data collected at redd locations



Existing	
Velocity (ft/s)	SI Value
0.00	0.00
0.30	0.00
1.28	0.34
2.26	1.00
3.25	0.86
4.23	0.30
5.22	0.12
6.20	0.08
6.23	0.00

Agency	
Velocity (ft/s)	SI Value
0.00	0.00
0.25	0.20
0.75	0.70
1.00	1.00
1.50	1.00
2.00	1.00
2.50	1.00
2.75	0.80
3.25	0.70
3.75	0.60
4.25	0.30
4.75	0.1
5	0



Existing	
Depth (ft)	SI Value
0.00	0.00
0.13	0.00
0.46	0.50
0.79	1.00
1.12	1.00
1.44	0.60
1.77	0.40
2.20	0.20
2.30	0.00

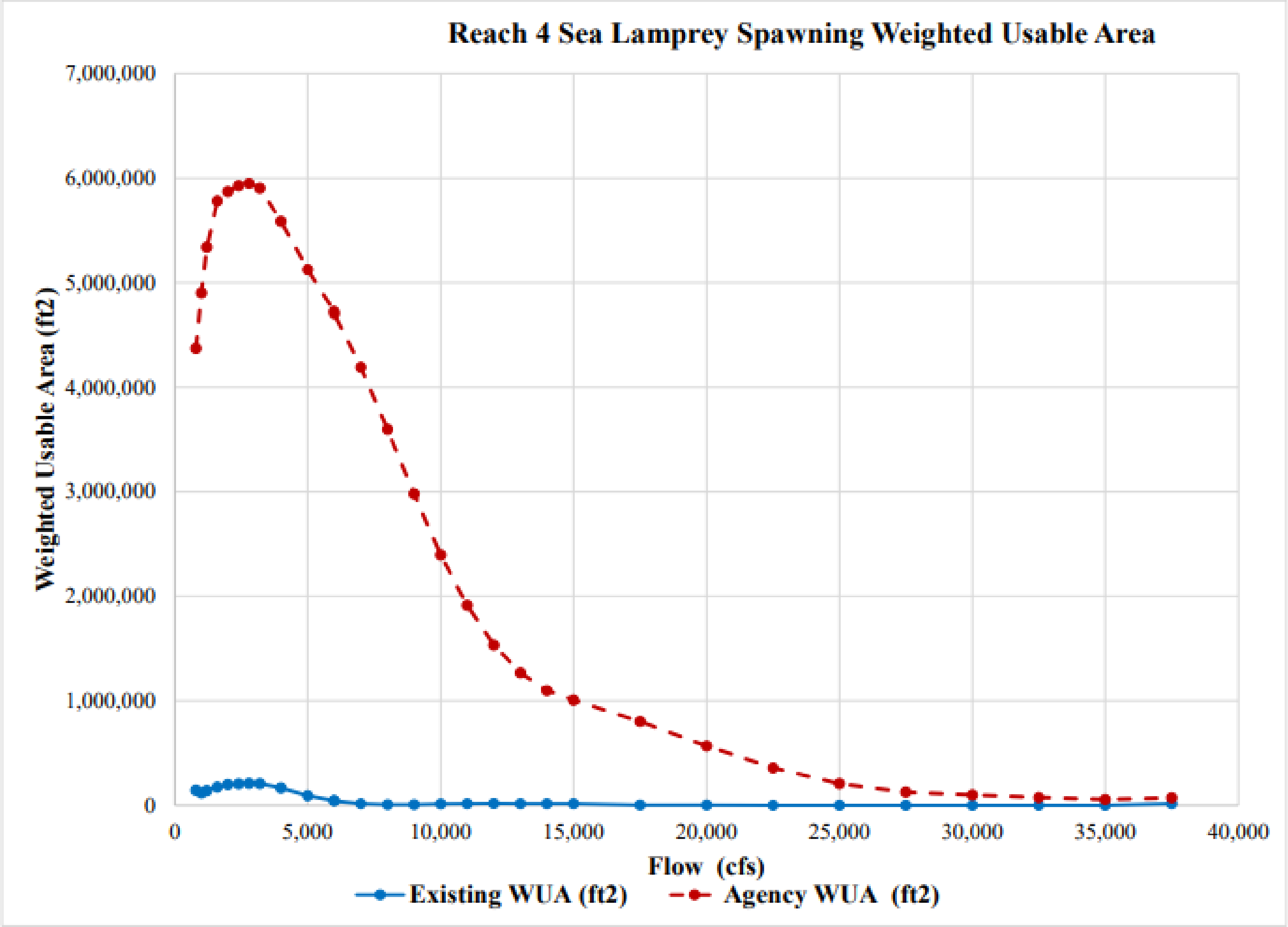
Agency	
Depth (ft)	SI Value
0.00	0.00
0.25	0.20
0.75	0.60
1.25	0.70
1.75	0.80
2.00	1.00
2.50	1.00
3.00	1.00
3.50	1.00
3.75	0.90
4.25	0.80
4.75	0.55
5.25	0.30
5.75	0.20
6.25	0.20
6.75	0.20
7.25	0.20
7.75	0.1
8.25	0

Figure 2.1-1: Existing and New (Agency) Sea Lamprey Spawning HSI Curves for Velocity and Depth

Instream Flow Study ADDENDUM 4
New Sea Lamprey HSI Curves

Develop new WUA curves with agency Sea Lamprey Spawning HSI curves

Reach 4



Adult Shad Passage Study Chronology

Date	Milestone
10/14/16	FL filed Study Report
10/31/16 -11/01/16	Study Report Meetings
12/15/16	Deadline for Stakeholder Comments on Study Report
01/17/17	FL issued Stakeholder Response to Comments. FL agrees to file Addendum 1 on various questions asked by stakeholders
02/17/17	FERC issued Determination Letter. FERC requires: • Re: Post-Mortality Drift of Tagged Shad*: FirstLight proposes to count shad that were not detected or were detected by only one stationary antenna downstream of the project as a passage-related mortality (i.e., shad passing two or more antennas will be treated as survivors). We expect that few of the dead test fish would have drifted past multiple antenna locations; therefore, FirstLight's proposed new analysis should provide a reasonable estimate of adult shad downstream passage survival.*
05/01/17	FL filed Addendum 1

FirstLight Power Resources

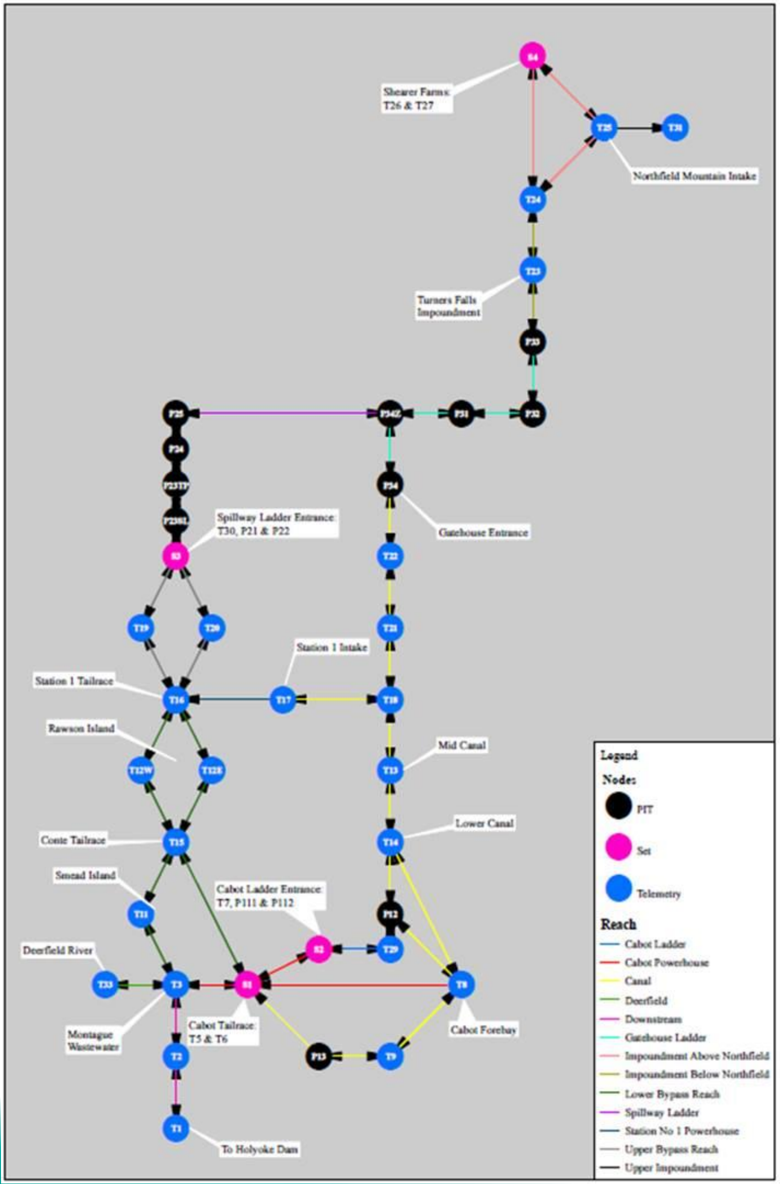
Adult Shad Passage Study

Due to comments the adult shad study data was reanalyzed and now includes:

Simplification of analysis via grouping of receivers into representative reaches rather than receiver – receiver

The removal of fallback fish and other false positives

Separating fish into their migration and emigration phases



Dual Tagged vs PIT Only Performance

- Addresses: CRWC-1(2), CRWC-10, MADFW-3, USFWS-15(1), USFWS-16, USFWS-21
- Created a release cohort CJS model with release at Holyoke and recapture occasions at PIT arrays (table 2.3-1)

Tag Plan	Parameter	Φ	SE	Lower	Upper
Dual	Release – 1st ladder	0.27	0.02	0.23	0.31
	1st ladder – Gatehouse ladder	0.26	0.04	0.19	0.35
	Gatehouse Ladder - Vernon	0.71	67.66	0.00	1.00
PIT only	Release – 1st ladder	0.34	0.03	0.28	0.41
	1st ladder – Gatehouse ladder	0.28	0.05	0.19	0.39
	Gatehouse Ladder - Vernon	0.62	55.35	0.00	1.00

- Test of proportions between gated reaches (table 2.3-3)

Reach	PIT Passage Efficiency (%)	Dual Passage Efficiency (%)	P
Holyoke- Project	23.3 (17.6-28.9)	30.7(24.6-36.9)	0.01
Cabot Ladder	17.2 (7.5-27.0)	13.3 (3.4-23.3)	0.79
Spillway Ladder	45.8 (25.9-65.8)	45.5 (16.0-74.9	1
Canal - Gatehouse	58.3 (45.9-70.8)	25.0 (13.7-36.3)	<0.001
Gatehouse Ladder	91.3 (83.2-99.4)	84.2 (60.6-97.3)	0.69

Fall Back Fish

Fish that exhibit irregular downstream movement after tagging and release are considered fallback fish.

The behavior of these fish may indicate potential adverse effects from handling and tagging, therefore these fish were removed from all upstream migration analyses.

Fallback fish by release cohort

Release Site	Total Number of Fish Released	Number of Fallback Fish	Percent Fallback
Holyoke	433	203	47%
Canal	100	26	26%
Impoundment	260	171	66%

FirstLight Power Resources

Mortality

- Addresses: CRWC-4(1&2). USFWS-1(6), USFWS-10(1&2), USFWS-23(3), USFWS-24(3), USFWS-26(3)
- Table 2.6-2 – mortalities by reach and release cohort:

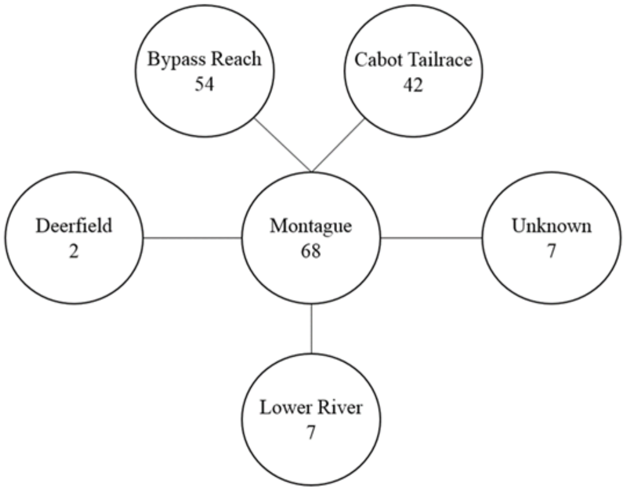
Phase	n	Release Location	Number of Mortalities by Reach			
			Holyoke to Project	Project to Bypass	Canal	TFI
Migration	155	Holyoke	2	0	0	0
	49	Canal	0	0	0	0
	89	Impoundment	0	0	0	4
Emigration	155	Holyoke	19	2	1	2
	49	Canal	15	8	2	1
	89	Impoundment	15	12	4	15
Fallback	104	All	12	4	1	2

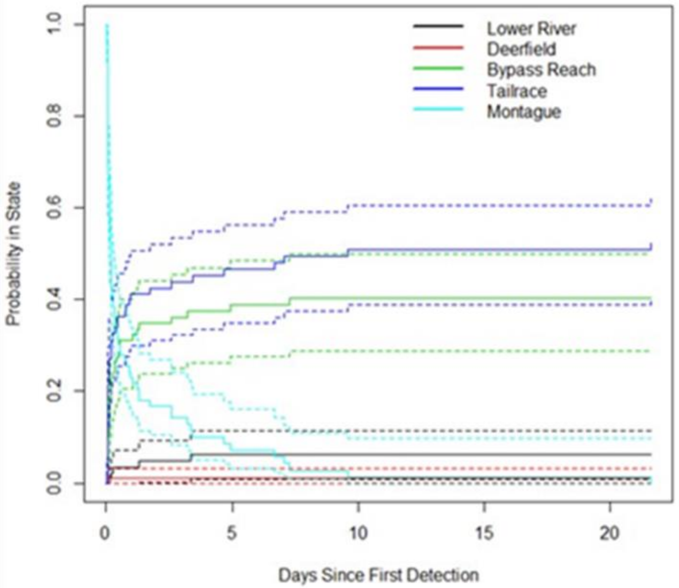
FirstLight Power Resources

Adult Shad Migration and Emigration Holyoke to Vernon

Station	Receiver ID	Distance (RKM)
Redcliffe Canoe Club	T1	137.42
Sunderland Bridge	T2	176.1
Montague Wastewater	T3	190.47
Smead Island	T11	191.61
Cabot Tailrace	T5	191.98
Cabot Farfield	T6	192.08
Conte Discharge	T15	192.7
Rawson Island	T12E/W	193.21
Station 1 Tailrace	T16	194.93
Dam River Right	T19	196.45
Dam River Left	T20	196.62
Impoundment	T23	197.19
Gill Bank	T24	204.62
NMPS Intake	T25	205.51
Shearer Farm	T26/T27	206.24

Montague Spoke Model.





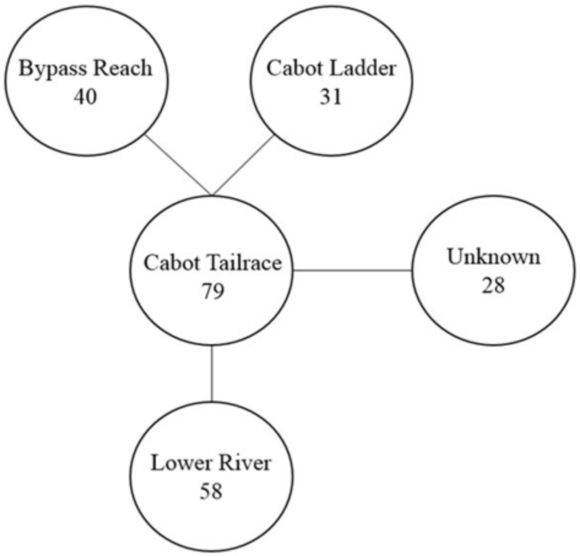
Best Model	Covariates	HR	(+/-)
Montage > Bypass	Diurnal	1.14	(0.57,2.29)
	Bypass (kcfs)	2.31	(1.67,3.21)
	Cabot (kcfs)	1.39	(1.17,1.64)
	Bypass:Cabot	0.94	(0.91,0.97)

Best model: lowest AIC

Best Model	Covariates	HR	(+/-)
Montage > Tailrace	Bypass (kcfs)	0.76	(0.62, 0.93)

Best model: significant LR and HR

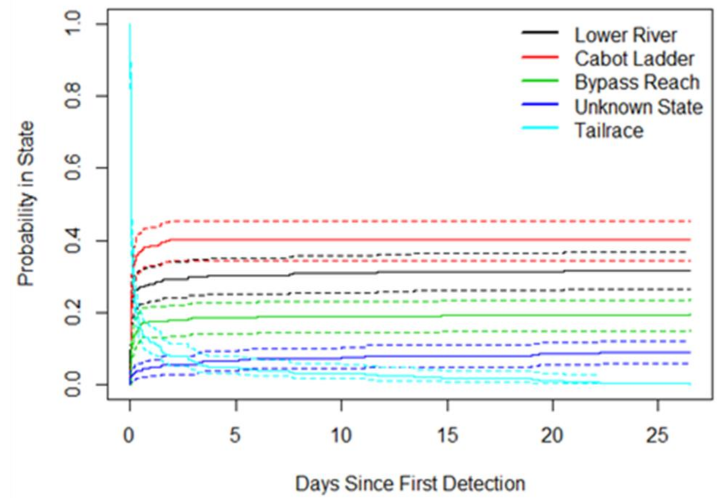
Cabot Tailrace Model

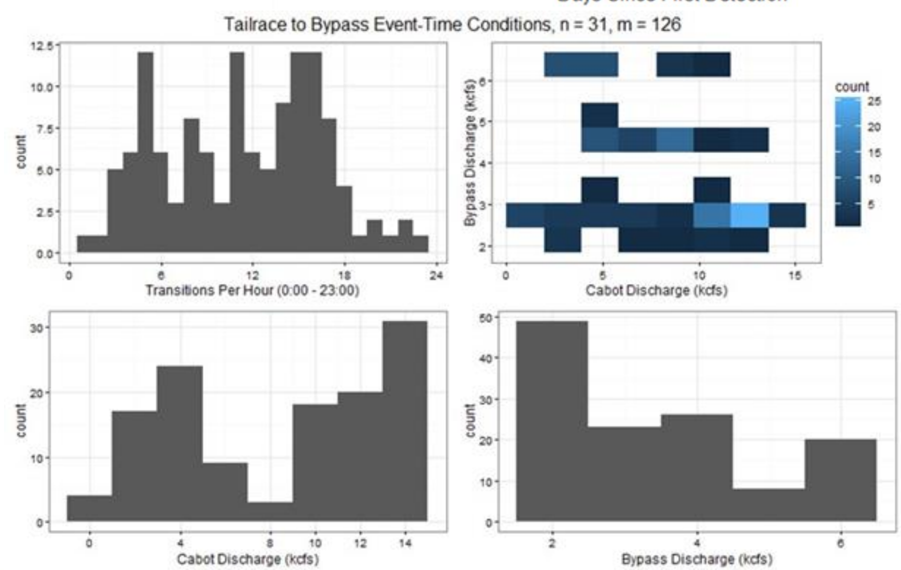


While more fish entered the bypass reach than Cabot Ladder, the number of events into Cabot Ladder was more, hence why the Nelson-Aalen estimate is higher.

31 fish made 126 movements into Cabot Ladder (median = 3, max = 13)

37 fish made 61 movements into the Bypass Reach (median = 1, max = 8)

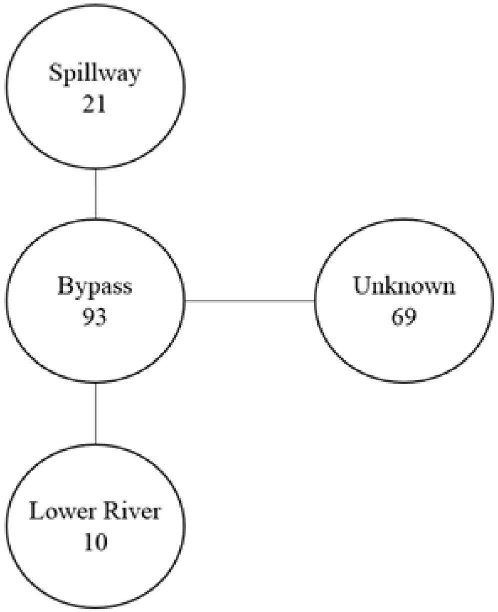


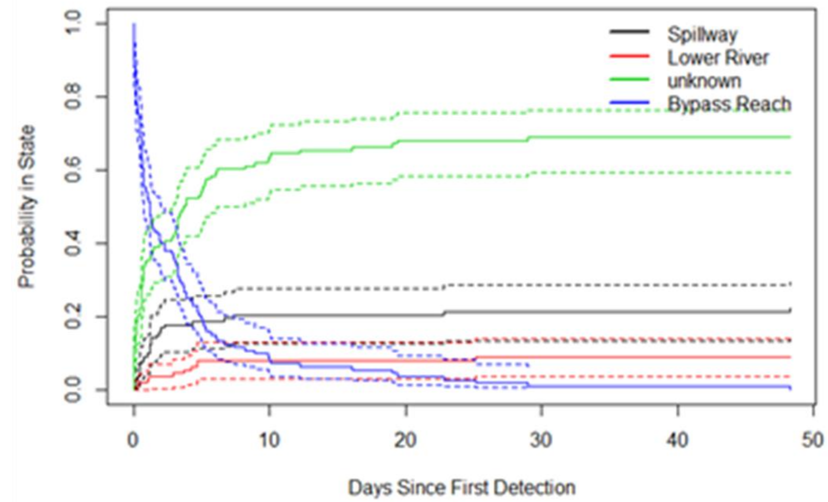


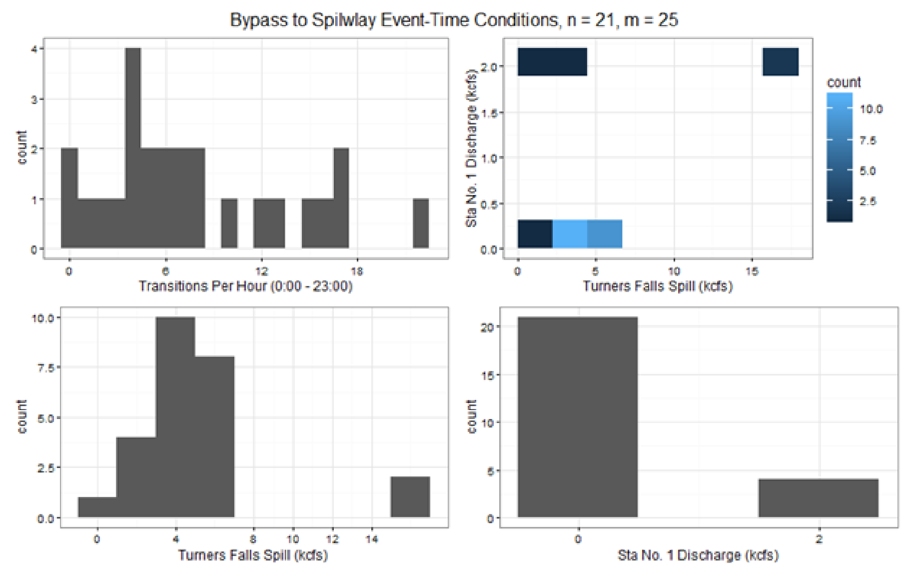
Best Model	Covariates	HR	(+/-)
Tailrace > Ladder	Diurnal	1.62	(0.91,2.87)
	Cabot (kcfs)	1.16	(1.00,1.34)
	Bypass (kcfs)	1.30	(0.91,1.88)
	Bypass:Cabot	0.96	(0.92,0.99)

Best model: lowest AIC

Bypass Migration Model



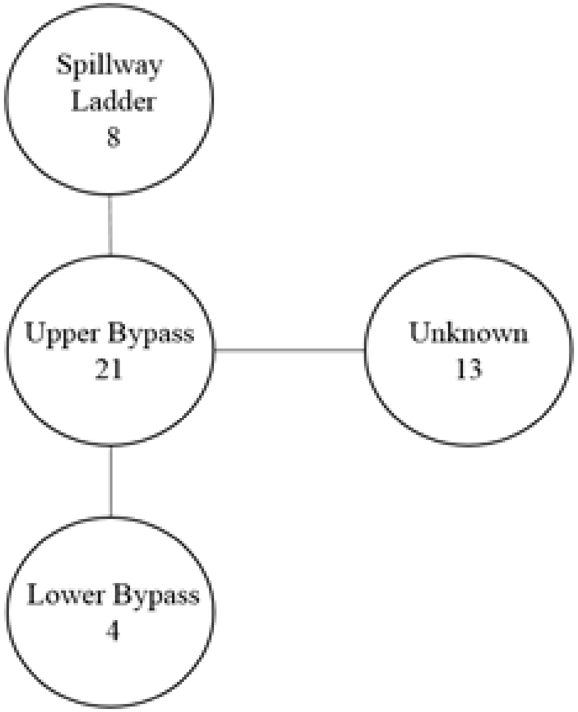


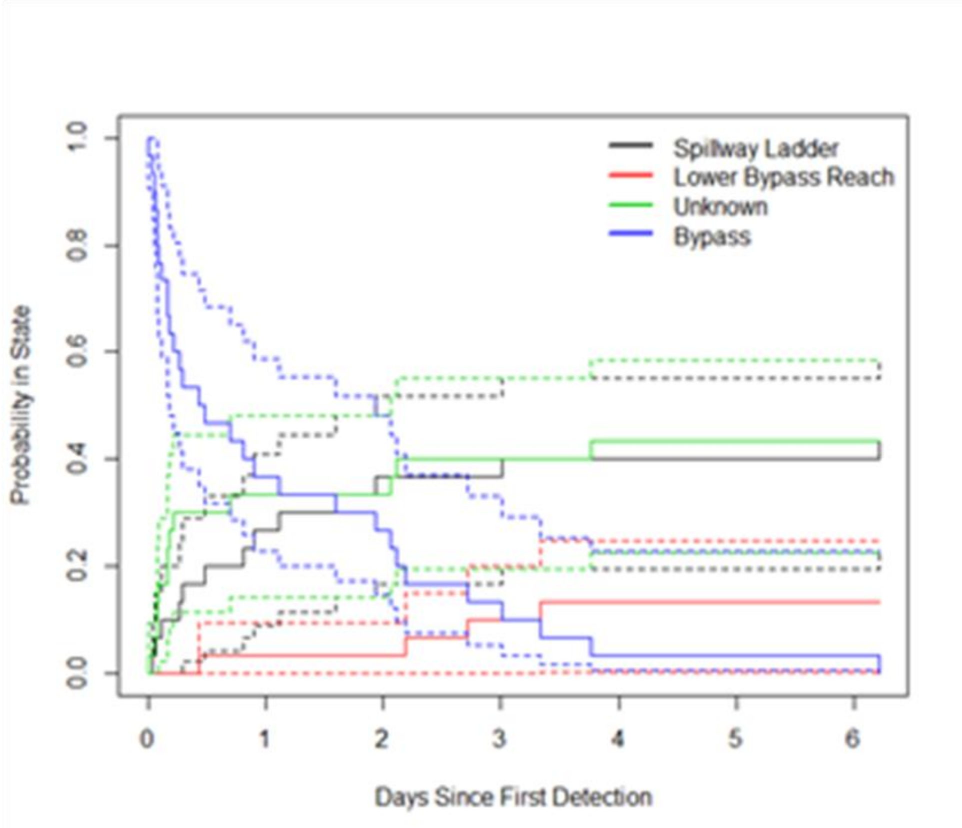


Best Model	Covariates	HR	(+/-)
To Spillway	Diurnal	0.41	(0.18,0.93)
	Cabot (kcfs)	1.22	(1.09,1.36)

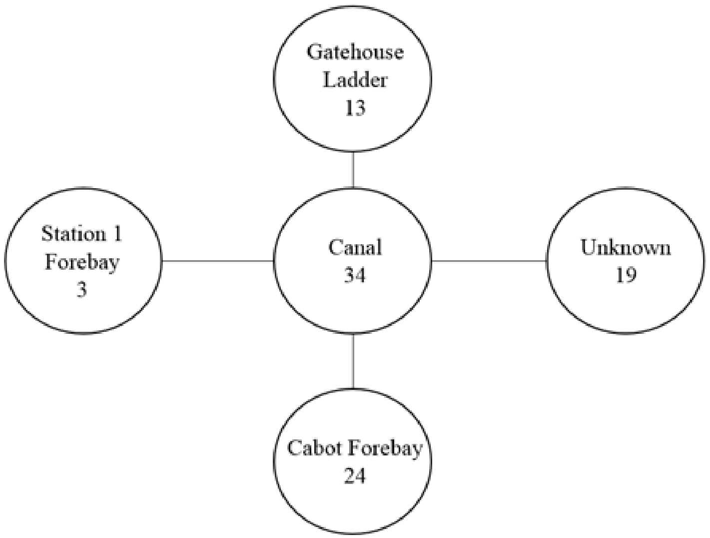
Best model: lowest AIC

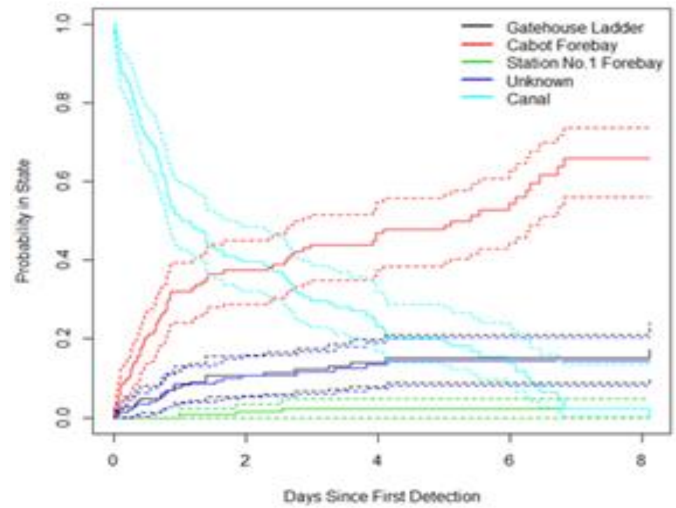
Spillway Ladder Attraction Model

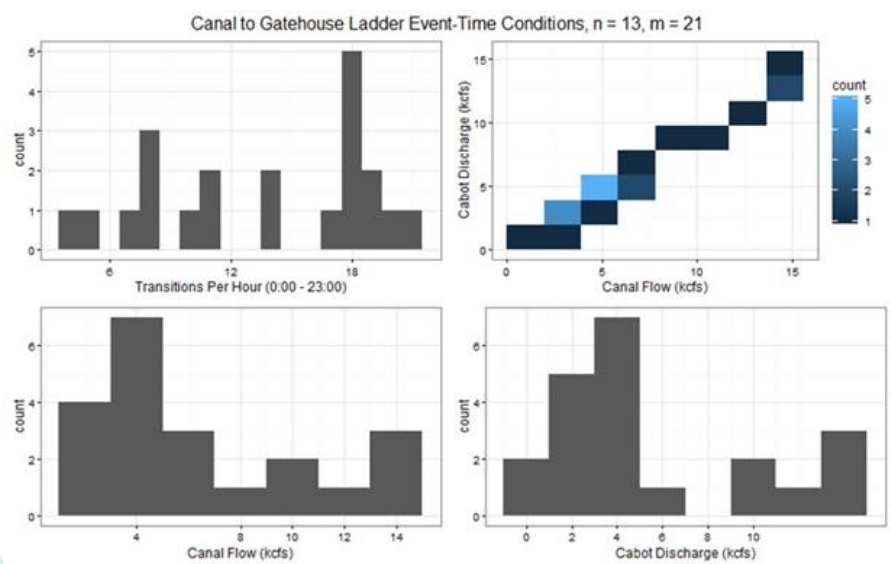




Upstream Canal Model

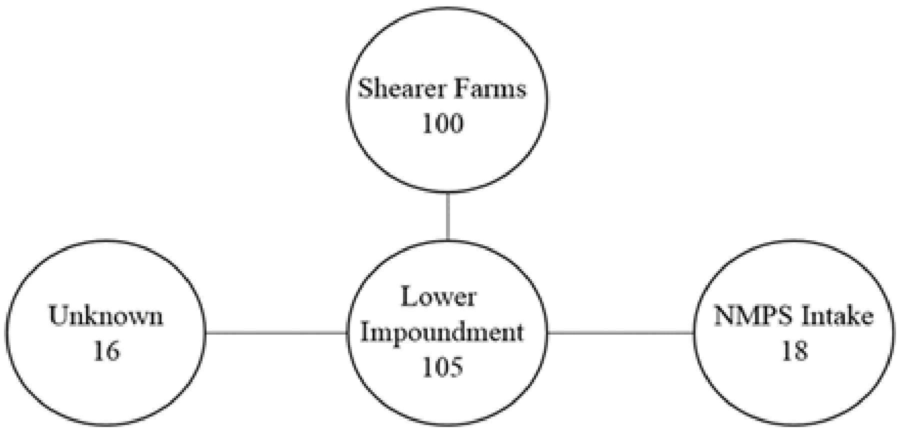


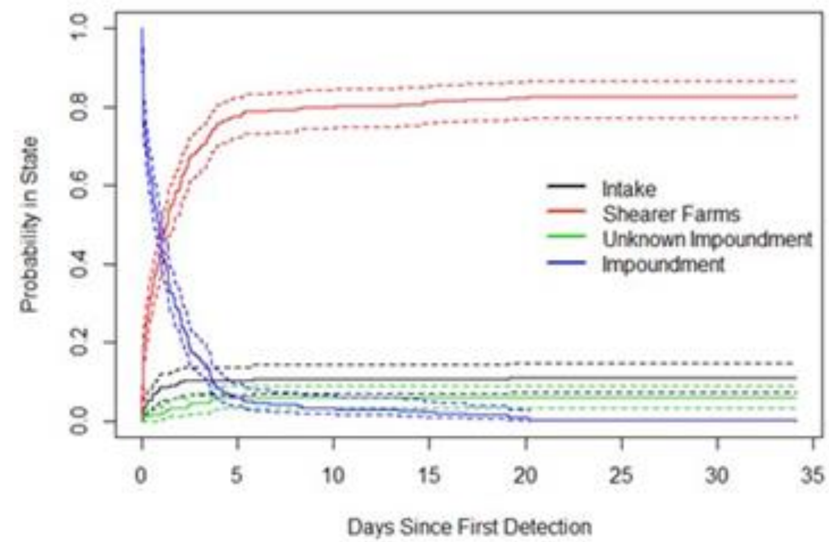


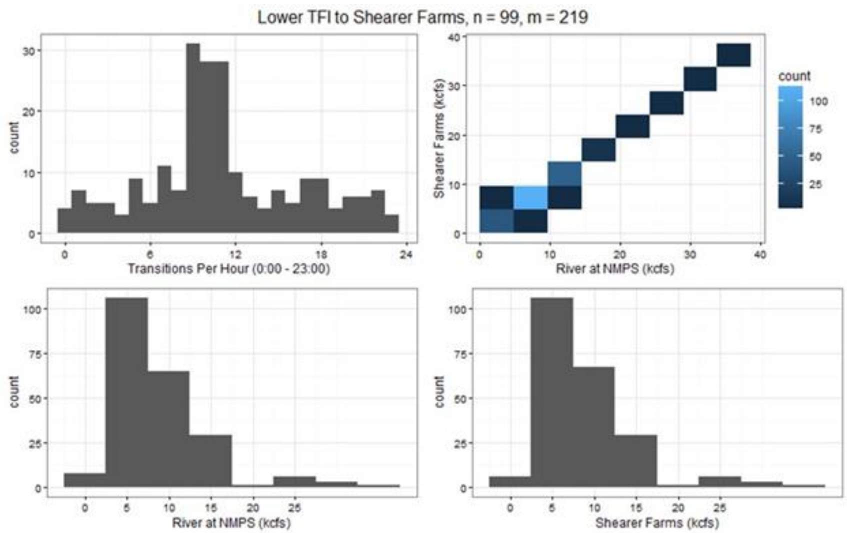


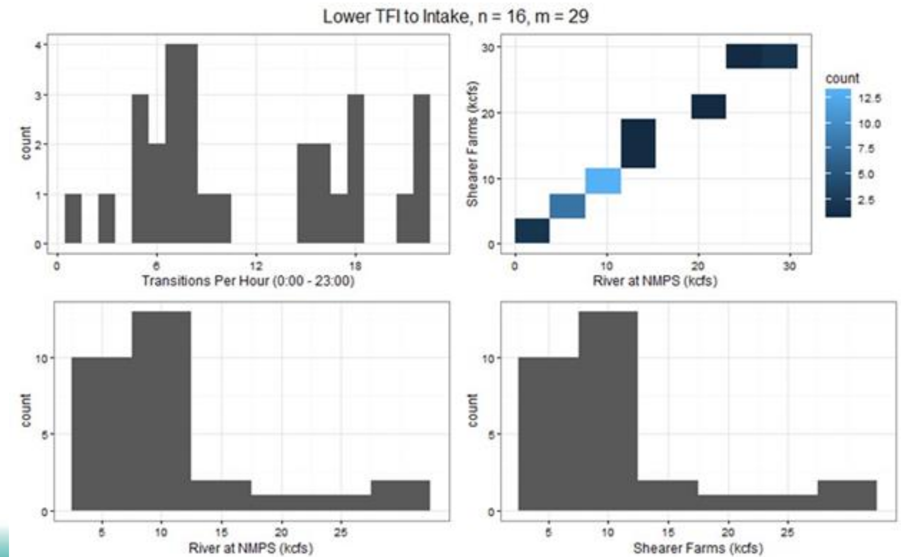
Reach	Survival Rate (φ)	Lower	Upper
Release: Lower Canal	1.0	0.96	1.0
Lower Canal: Mid Canal	0.64	0.51	0.76
Mid Canal: d/s Sta No 1	0.85	0.71	0.95
d/s Sta No 1: Upper Canal	0.82	0.65	0.93
Upper Canal: d/s Gatehouse	0.92	0.79	0.99
d/s Gatehouse: Gatehouse Ladder	0.91	0.39	0.81
Gatehouse Ladder: TFI	0.87	0.47	1.0

TFI Upstream Migration Model

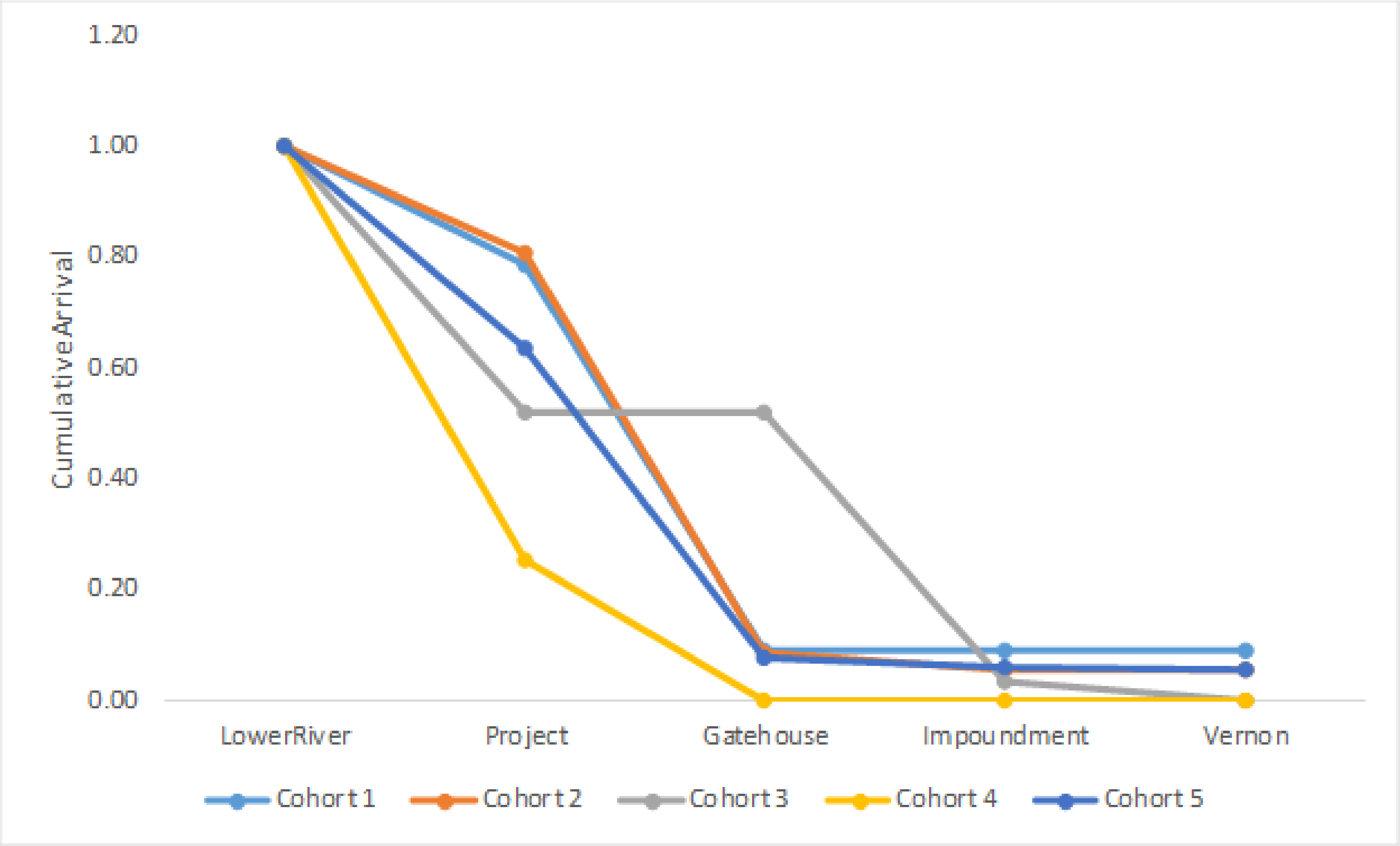




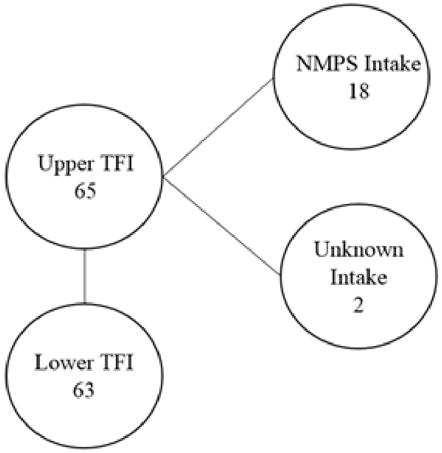


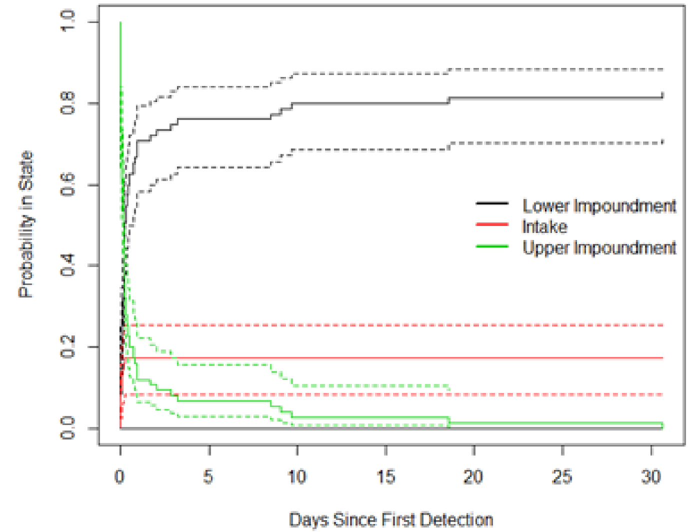


Overall Probability of Arrival at Vernon

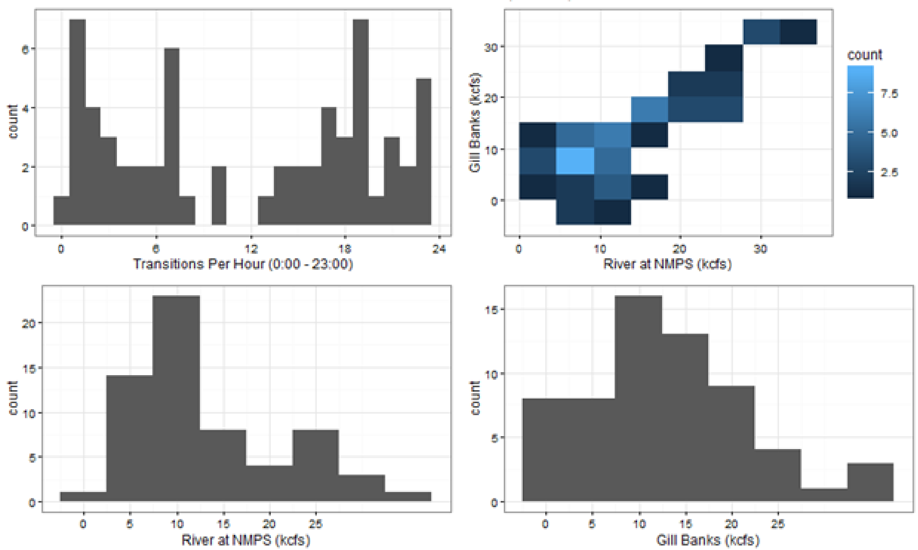


TFI Emigration Model

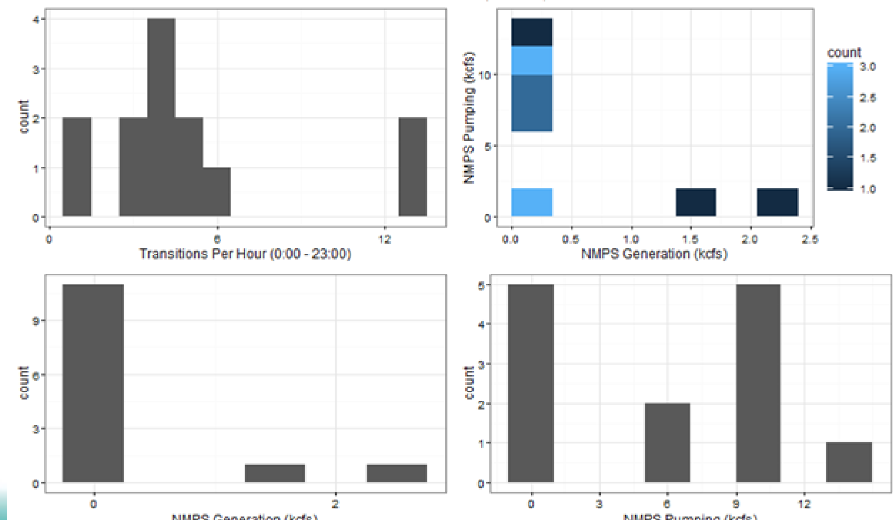




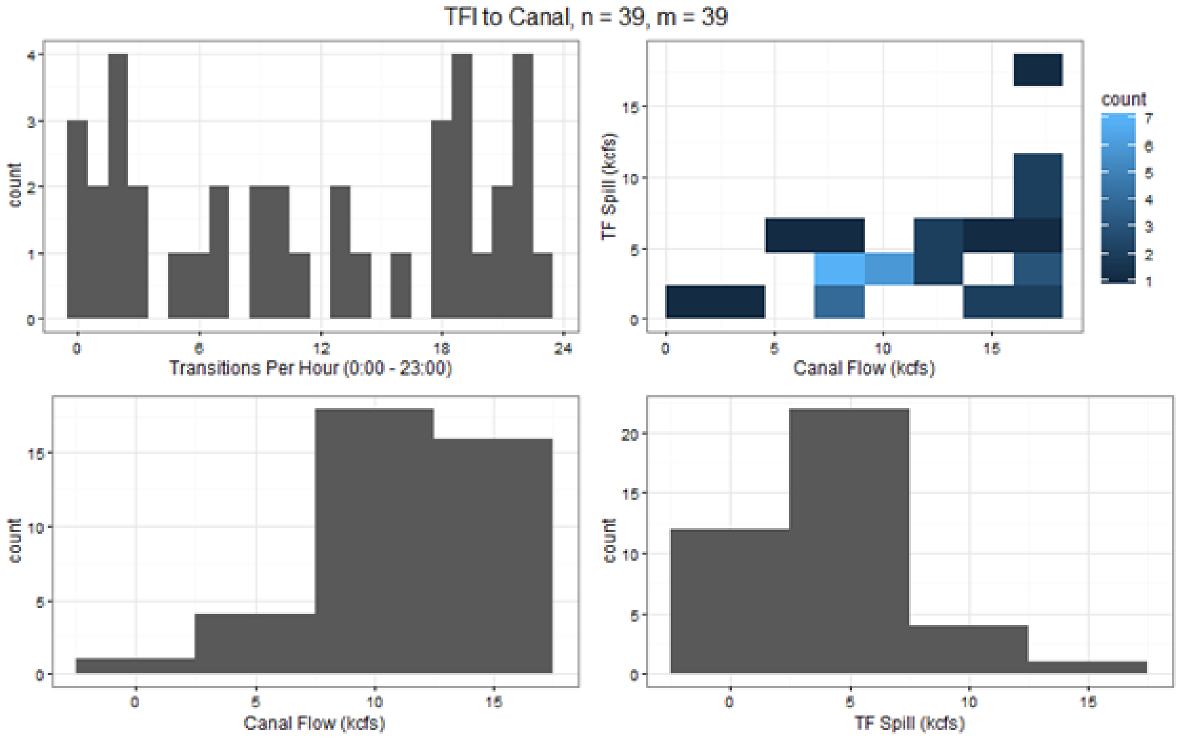
Shearer Farms to Lower TFI, n = 53, m = 62

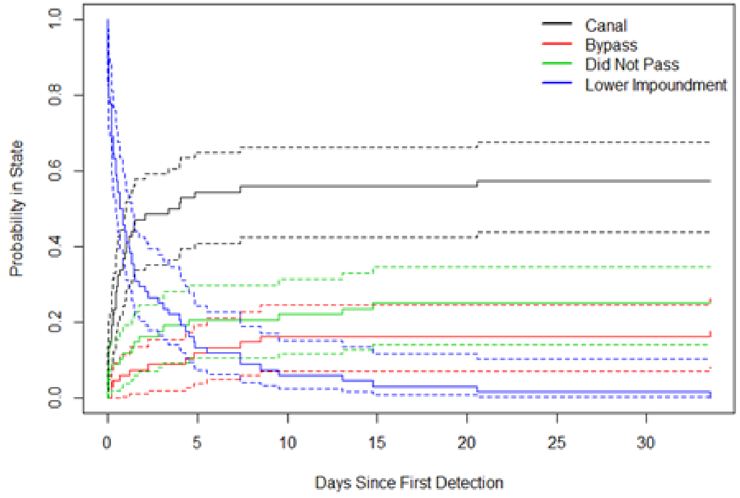


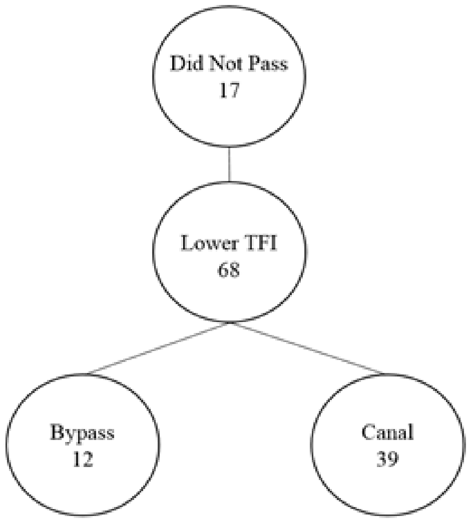
Shearer Farms to Intake, n = 13, m = 13



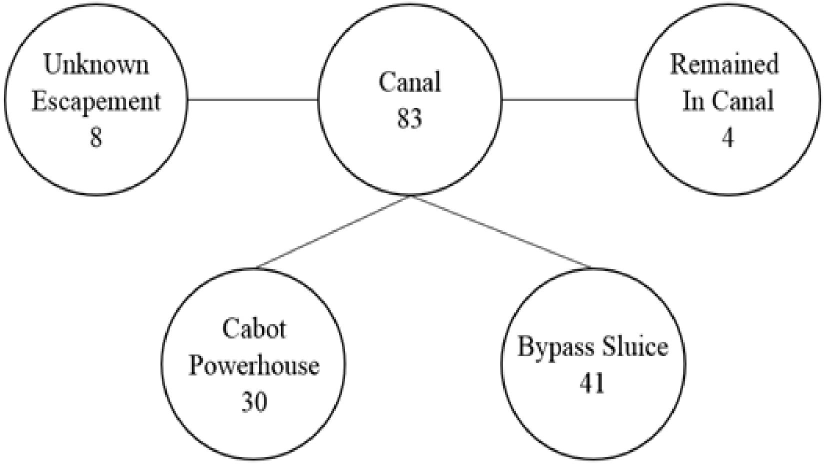
Route Choice at TFD Model

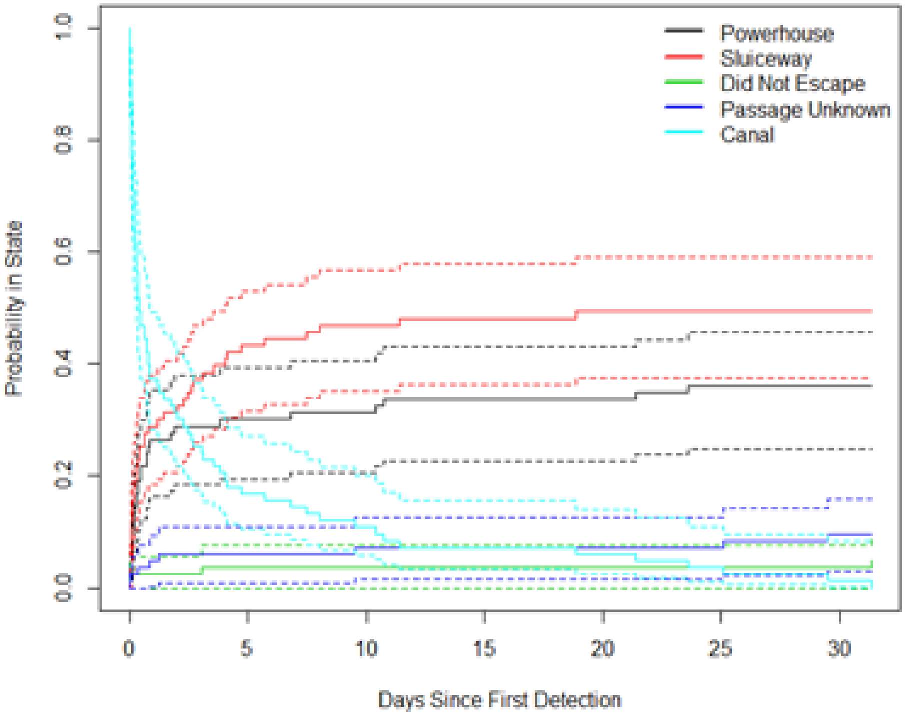




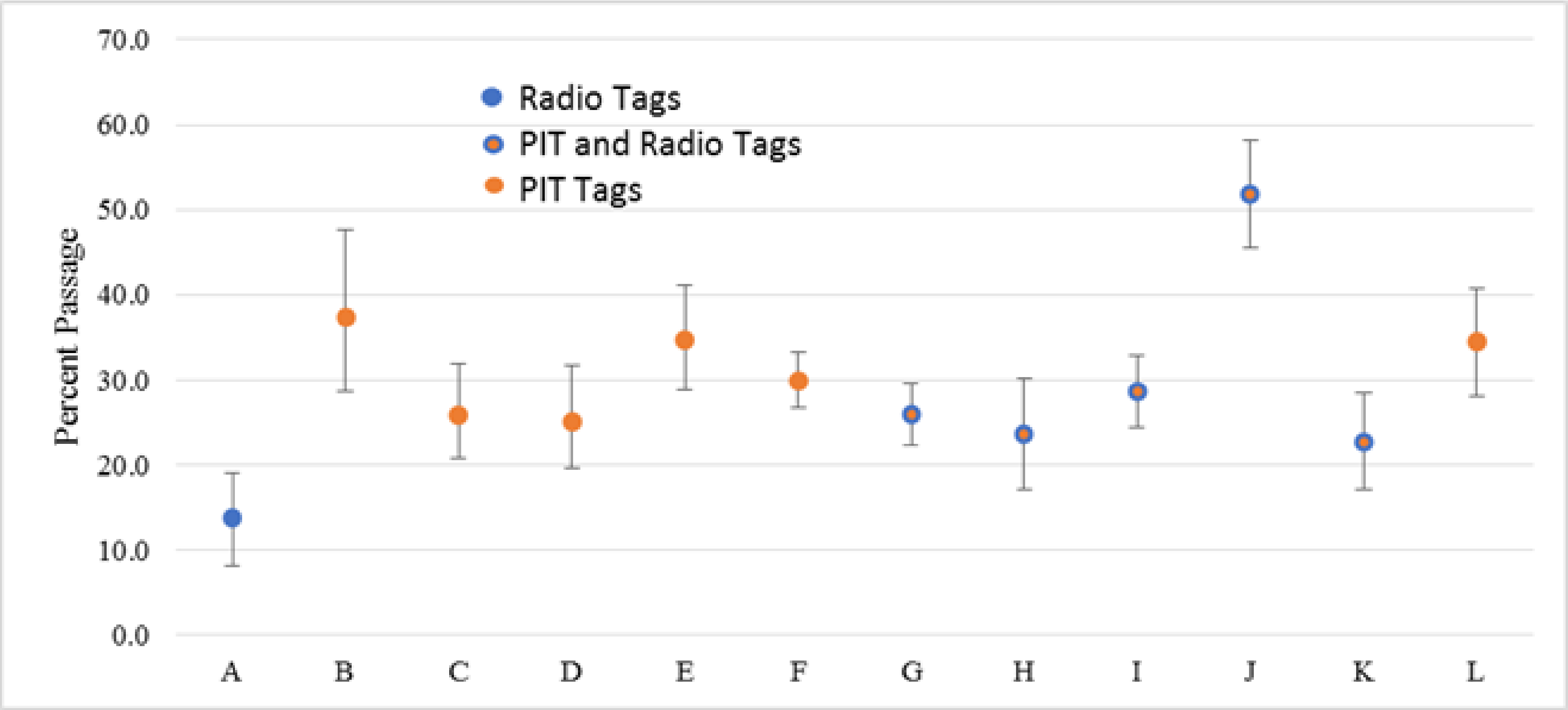


Canal Escapement Model



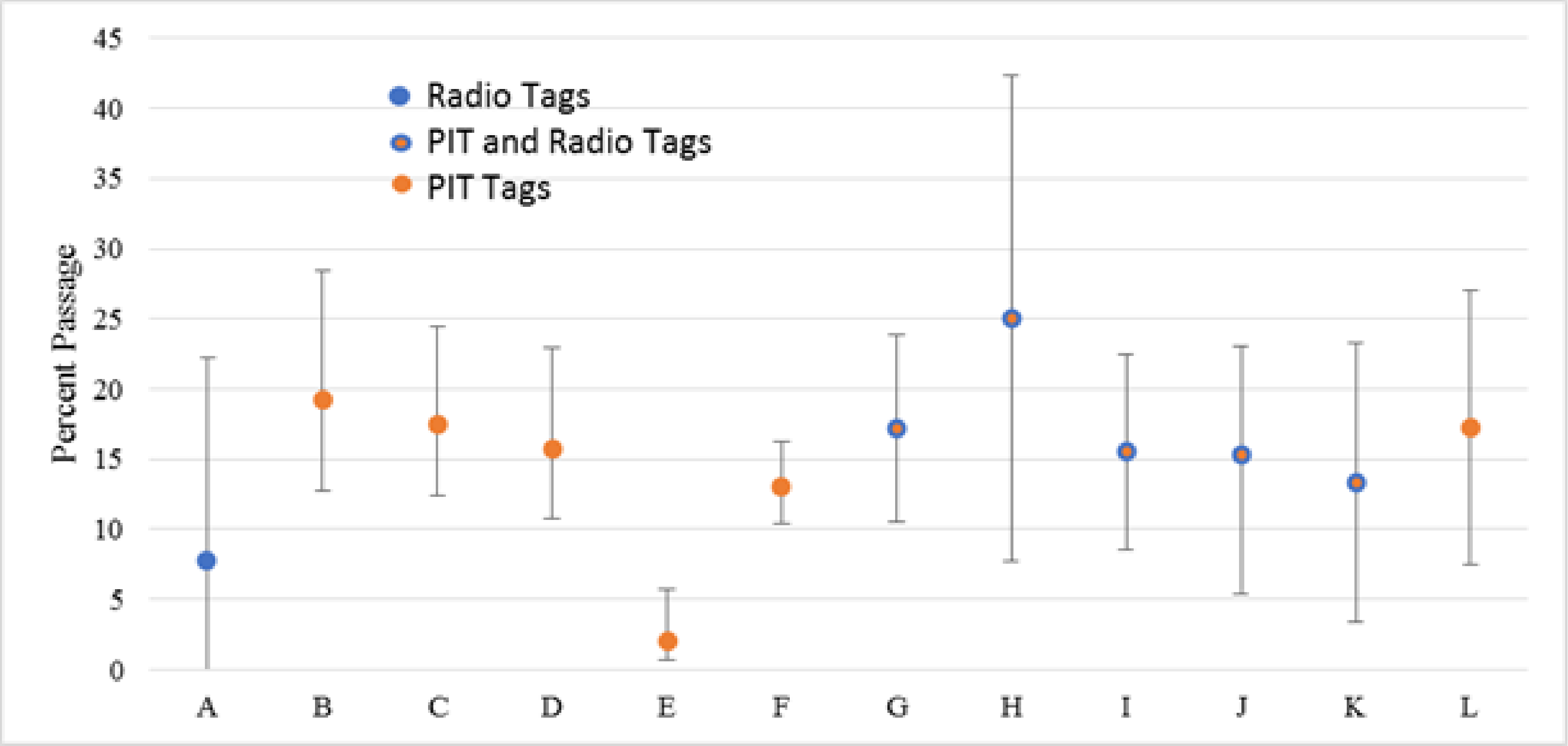


Meta Analysis: Holyoke Fish Lift to Turners Falls Project



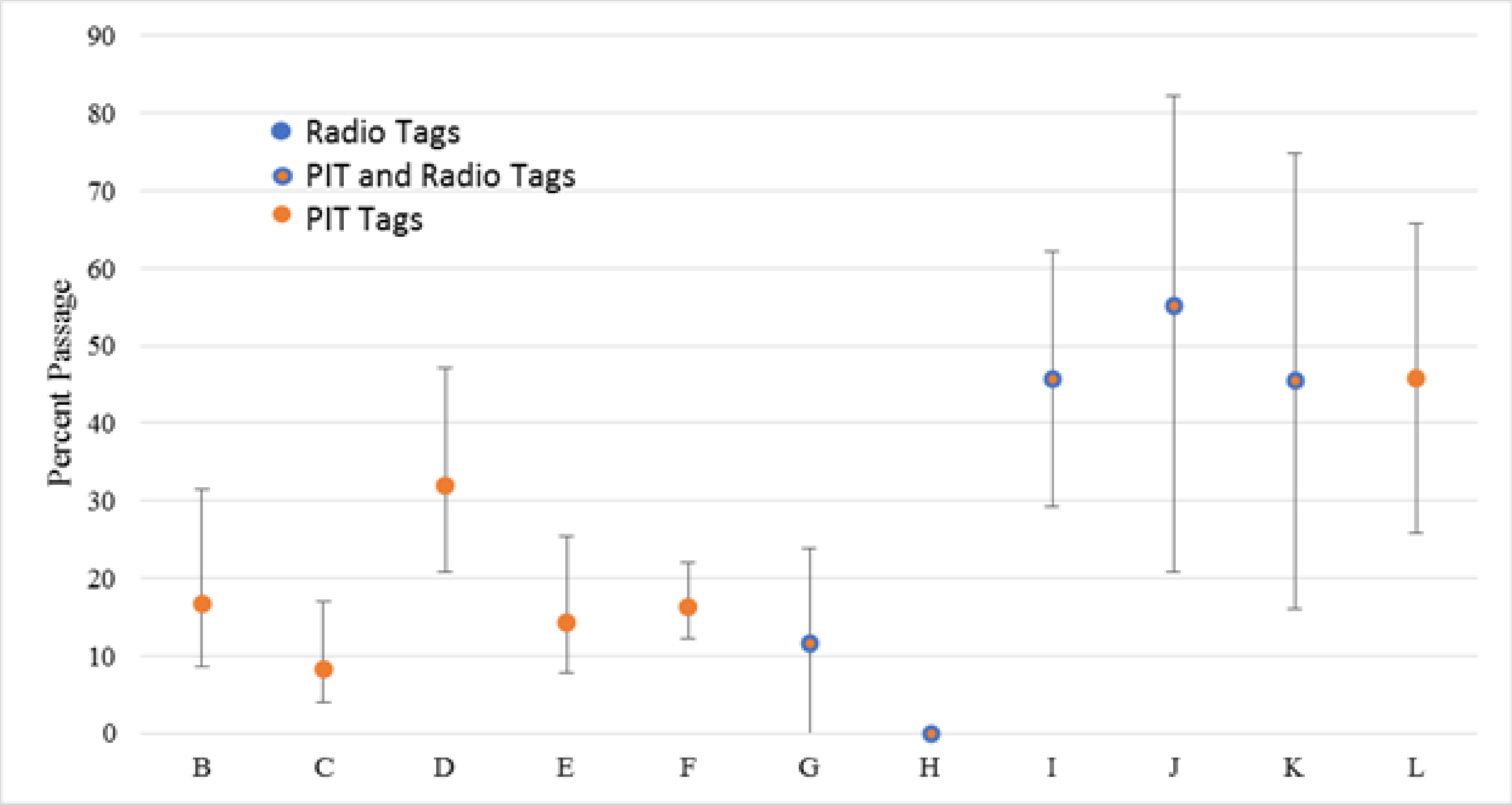
Parameter	Dual Tagged	Pit Tagged Only
% Passage	23.3 (17.6 – 28.9)	30.7 (24.6 – 36.9)
N enter	215	218
N exit	50	67

Meta Analysis: Cabot Fish Ladder Efficiency



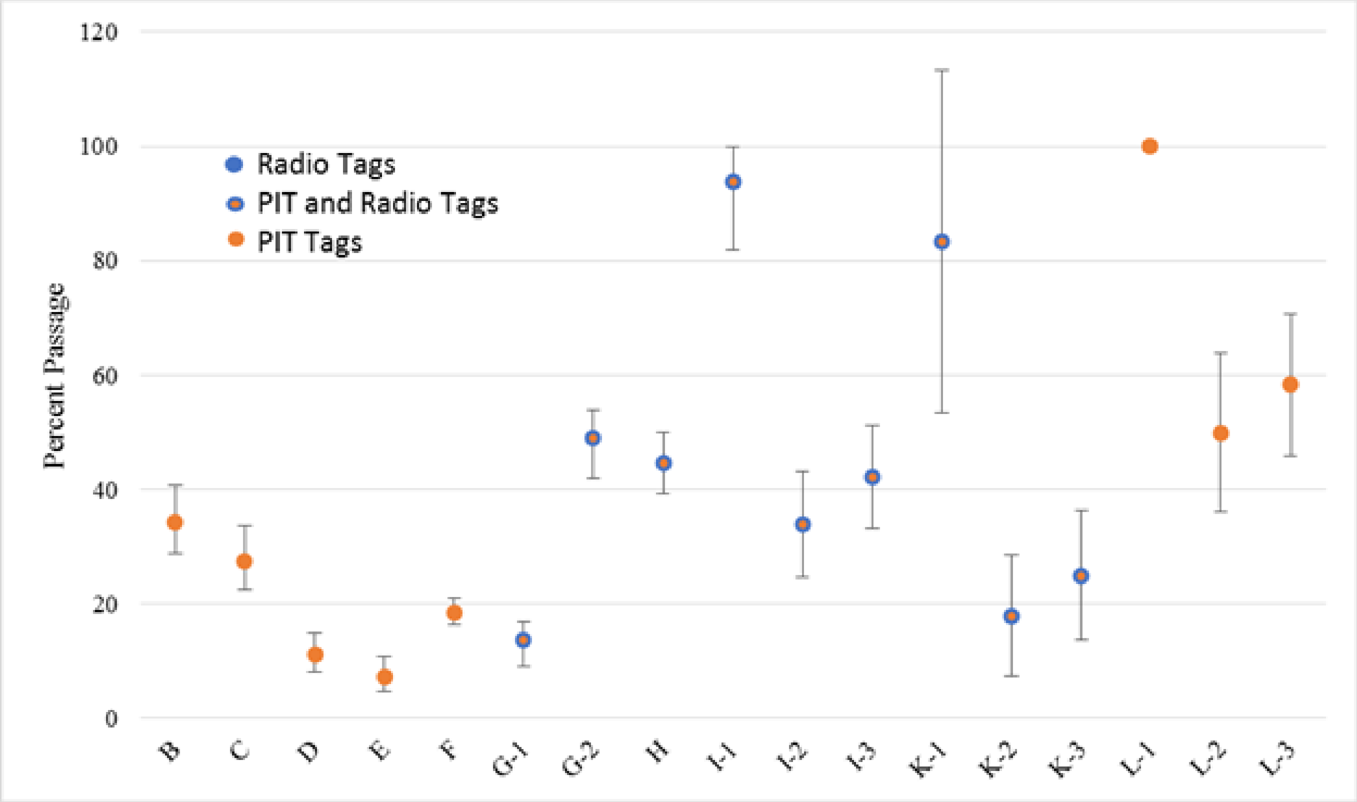
Parameter	Dual Tagged	Pit Tagged Only
% Passage	13.3 (3.4 – 23.3)	17.2 (7.5 – 27.0)
N enter	45	58
N exit	6	10

Meta Analysis: Spillway Ladder



Parameter	Dual Tagged	Pit Tagged Only
% Passage	45.5 (16.0 – 74.9)	45.8 (25.9 – 65.8)
N enter	11	24
N exit	5	11

Meta Analysis: Power Canal



Parameter	Dual Tagged	Pit Tagged Only
% Passage	25.0 (13.7 – 36.3)	58.3 (45.9 – 70.8)
N enter	56	60
N exit	14	35

FirstLight Power Resources

Sea Lamprey Study Chronology

Date	Milestone
10/14/16	FL filed Study Report
10/31/16 -11/01/16	Study Report Meetings
12/15/16	Deadline for Stakeholder Comments on Study Report
01/17/17	FL issued Stakeholder Response to Comments
02/17/17	FERC issued Determination Letter. FERC requires: • *Therefore, we recommend that FirstLight consult with the stakeholders and establish parameters for a low-flow scenario or scenarios and then run the hydraulic model for the selected low-flow scenarios. These modeling results should be used to describe, in an addendum to be filed by May 15, 2017, inundation and exposure of the locations where the 29 redds were documented.*
05/01/18	FL filed Addendum 1

Sea Lamprey Study-Addendum 1

- Sea Lamprey spawning documented at the Hatfield S Curve (below Cabot), Stebbins Island (just below Vernon), and three tributaries- Fall, Millers, and Ashuelot Rivers.
- No hydraulic model exists for the three tributaries; no assessment possible.
- For the hydraulic model below the Montague USGS Gage, there is no transect located at the Hatfield S Curve, thus it is not possible to determine impact of Project operations on this spawning location.
- Six redds were located near Stebbins Island and were assessed using the hydraulic model.

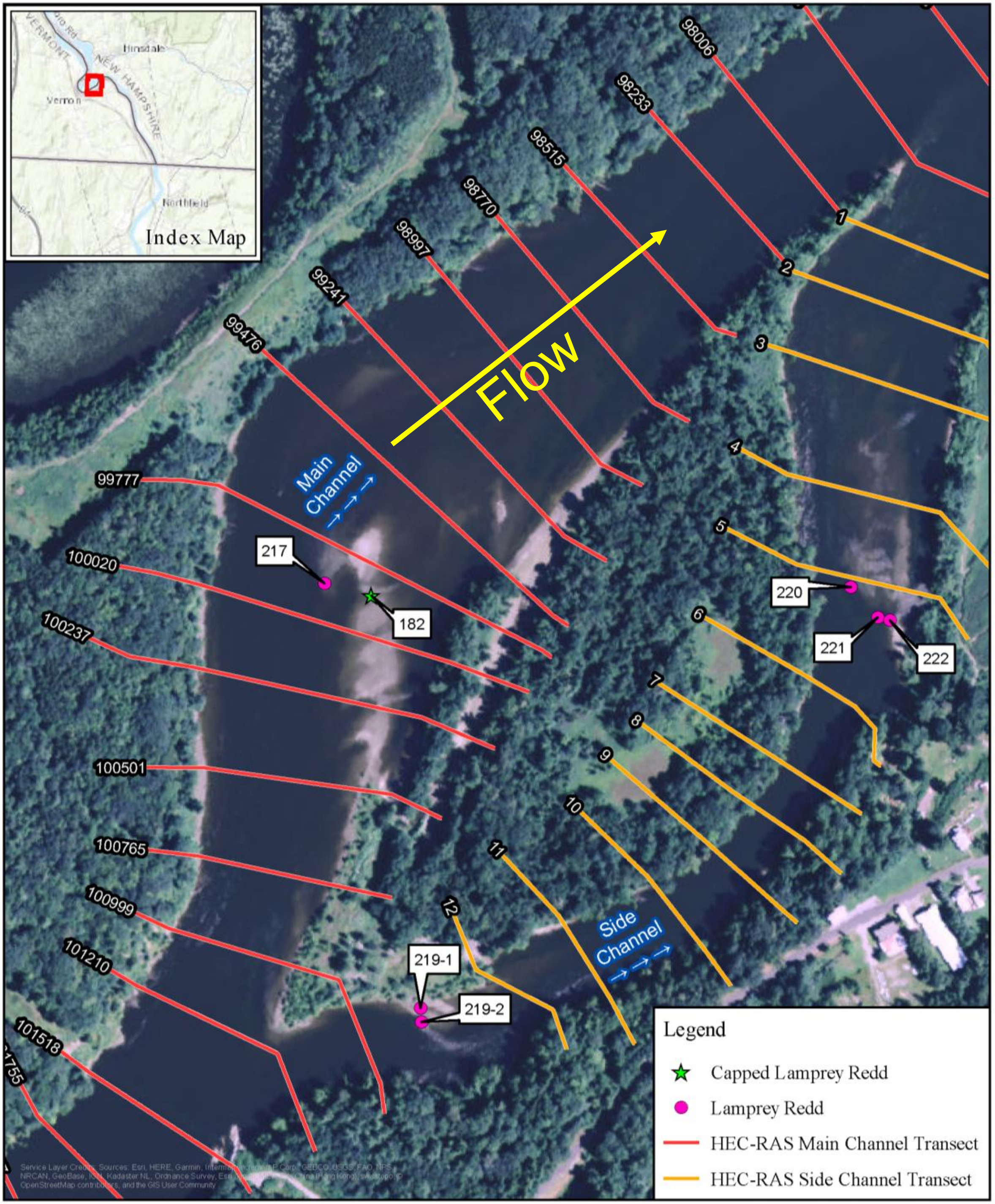
Sea Lamprey Study- Addendum 1

- Ran the hydraulic model in an unsteady mode to simulate on an hourly basis water surface elevations (WSELs) near the redds for the Sea Lamprey spawning season (May 20-July 31) and for the years 2000-2015 (excluding 2010; NFM did not operate).

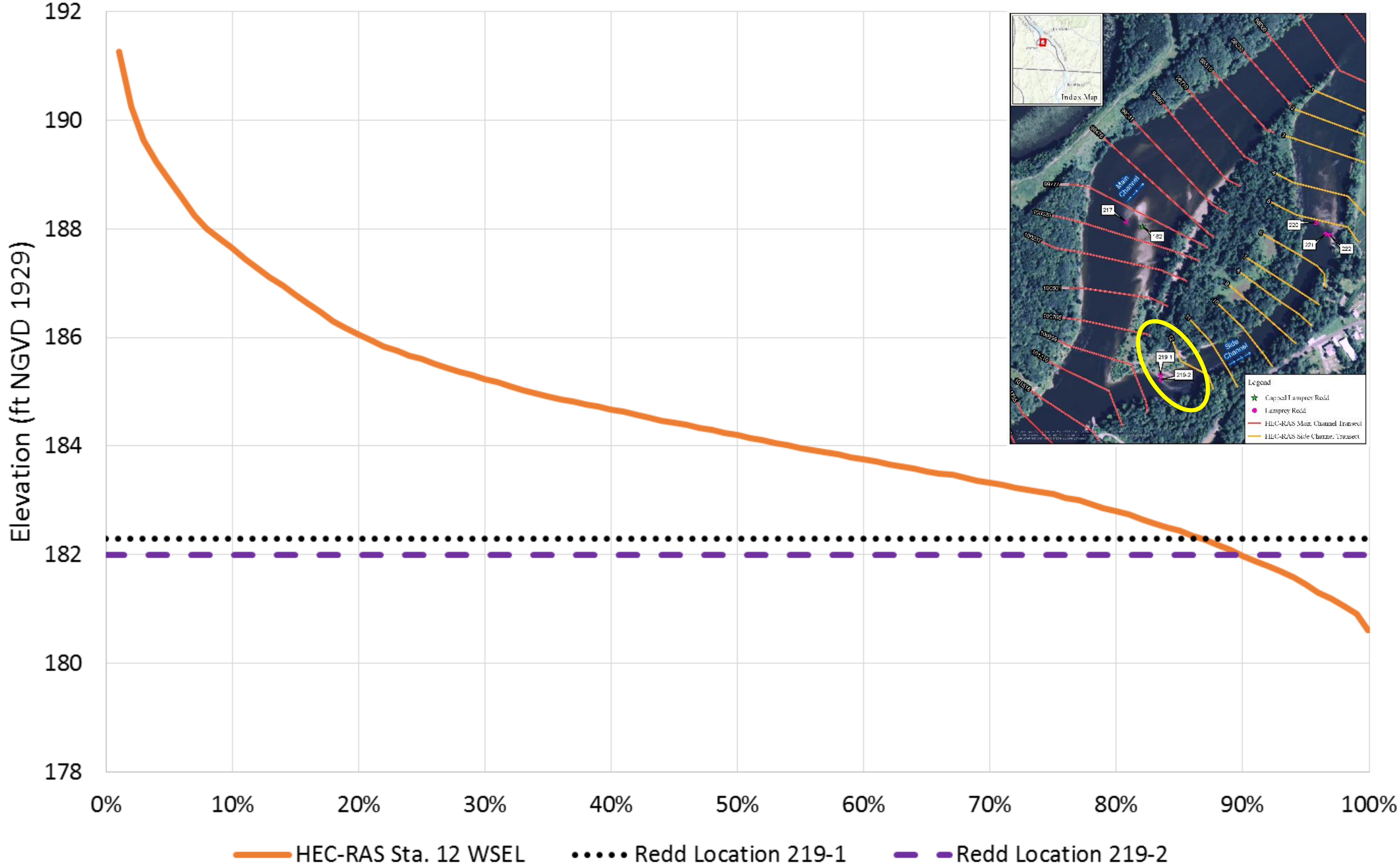
- Hydraulic model inputs: Observed data---Vernon discharge, Ashuelot and Millers River flow, TFI WSEL at Turners Falls Dam and NFM pump and gen flows.

- Using hydraulic model output, WSEL duration curves were developed at the redd locations.

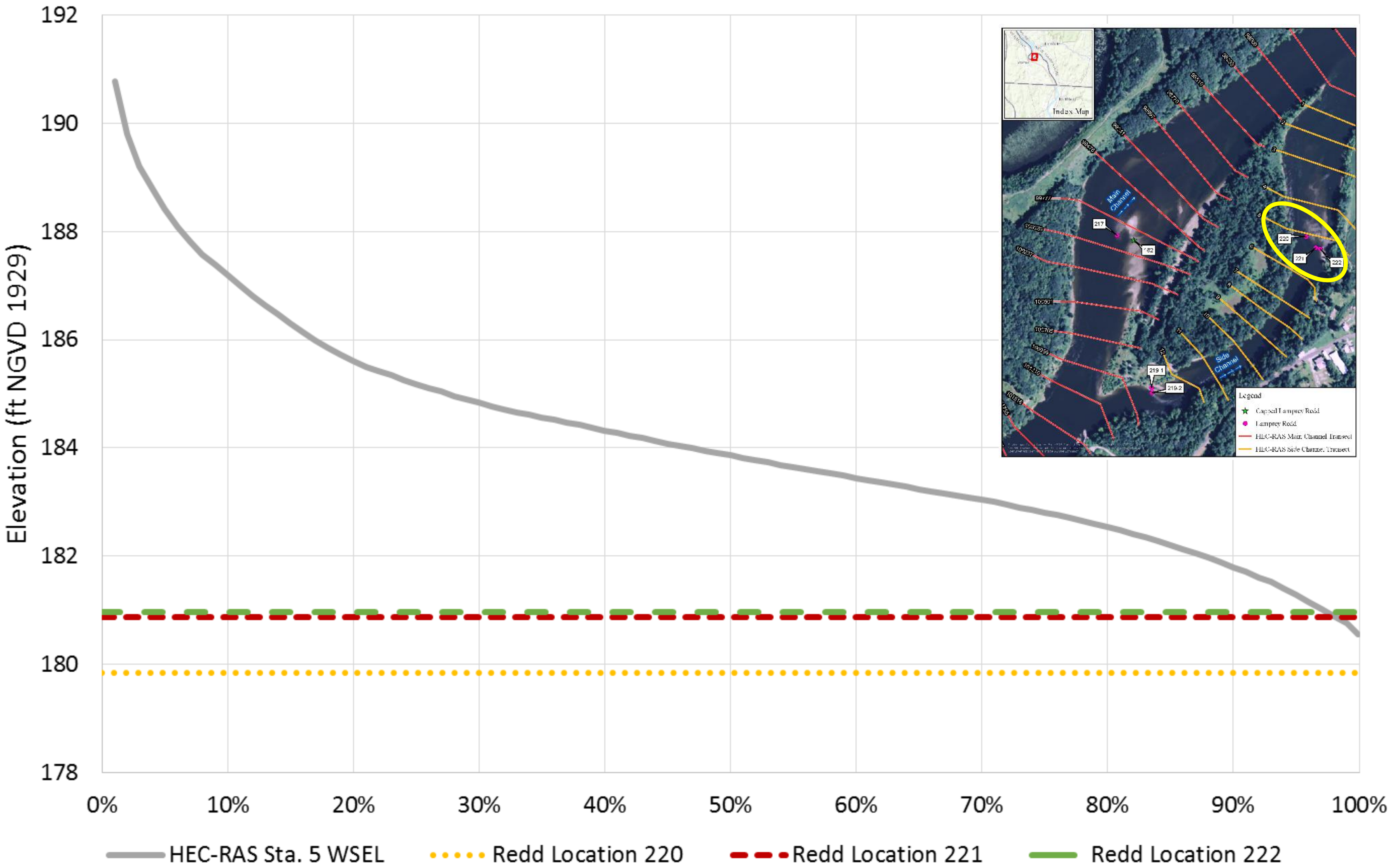
Sea Lamprey Redd Locations



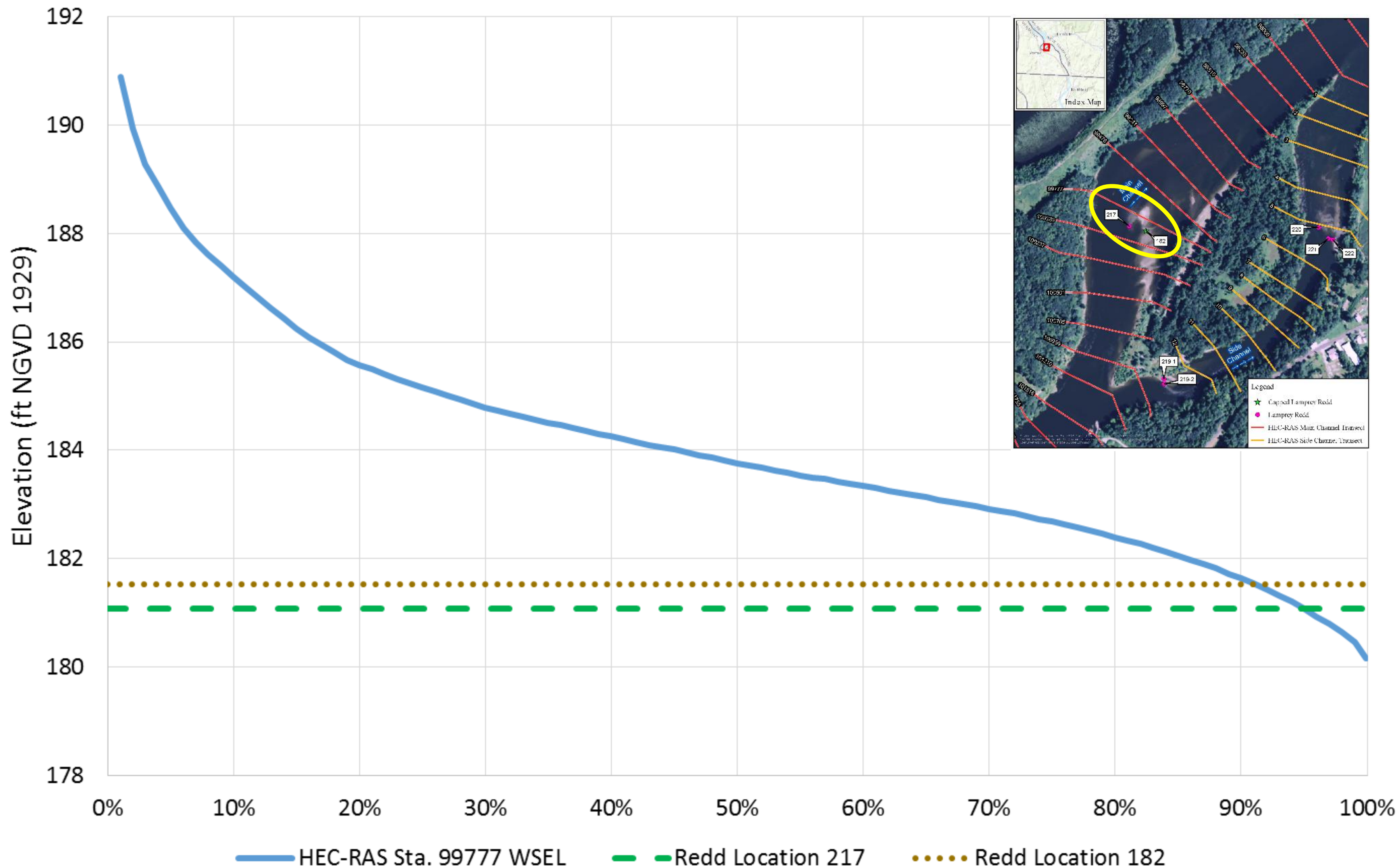
WSEL Duration Curve at Sea Lamprey Spawning Locations (219-1 and 219-2)
Upstream End of Stebbins Island
Based on hourly modeled data for May 20-July 31 for 2000-2015 (not 2010)



WSEL Duration Curve at Sea Lamprey Spawning Locations (220, 221, 222).
On right channel around Stebbins Island looking downstream
Based on hourly modeled data for May 20-July 31 for 2000-2015 (not 2010)



WSEL Duration Curve at Sea Lamprey Spawning Locations (182 and 217)
Left Side of Stebbins Island Looking Downstream
Based on hourly modeled data for May 20-July 31 for 2000-2015 (not 2010)



Erosion Causation Study Chronology

Date	Milestone
10/14/16	FL filed Study Report
10/31/16 -11/01/16	Study Report Meetings
12/15/16	Deadline for Stakeholder Comments on Study Report
01/17/17	FL issued Stakeholder Response to Comments. FL agrees to file Addendum 1 Evaluate Impact of Greater Use of Upper Reservoir Storage on TFI Erosion
02/17/17	FERC issued Determination Letter. No further analysis required.
04/03/17	FL re-issues Erosion Causation Report due to inadvertently flipped transects. Also files Addendum 1.

Greater Use of Upper Reservoir Storage on TFI Shoreline Erosion

- In its Draft License Application, FL proposed to expand use of the Upper Reservoir storage from 1000.5 to 938 feet (current) to 1004.5 to 920 feet (proposed) year round.

- FL conducted various analyses to quantify the change in bank-erosion rates under the proposed expanded use scenario when compared to baseline conditions using a suite of models

- The analysis was completed by the team of Simons & Associates, Cardno and GSE

- The analysis required running the following models:

  - Operations Model (HEC-ResSim) to simulate current and proposed use of the Upper Reservoir Storage. Outputs from this model were then fed into the hydraulic model and included: TFI inflow, NFM pump/gen flow, and TFI elevation at TF Dam.

  - Hydraulic model (HEC-RAS) to simulate hydraulics in the TFI. Outputs of the hydraulic model were fed into the erosion model and included: TFI water surface elevations at different locations along the TFI and energy grade line slope.

  - Erosion model (BSTEM) to simulate bank-erosion rates at the 25 detailed study sites previously established throughout the TFI as part of Study No. 3.1.2

Greater Use of Upper Reservoir Storage on TFI Shoreline Erosion

Operations Modeling Scenario	Input Hydrology	Input NFM Pump/Gen schedule
Baseline Conditions	Calendar Year 2002	2009 Observed Schedule
Expanded Use Scenario	Calendar Year 2002	2009 Modified Schedule to make greater use of Upper Reservoir Storage

- FirstLight operations personnel modified the 2009 pump/gen schedule (with the benefit of hindsight) to determine how the Project would have operated if additional Upper Reservoir Storage had been available.
- The operations model was subsequently run for two scenarios – **Baseline Condition (BL)** and **Expanded Use Scenario (EUS)**

Operations Model

Outputs:
- Vernon Discharge
- NFM pump/gen flows
- Ashuelot & Millers River flows
- TFI WSEL at Dam

Hydraulic Model

Outputs:
- Flow
- Water Surface Elev.
- Energy Grade Line

(at 25 detailed study sites)

Erosion Model

BSTEM was simulated for both boat waves on and off at all 25 detailed study sites. The difference in erosion between BL & EUS would be attributable to greater use of the Upper Reservoir

Greater Use of Upper Reservoir Storage on TFI Shoreline Erosion – HEC-ResSim Modeling Period

- The first step in the analysis was to identify a representative year, or years, to analyze. As previously noted, the 2002 hydrology and 2009 pump and generation (pump/gen) schedule for NFM were selected

- The 2002 hydrology was selected as flows were generally observed to be lower than average as compared to the recent period of record (i.e., 1975-2015), while also still including a period with peak flows from Vernon in excess of 60,000 cfs.

- By selecting a lower flow period, as opposed to a high flow period, FL simulated a period when the potential for Project operations to cause erosion would be greatest.

- The 2009 pump/gen schedule was chosen as it represented a typical year of current operations. The daily volume of water used for generation in 2009 was about average for the 2000-2014 period and higher than the recent years of current NFM operations

- Finally, the 2002 hydrology and 2009 pump/gen schedule were also selected to ensure consistency with past analyses which have been conducted (i.e., winter 2014/2015 temporary amendment)

Greater Use of Upper Reservoir Storage on TFI Shoreline Erosion – HEC-ResSim Modeling Period

2009 Pump/Gen

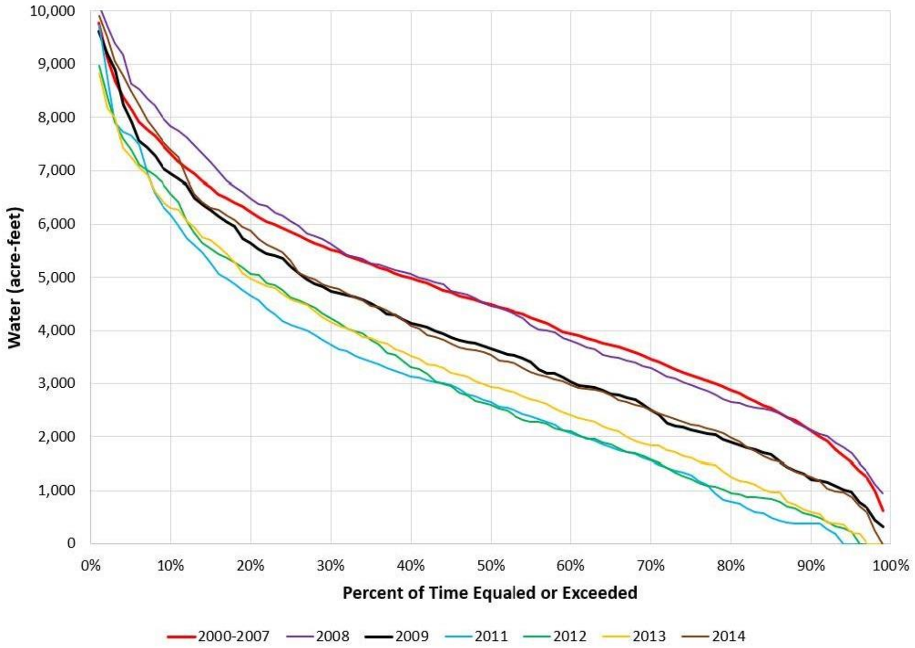


Figure 2-3: Daily Volume (acre-feet) of Water Use at Northfield Mountain for Generation

2002 Hydrology

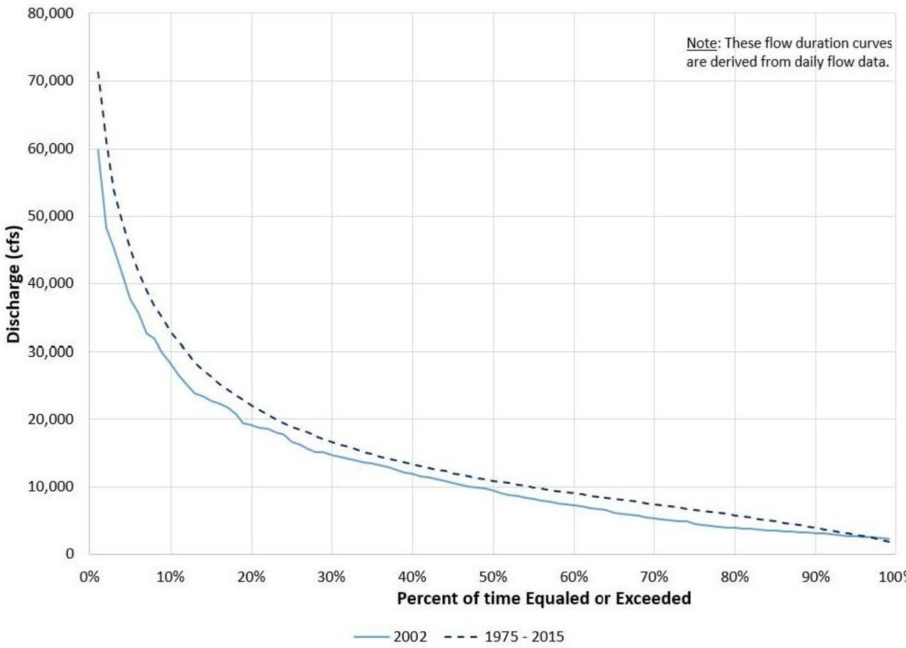
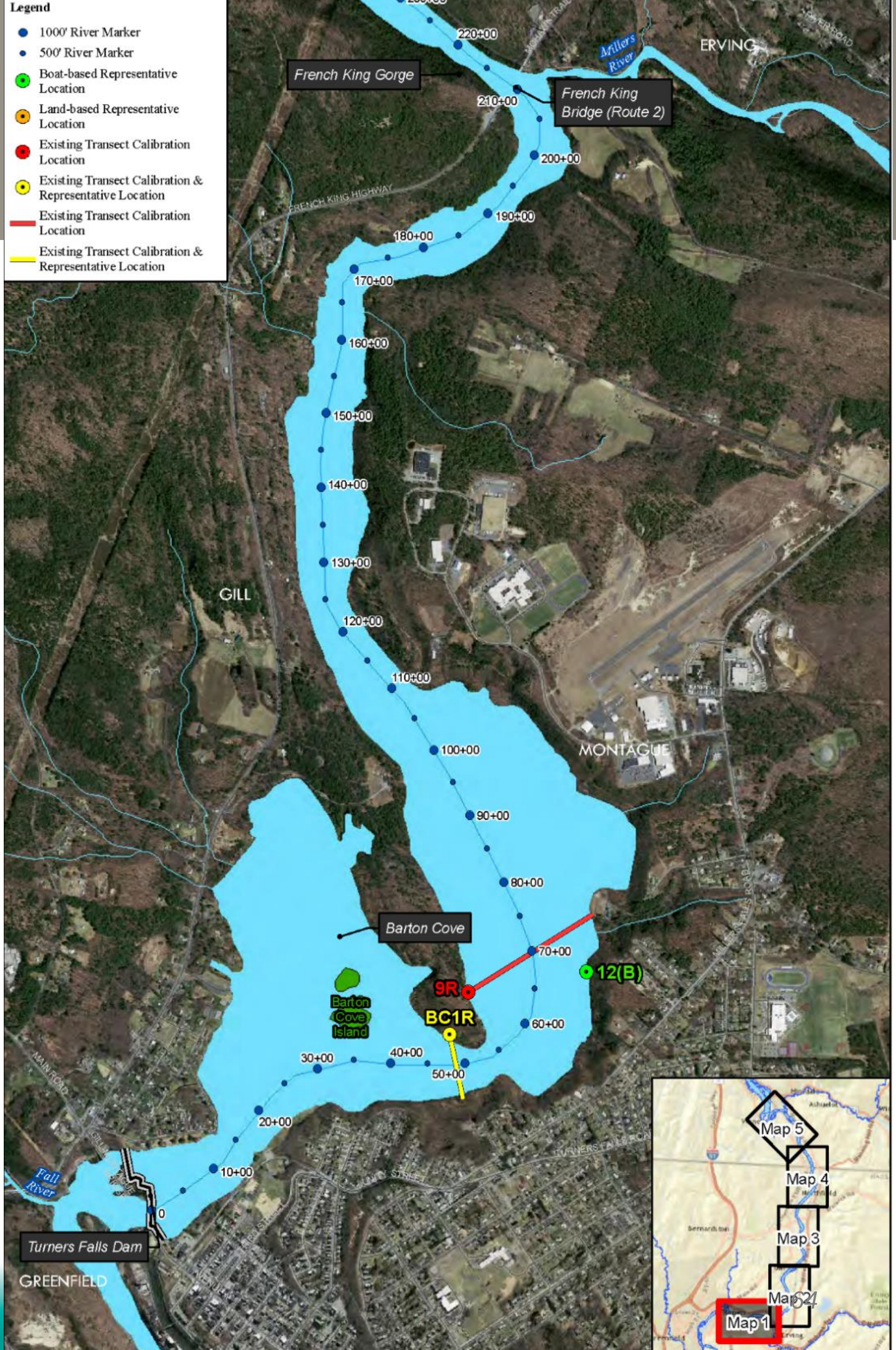
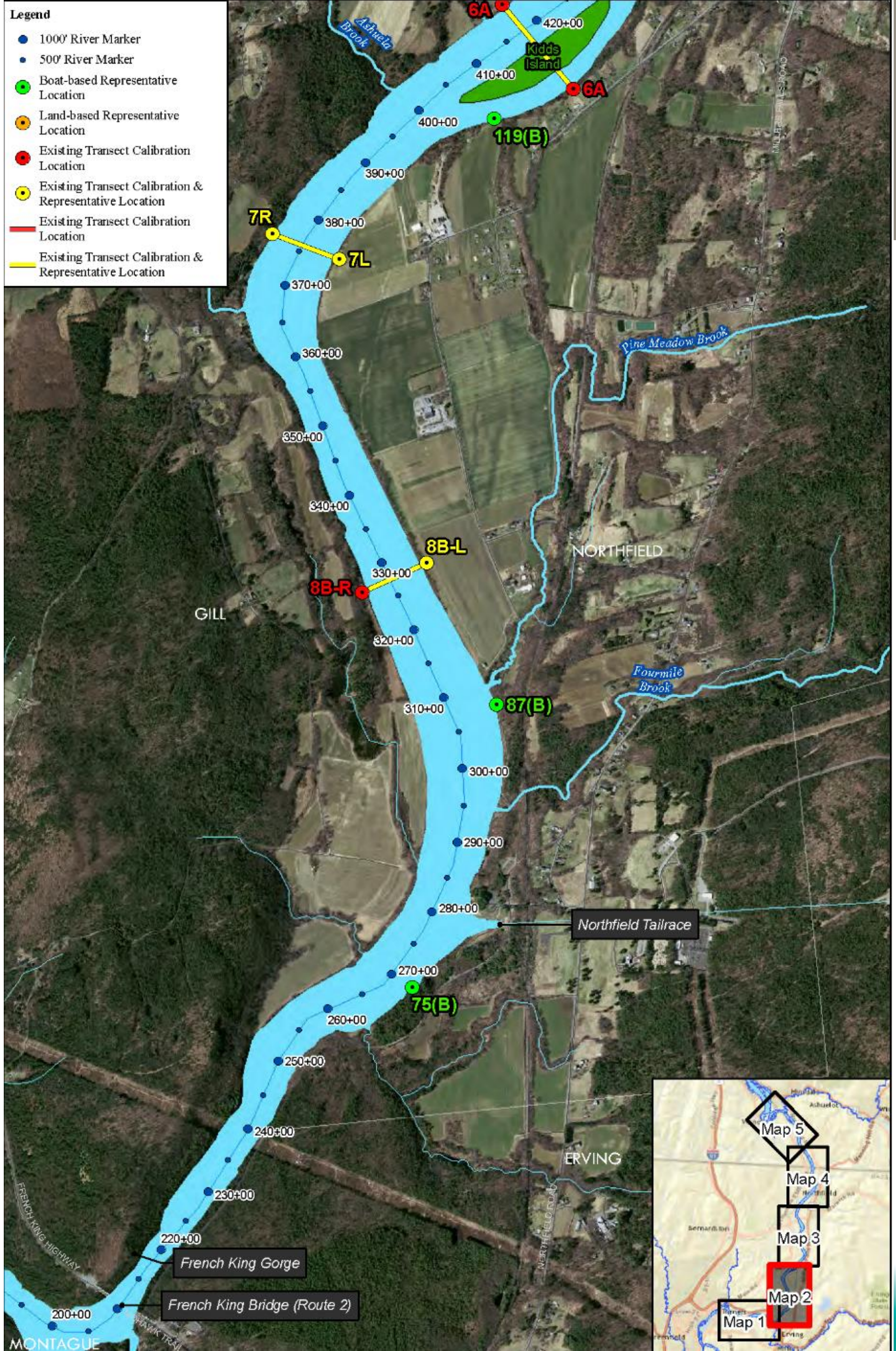


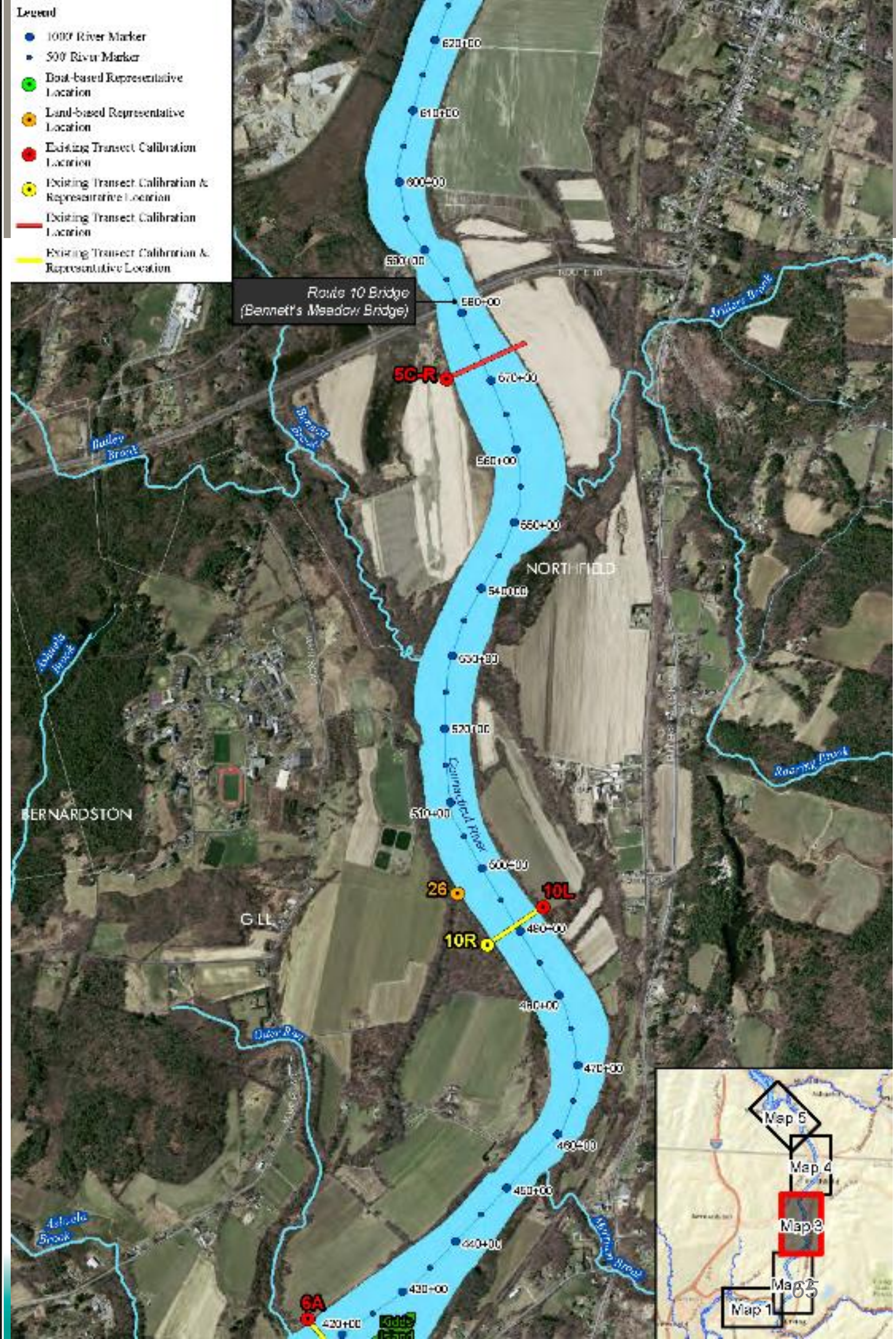
Figure 2-1: Montague USGS Gage – Comparison of Annual Flow Duration Curve

Detailed Study Sites Previously Established during Study 3.1.2

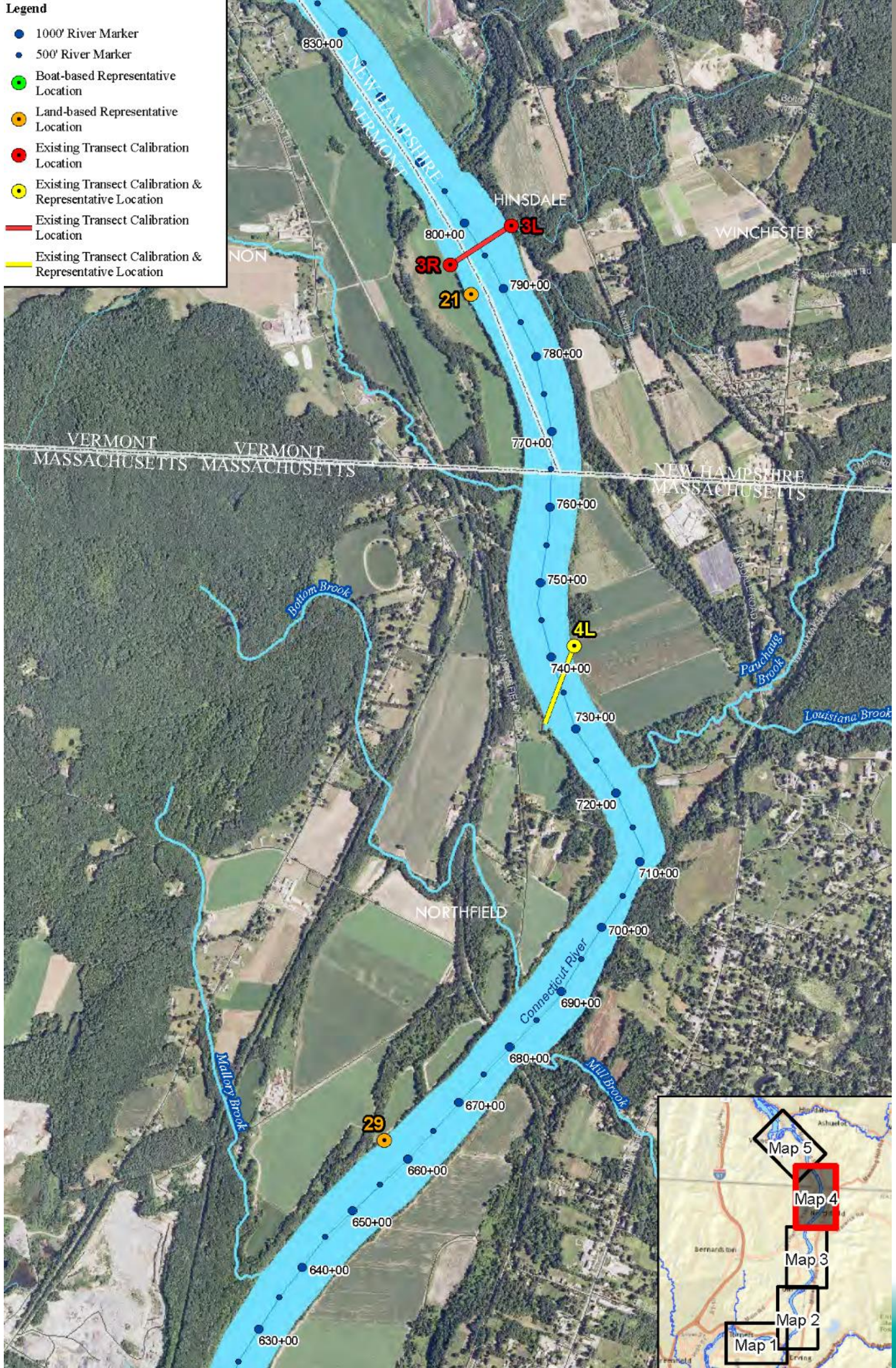


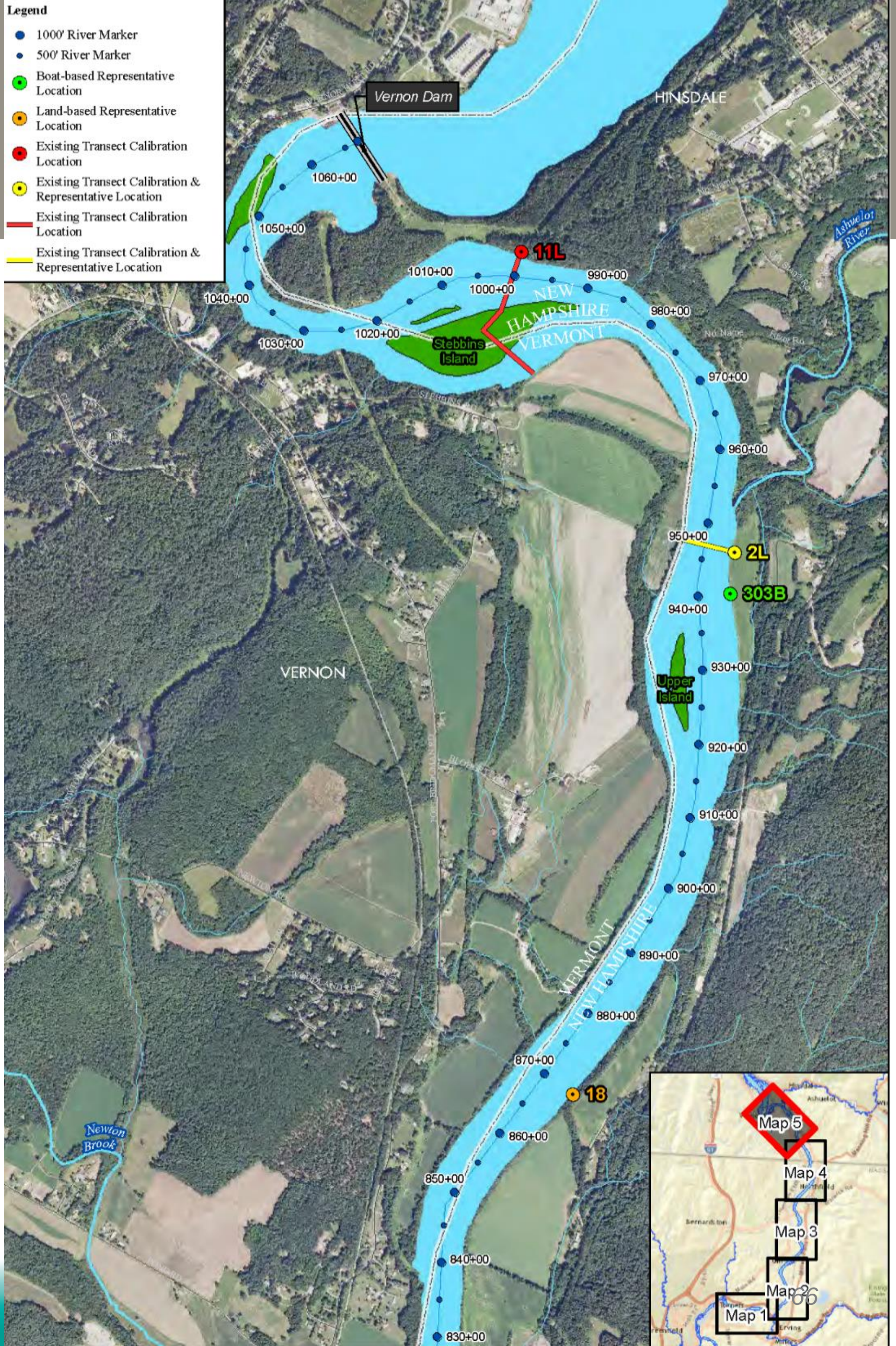


Legend
1000' River Marker
500' River Marker
Boat-based Representative Location
Land-based Representative Location
Existing Transect Calibration Location
Existing Transect Calibration & Representative Location
Existing Transect Calibration Location
Existing Transect Calibration & Representative Location
6A
420+00
Kidds Island
410+00
6A
400+00
119(B)
Ashuela Brook
390+00
7R
380+00
7L
370+00
360+00
Pine Meadow Brook
350+00
340+00
8B-L
330+00
8B-R
NORTHFIELD
GILL
320+00
Fourmile Brook
310+00
87(B)
300+00
290+00
280+00
Northfield Tailrace
270+00
75(B)
260+00
250+00
240+00
ERVING
230+00
220+00
French King Gorge
French King Bridge (Route 2)
200+00
MONTAGUE
FRENCH KING HIGHWAY
Map 5
Map 4
Map 3
Map 2
Map 1



Legend
1000' River Marker
500' River Marker
Boat-based Representative Location
Land-based Representative Location
Existing Transect Calibration Location
Existing Transect Calibration & Representative Location
Existing Transect Calibration Location
Existing Transect Calibration & Representative Location
620+00
610+00
600+00
590+00
Route 10 Bridge (Bennett's Meadow Bridge)
580+00
5C-R
570+00
Dudley Brook
560+00
550+00
NORTHFIELD
540+00
530+00
520+00
BERNARDSTON
Connecticut River
510+00
500+00
26
10L
10R
GILL
490+00
480+00
Roaring Brook
470+00
460+00
450+00
440+00
430+00
Ashuela Brook
6A
420+00
Kidds Island
Map 5
Map 4
Map 3
Map 2
Map 1


Legend
1000' River Marker
500' River Marker
Boat-based Representative Location
Land-based Representative Location
Existing Transect Calibration Location
Existing Transect Calibration & Representative Location
Existing Transect Calibration Location
Existing Transect Calibration & Representative Location
830+00
NEW HAMPSHIRE
VERMONT
HINSDALE
3L
800+00
3R
21
790+00
780+00
WINCHESTER
770+00
VERMONT
MASSACHUSETTS
VERMONT
MASSACHUSETTS
NEW HAMPSHIRE
MASSACHUSETTS
760+00
Bottom Brook
750+00
4L
740+00
730+00
Pauchaug Brook
Louisiana Brook
720+00
710+00
NORTHFIELD
700+00
Connecticut River
690+00
680+00
Mill Brook
670+00
Mallory Brook
29
660+00
650+00
640+00
630+00
Map 5
Map 4
Map 3
Map 2
Map 1


Legend
1000' River Marker
500' River Marker
Boat-based Representative Location
Land-based Representative Location
Existing Transect Calibration Location
Existing Transect Calibration & Representative Location
Existing Transect Calibration Location
Existing Transect Calibration & Representative Location
Vernon Dam
HINSDALE
1060+00
1050+00
11L
1010+00
990+00
1000+00
1040+00
NEW HAMPSHIRE
VERMONT
980+00
1020+00
1030+00
Stebbins Island
970+00
960+00
950+00
2L
303B
940+00
VERNON
Upper Island
930+00
920+00
910+00
900+00
890+00
VERMONT
NEW HAMPSHIRE
880+00
870+00
18
860+00
Newton Brook
850+00
840+00
830+00
Map 5
Map 4
Map 3
Map 2
Map 1

BSTEM – Differences in Unit Bank-Erosion Rates EUS-BL

Site	EUS - BL
	Cubic feet/foot/year
11L	-0.003
2L-Pre	-0.012
2L-Post	0.000
303BL	-0.004
18L	0.000
3L	-0.007
3R-Pre	-0.013
3R-Post	-0.001
21R	0.003
4L	0.000
29R	-0.004
5CR	-0.010
26R	0.010
10L	0.000
10R-Post	0.000

Site	EUS - BL
	Cubic feet/foot/year
6AL-Pre	0.000
6AL-Post	0.000
6AR-Post	0.000
119BL	0.00
7L	0.011
7R	0.00
8BL	0.000
8BR-Pre	0.000
8BR-Post	0.000
87BL	0.011
75BL	0.033
9R-Pre	0.000
9R-Post	0.000
12BL	0.010
BC-1R	0.000

Greater Use of Upper Reservoir Storage on TFI Shoreline Erosion - Results

- The results of the various modeling and analyses conducted found that increasing the useable storage volume of the Upper Reservoir resulted in no impact on streambank erosion in the TFI
- Outputs from the HEC-ResSim model indicated that although the EUS results in more pumping and generation than the BL condition, the corresponding increase in WSEL is negligible with the difference in WSEL's between the scenarios ranging from -0.27 ft to 0.12 ft, with an average difference of -0.01 ft.
- The results of the HEC-RAS water level duration analysis found that the water surface associated with the EUS rests on the lower bank 78-93% of the time. As discussed in the final report for Study No. 3.1.2, minimal to no erosion occurs when the water surface rests on the lower bank
- The results of the BSTEM modeling found that the EUS had no measureable impact on bank-erosion rates when compared to the BL condition.
- The difference between the bank-erosion rates for the EUS and BL conditions at all sites is well within the accuracy of the underlying data and/or sensitivity of the model and yield immeasurable differences in unit-erosion rates

NFM Ichthyoplankton Study Chronology

Date	Milestone
03/01/16	FL filed Study Report (Year 1- 2015)
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: • Re: Study Methods: *Therefore, we recommend that FirstLight conduct the 2016 ichthyoplankton entrainment study as proposed.* • Re: Analysis of River Discharge: *Therefore, as required by the January 22, 2015, letter, FirstLight should include river discharge in its analyses of 2015 and 2016 ichthyoplankton density estimates and entrainment rates in its supplemental report for the 2016 study.*
12/28/16	FL filed Study Report (Year 2- 2016)
03/16/17	Study Report Meeting
05/01/17	Deadline for Stakeholder Comments on Study Report
05/30/17	FL issued Stakeholder Response to Comments
06/27/17	FERC issued Determination Letter. Did not address Ichthyoplankton Study.
07/28/17	FL files Addendum 1

NFM Ichthyoplankton Study

Addendum 1

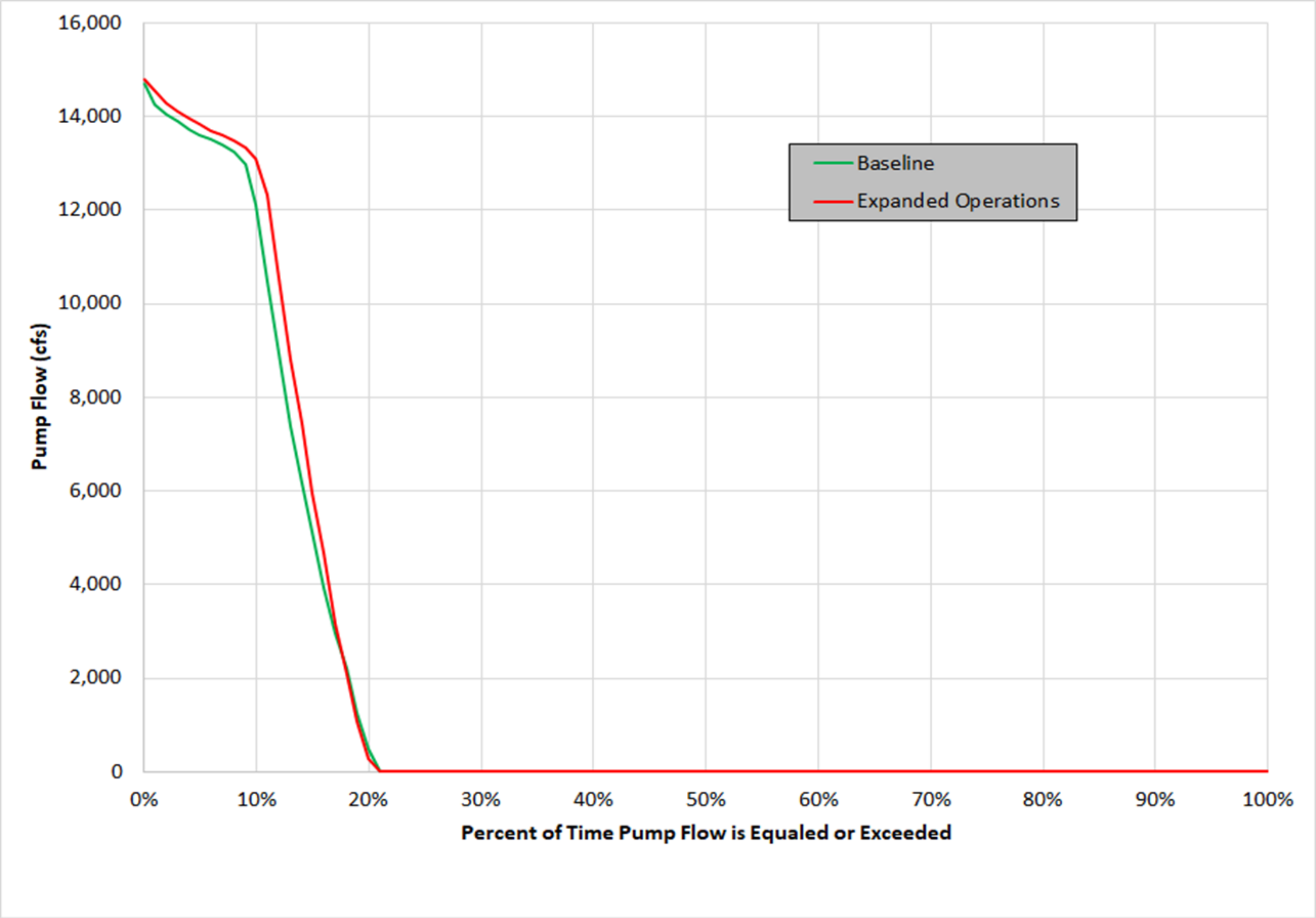
Purpose of the addendum was to estimate American shad ichthyoplankton entrainment under potential future expanded Upper Reservoir storage at NFM.

FirstLight simulated expanded operations in the operations model as part of the Study No. 3.1.2 *Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability*

Two operations model (HEC-Res Sim) runs reflecting baseline conditions (existing operations) and expanded operations were used to compare the volume of water used for pumping and generating under baseline and expanded operations using conditions from 2002 hydrology and 2009 NFM Pump/Gen schedule.

Modeling Scenario	Input Hydrology	Input Pump/Gen
Baseline Condition	2002	2009
Expanded Operations	2002	Modified 2009

NFM Ichthyoplankton Study



NFM Ichthyoplankton Study

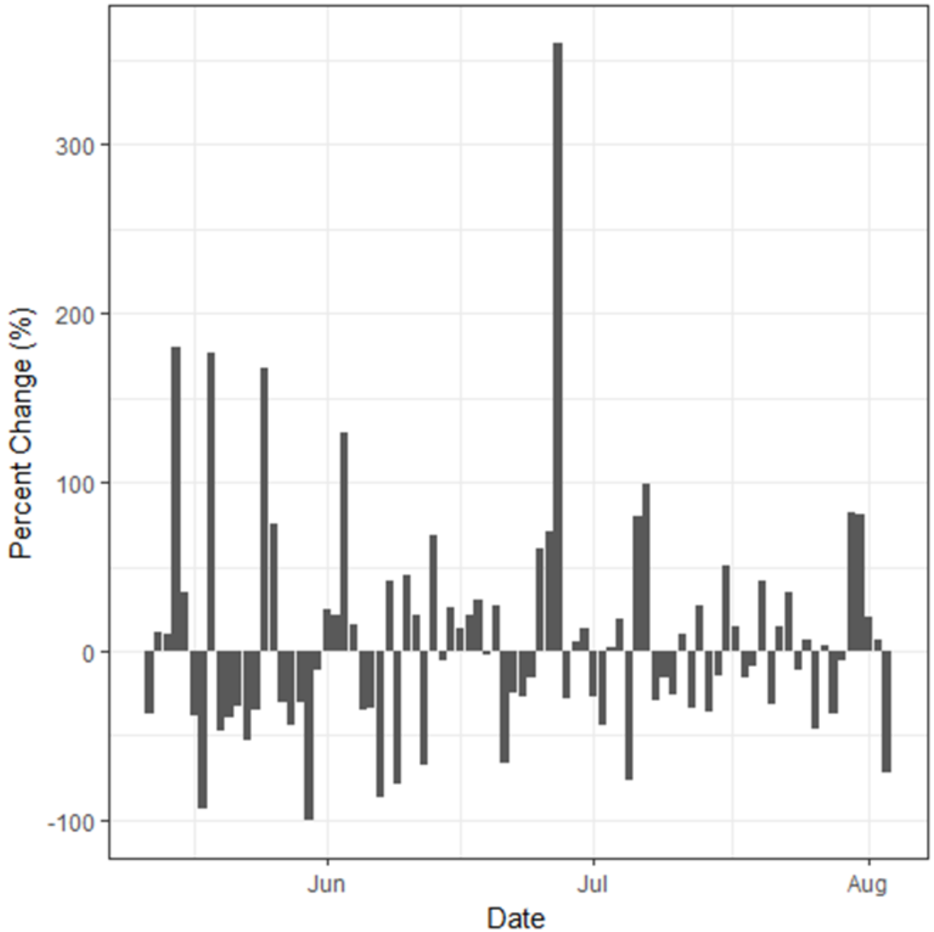
- To estimate the increase in ichthyoplankton entrainment due to expanded operations, the pumped flow data for the baseline and expanded operations was used for the period when shad eggs and larvae would be present in the TFI.

- Specifically, the increase in the volume of water pumped (in cubic meters, m^3) under expanded operations was compared against baseline conditions.

- The percent increase (or decrease in some cases) in pump flows was used, along with the observed data collected in 2016, to estimate the increase in eggs/larvae due to expanded operations.

- A simple weekly volumetric extrapolation was used to estimate entrainment, where a measure of organism density (org/m^3) is multiplied by a volume of water (m^3) to estimate the number of entrained organisms per unit of time (week).

NFM Ichthyoplankton Study



The daily percent change in pump volume under expanded operations compared to baseline conditions throughout the spawning season.

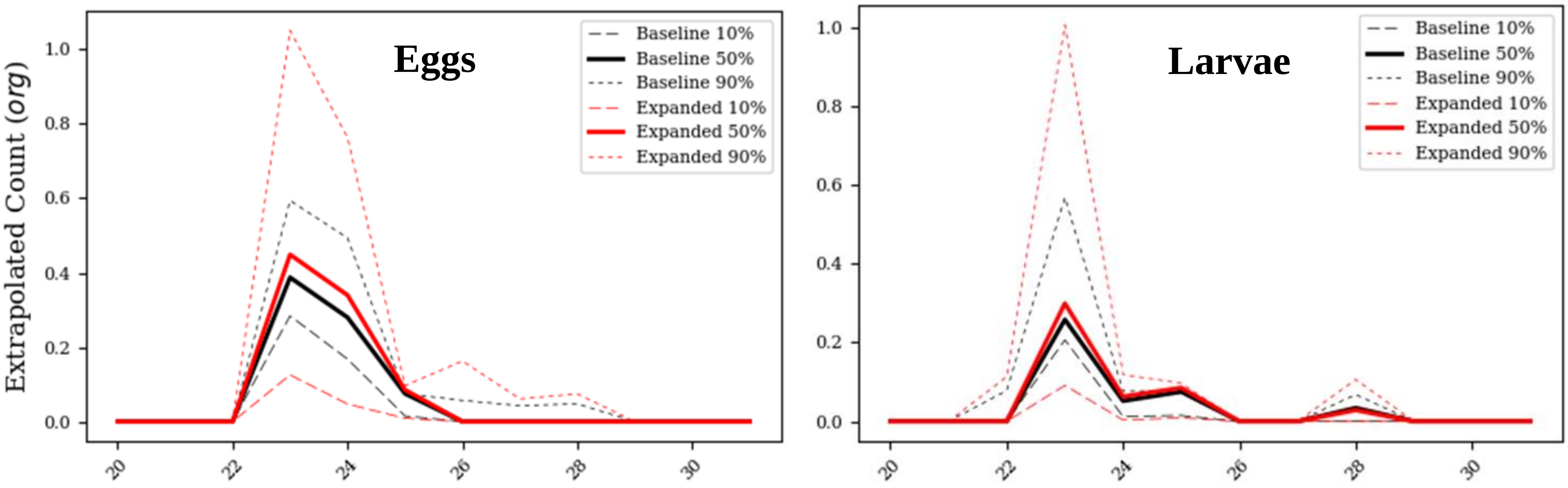
NFM Ichthyoplankton Study

The weekly organism densities (org/m^3) at the 10th, 50th and 90th percentiles and the number of samples (n) per week with which we calculated these percentiles.

Week	Shad Eggs			n	Shad Larvae			n
	10%	50%	90%		10%	50%	90%	
20	0	0	0	3	0	0	0	3
21	0	0	0	4	0	0	0	4
22	0	0	0	5	0	0	0.024	5
23	0.088	0.120	0.184	3	0.064	0.080	0.176	3
24	0.081	0.135	0.238	4	0.006	0.025	0.037	4
25	0.004	0.020	0.020	3	0.004	0.020	0.020	3
26	0	0	0.016	3	0	0	0	3
27	0	0	0.012	5	0	0	0	5
28	0	0	0.014	4	0	0.01	0.02	4
29	0	0	0	5	0	0	0	5
30	0	0	0	4	0	0	0	4
31	0	0	0	4	0	0	0	4

NFM Ichthyoplankton Study

Weekly extrapolation of entrained American Shad using 2016 observed data adjusted based on week percent change in pump volumes under expanded operations versus baseline conditions.



NFM Ichthyoplankton Study

Equivalent adult estimates of all entrained eggs at the 10th, 50th, and 90th percentile using the weekly extrapolation method.

Equivalent Age	Baseline Conditions			Expanded Operations		
	10%	50%	90%	10%	50%	90%
J	2,321	3,960	7,713	974	4,560	12,895
3	80	136	266	34	157	444
4	177	303	590	75	349	986
5	53	90	175	22	103	293
6	3	4	8	1	5	14
7	0	0	0	0	0	0

NFM Ichthyoplankton Study

CONCLUSIONS

- Expanded operations will result in more hours of pumping and more volume of water pumped, leading to an increase in the number of equivalent American shad adults lost.

- Throughout the spawning season, both operating conditions and organism density will change.

- To capture some of this variability, the 10th and 90th percentiles were chosen because they bound 80% of the known variability in both sample densities and potential expanded operations.

- The 50th percentile extrapolates on the median sample density, and should be considered the expected entrainment.

- Overall, it is predicted that 600 additional juveniles and 81 adults may be affected by ichthyoplankton entrainment under expanded operations.

RTE 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: • Re: MADFW Study Requests: 1) copies of maps of historic and potentially suitable habitat for state listed plants, 2) description of habitat suitability preferences used for each of the state listed plants, 3) copies of data regarding plant health and vigor and 4) information on how plant densities varied with WSEL. *Because this information could be useful for staff's analysis of project-related effects, staff recommends that the information requested by Massachusetts DFW be included in the addendum or FirstLight should indicate why the information cannot be provided.* (Addendum 1)
10/14/16	FL filed Addendum 1
10/31-11/1/16	Study Report Meeting
12/15/16	Deadline for Stakeholder Comments on Study Report
01/17/17	FL issued Stakeholder Response to Comments
02/17/17	FERC issued Determination Letter. FERC required: • Re: Puritan Tiger Beetle*: However, because the maximum, mean, and median monthly water surface elevations, as well as standard deviations, are available and may provide additional information useful for evaluating project effects on shoreline areas, we recommend that FirstLight prepare and file a table that includes this information with its proposed addendum to be filed by April 3, 2017.* • Re: Invasive Plants: "*For the reasons described in staff's March 6, 2014, letter, FirstLight was required to survey for Salix exigua (not spp. interior), Alnus glutinosa, and Salix purpurea; therefore, we recommend requiring FirstLight to conduct surveys for these species and file an addendum to the study report by July 31, 2017*."
04/03/17	FL filed Addendum 2

FirstLight Power Resources

RTE Study

Comment	Response
MDFW-1: Puritan Tiger Beetle (PTB): Wanted figures to include monthly mean and median WSELs for May to Aug, Jan-Apr and Sep-Dec.	Addressed in 1/17/17 response matrix.
MDFW-2: Cobblestone Tiger Beetle (CTB)- wanted the Montague USGS Gage Rating Curve	Addressed in 1/17/17 response matrix.
MDFW-3: CTB- MADFW requested figures showing the % of time potential CTB habitat was inundated for bins of 1-5, 6-9, 10-14, and 15+ hrs.	Addressed later in Presentation. Provided in a spreadsheet as part of Addendum 2.
MDFW-4: CTB- Provide mean, median number of hrs/day, and number of times/day each elevation (104-125 ft) was inundated for each calendar yr averaged across the 8-yr period of record for each transect	Provided in a spreadsheet as part of Addendum 2.
MDFW-5: PTB- MADFW requested figures showing the % of time potential CTB habitat was inundated for bins of 1-5, 6-9, 10-14, and 15+ hrs.	Addressed later in Presentation. Provided in a spreadsheet as part of Addendum 2.
MDFW-6: PTB- Provide the mean, median number of hours per day, and number of times per day each elevation was inundated for each calendar yr averaged across the 8-yr period of record for each transect.	Provided in a spreadsheet as part of Addendum 2.
MDFW-7: RTE Plants- Provide maps to show all know, historic and potentially suitable habitats.	An ArcGIS polygon file of mapped unoccupied habitat was provided in 1/17/17 response matrix (Attachment B)
MDFW-8: RTE Plants-Define habitat suitability preferences for each species based on an assessment of inundation duration, frequency and timing at the soil interface.	Addressed later in Presentation. Provided in a spreadsheet as part of Addendum 2.
MDFW-9: RTE Plants- Calculate and provide a table showing the number of hours/day each elevation was inundated, and the number of times each elevation was inundated on each calendar yr (5/15-10/31) for each yr of the 8-yer period of record	Provided in a spreadsheet as part of Addendum 2.

RTE Study

Comment	Response
MDFW-10: RTE Plants- For the analysis conducted in MDFW-9, FL to provide table of daily mean, median number of hrs/day and number of times/day each elevation (178 to 198 ft) was inundated for each calendar day (5/15-10/31) average across the 8-yr period of record	Provided in a spreadsheet as part of Addendum 2.
MDFW-11: RTE Plants- For Reach 3 of bypass, provide table of predicted WSELs. Provide stage vs discharge information for plants in bypass.	Addressed later in Presentation. ArcGIS provided showing mapped RTE pants in the bypass and also rating curves provided.
MDFW-12: RTE Plants- provide the min and max elevation (measured at soil interface) for each spatially distinct population.	Addressed later in Presentation.
MDFW-13: RTE Plants- (Addressed in MADFW-11)	Addressed in MDFW-3
MDFW-14: RTE Plants- provide digital terrain model maps to show location and distribution of plant in the River2D portion of the bypass	Map was provided in response.
MDFW-15: RTE Plants- Conduct additional field survey for Tufted Hairgrass.	The location of Tufted Hairgrass was located at Transect 4A and a map was provided in the response. Elevation of the plant relative to elevation duration curves from May-Oct were provided.
MDFW-16: RTE Plants- Conduct additional field survey for Wright's Spike-rush, Intermediate Spike-Sedge and Ovate Spike Sedge	The location of the plants was located at Transect 11E (near Pauchaug boat launch) and a map was provided in the response. Elevation of the plant relative to elevation duration curves from May-Oct were provided.

RTE Study

Comment	Response
MDFW-17: RTE Plants- Require FL either re-collect data on the transects or provide supplemental elevation data for the plants.	Addressed in 1/17/17 response matrix. Provided an ArcGIS shapefile of all elevation data collected during the 2015 survey.
MDFW-18: RTE Plants- Provide spreadsheet of data used to develop water surface elevation duration curves relative to the plant location	Provided in a spreadsheet as part of Addendum 2.
MDFW-19: RTE Plants- Provide spreadsheet of the base elevation of all plants.	Provided in a spreadsheet as part of Addendum 2.
MDFW-20: RTE Plants- Provide spreadsheet of WSEL elevation duration curves relative to the plants	Provided in a spreadsheet as part of Addendum 2.
MDFW-21: RTE Plants- Provide tables showing predicted WSELs over a range of flows for Transect T-3 in the bypass reach	Addressed in MDFW-20.
MDFW-22: RTE Plants- FL show areas occupied by various state-listed plants within Reach 2 and the northerly portion of Reach 3 of the bypass.	Addressed in 1/17/17 response matrix.
MDFW-23: Invasive Plants- provide maps of terrestrial invasive plants.	Addressed later in Presentation.

RTE Study

<u>MADFW-3 re: Cobblestone Tiger Beetle</u>

- FL previously showed the % of time potential CTB habitat was inundated for a period of 24 hrs and 0 hrs.
- MADFW requested figures showing the % of time potential CTB habitat was inundated for bins of 1-5, 6-9, 10-14, and 15+ hrs.
- Completed for May, Jun, Jul & Aug– examples below

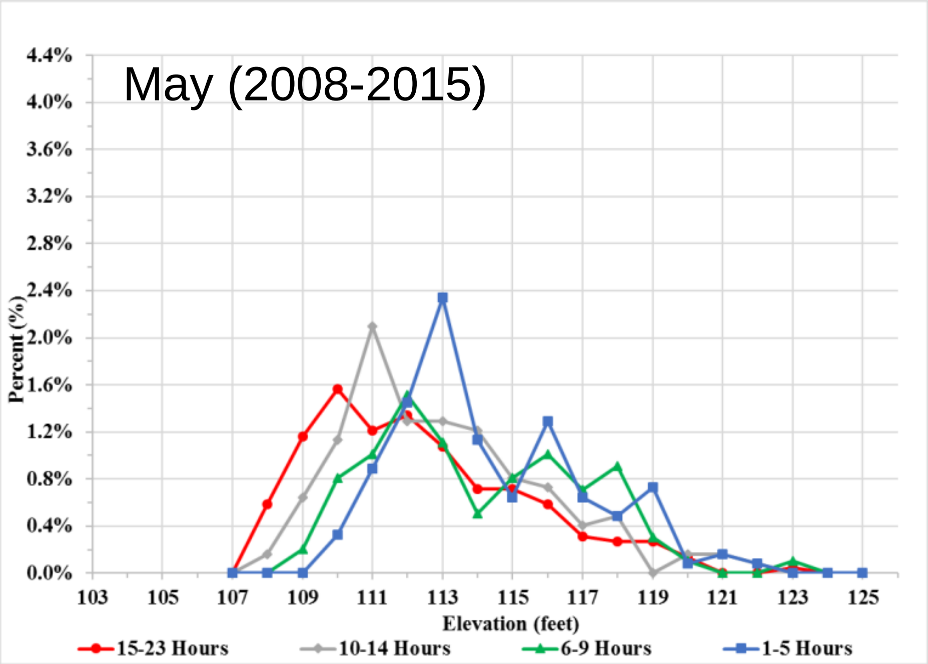


Figure 2.3-1 Average Percent of Days Potential Cobblestone Tiger Beetle Habitat was Inundated in May (2008-2015)

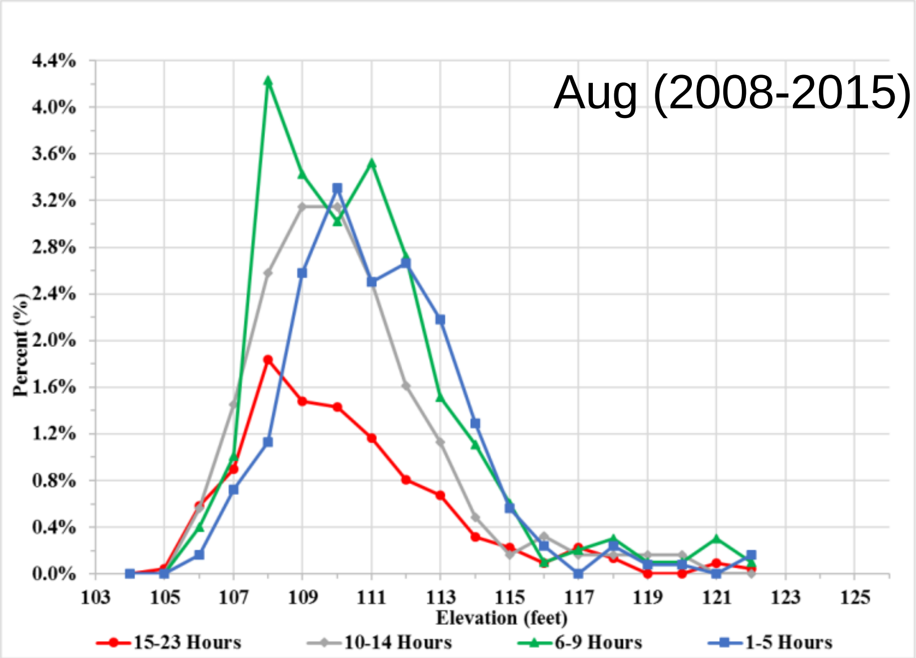


Figure 2.3-4 Average Percent of Days Potential Cobblestone Tiger Beetle Habitat was Inundated in August (2008-2015)

RTE Study

MADFW-5 re: Puritan Tiger Beetle

- FL previously showed the % of time potential PTB habitat (Rainbow Beach & North Bank) was inundated for a period of 24 hrs and 0 hrs.
- MADFW requested figures showing the % of time potential PTB habitat was inundated for bins of 1-5, 6-9, 10-14, & 15+ hrs.
- Completed for May, Jun, Jul & Aug for Rainbow Beach & North Bank– examples below

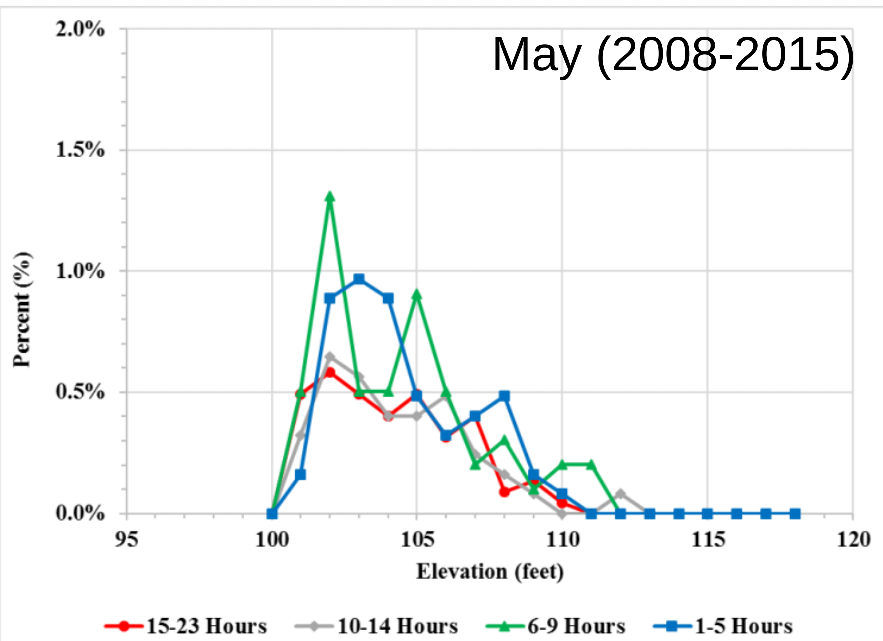


Figure 2.5-1 Average Percent of Days Potential Puritan Tiger Beetle Habitat at Rainbow Beach was Inundated in May (2008-2015)

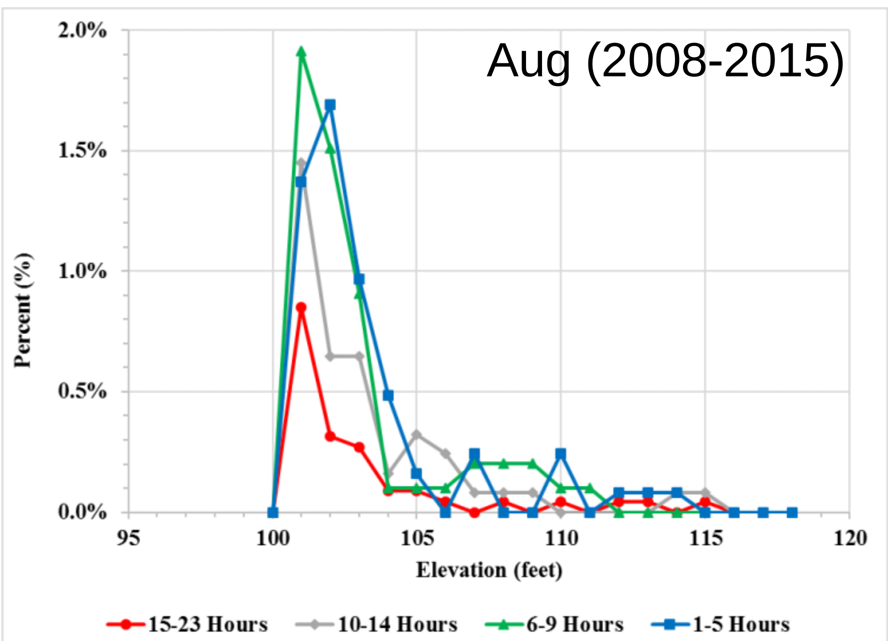


Figure 2.5-4 Average Percent of Days Potential Puritan Tiger Beetle Habitat at Rainbow Beach was Inundated in August (2008-2015)

RTE Study

MADFW-8 re: RTE Plants relative to Water Surface Elevations (WSELs)

- Figures were developed showing the range of elevations occupied by each plant at each transect, the flowering/seeding/fruiting period, average WSEL (from hydraulic model) and the duration of inundation. The average WSEL is shown for each transect location. Excel files of the data were filed with FERC in April 2017.

- The range of plant base elevations was determined resulting in a high and low base elevation (for all plants).

- The timing of year when the plant would be flowering/seeding/fruiting was determined.

- Hydraulic model was run on an hourly time step for the TFI (2000-2015) and below Montague (2008-2015) to obtain WSEL. Rare plants are located in TFI, bypass and below Montague. Transects were located near the rare plants which produced the WSEL data.

- Hourly WSEL data was used to compute average WSEL and the duration of inundation.

FirstLight Power Resources

RTE Study (MADFW-8)

Sandbar Willow

Table 2.8-1 Rare Plant Habitat Suitability Transect

	Species	Preferred Substrate	Flowering/Seeding/Fruiting Period[1]							Elevations Shown in Feet (NGVD 1929)					
			April	May	June	July	Aug	Sept	Oct	Min. Elev.	Max. Elev.	Mean Elev.	Low Flow (cfs)[2]	Mean Low Flow Elevation	Mean Plant Elevation Above Low Flow
1	*Salix exigya ssp. inerior*	Sandy, Gravelly, Rocky								105.7	105.9	105.8	2541	102.8	3.0
2	*Salix exigya ssp. inerior*	Sandy, Gravelly, Rocky								106.4	108.6	107.3	2518	102.8	4.5
3	*Prunus pumila*	Flood-scoured cobble and gravel								114.7	118.5	117.0	2124	105.3	11.7
4	*Symphyotrichum tradescantii*	Exposed Ledges								110.1	112.4	111.1	2037	106.5	4.6
4A	*Dechampsia cespitosa ssp. glauca*	Exposed Ledges, Cobble/Gravel Shores								109.0	-	109.0	2037	106.5	2.5
T-3 (IFIM)	*Symphyotrichum tradescantii*	Exposed Ledges								118.0	122.0	120.0	120	118.8	1.2
5	*Oligoneuron album*	Exposed Ledges/Outcrops								183.9	185.4	184.7	69	178.9	5.8
6	*Oligoneuron album*	Exposed Ledges/Outcrops								184.2	187.5	185.4	74	178.9	6.5
8	*Prunus pumila*	Flood-scoured cobble and gravel								188.2	190.4	189.2	524	180.7	8.5
9	*Prunus pumila*	Flood-scoured cobble and gravel								187.4	188.4	187.8	1031	180.9	6.9
10	*Alnus viridis ssp. crispa*	Exposed Ledges/Boulders								197.7	-	197.7	1031	180.9	16.8
10	*Salix exigya ssp. inerior*	Sandy, Gravelly, Rocky								186.6	190.96	188.52	1031	180.9	7.6
11D	*Eleocharis ovata*	Sandy River Banks								183.7	-	183.7	422	179.3	4.4
11D	*Egrostis frankii*	Sandy River Banks								187.2	-	187.2	422	179.3	7.9
11E	*Eleocharis intermedia*	Muddy Riverbanks								183.93	-	183.93	422	179.3	4.6

[1]MADFW Species Fact Sheets (http://www.mass.gov/eea/agencies/dfg/dfw/natural-heritage/species-information-and-conservation)
[2]Based on the Average minimum flow observed in August (2000-2015 for impoundment and 2008-2015 downstream of Turners Falls)

RTE Study (MADFW-8)

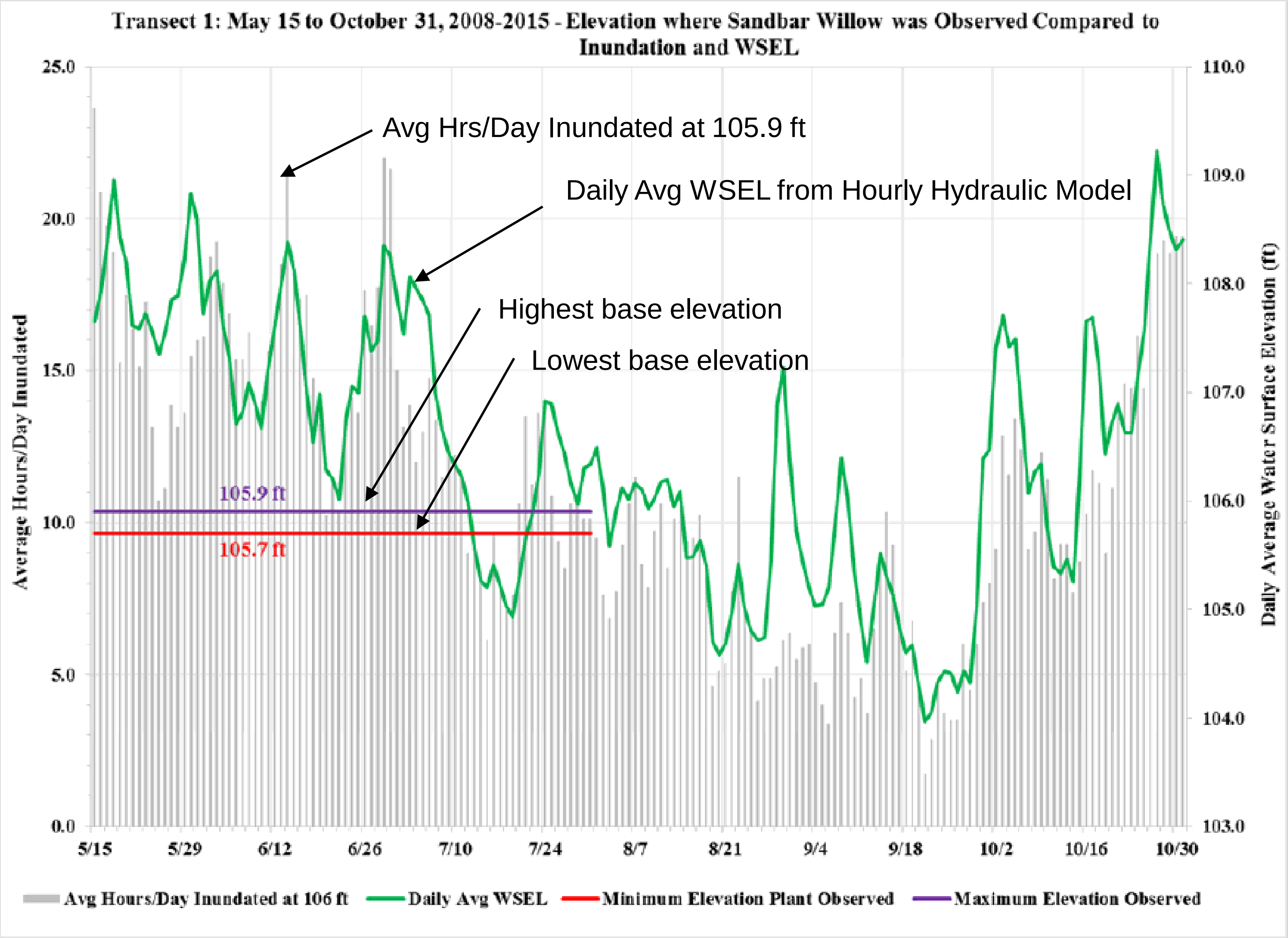
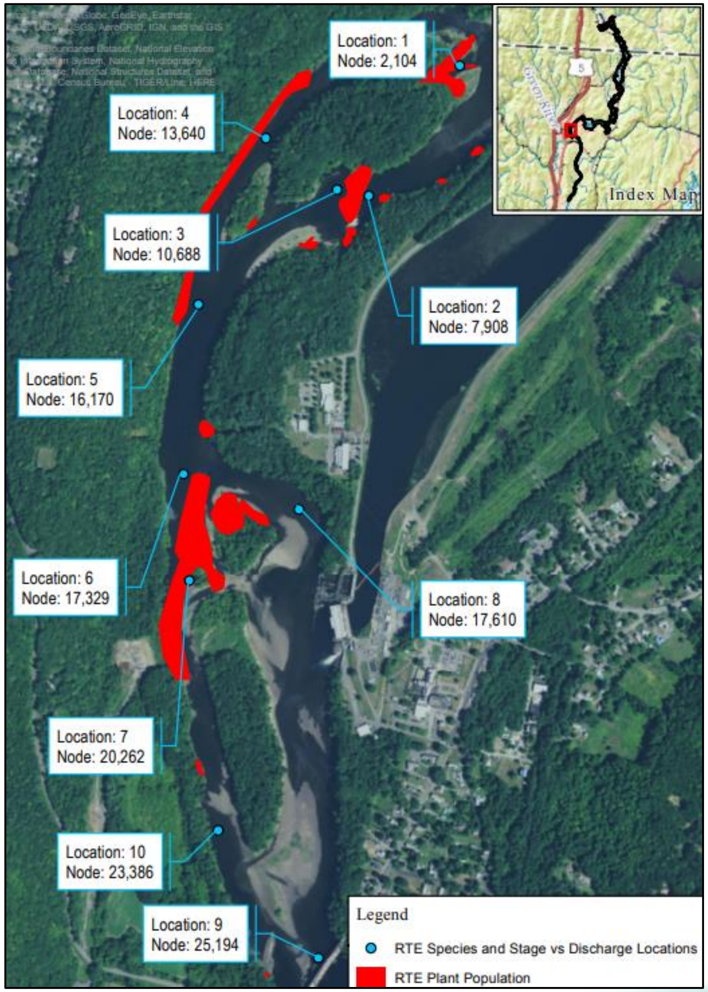
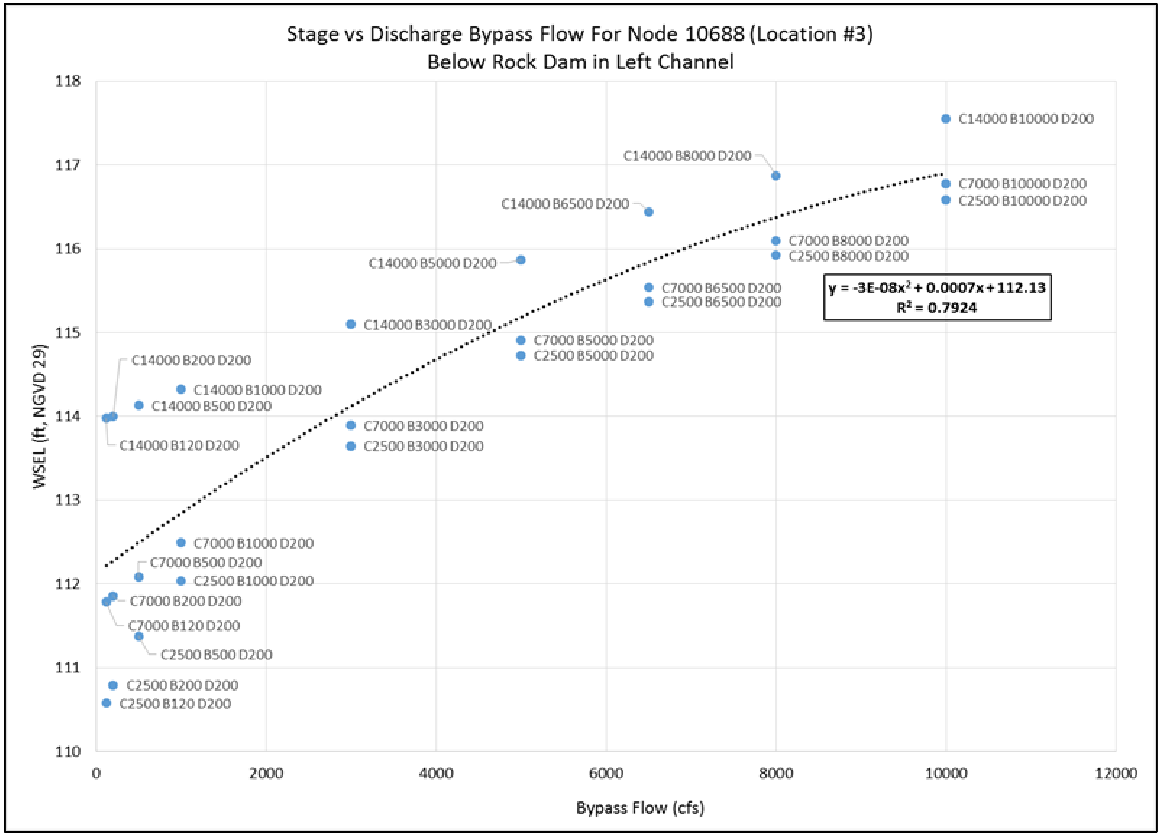


Figure 2.8-2 Transect 1: May 15 to October 31, 2008-2015 - Elevation where Sandbar Willow was Observed Compared to Inundation and WSEL

RTE Study

MADFW-11 re: RTE Plants in Bypass and Rating Curves

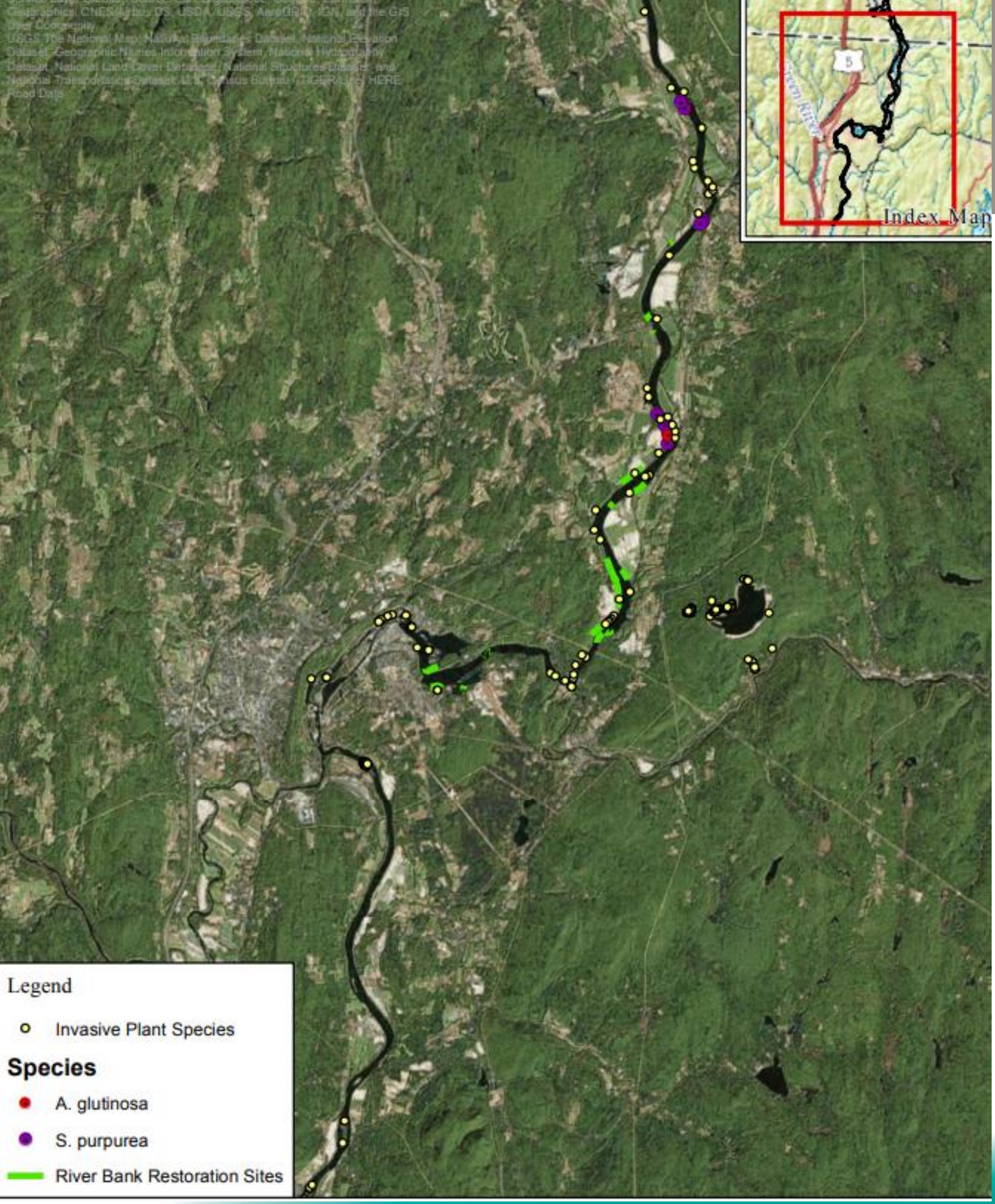




RTE Study

MADFW-12 re: RTE Plants- Min and Max Elevations

Population ID	Common Name	Species Name	Population Area (Sq M)	Estimated Population (Number of Plants)	Calculated Density (Plant/Sq M)	Elevations in Feet (NGVD 1929)		
						Minimum Elevation	Maximum Elevation	Mean Elevation
20	mountain alder	Alnus viridis ssp. crispa	4.0	1.0	0.25	137.4	139.0	138.3
27	Tradescant's aster	Symphyotrichum tradescantii	7.3	1.0	0.14	127.0	129.2	127.8
50	mountain alder	Alnus viridis ssp. crispa	189.0	1.0	0.01	114.4	126.3	117.2
65	Tradescant's aster	Symphyotrichum tradescantii	81.3	1.0	0.01	109.6	111.9	111.0



RTE Study

MADFW-23 re: Location of Invasive Plants

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: • *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.*