May 31, 2016

VIA ELECTRONIC FILING

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

Re: FirstLight Hydro Generating Company, Turners Falls Hydroelectric Project (FERC No. 1889) and Northfield Mountain Pumped Storage Project (FERC No. 2485).
Response to Stakeholder Requests for Study Modifications and/or New Studies Based on the Study Report and Meeting Summary

Dear Secretary Bose:

Pursuant to the regulations of the Federal Energy Regulatory Commission (Commission or FERC), Title 18 Code of Federal Regulations (18 C.F.R.) § 5.15(f), FirstLight Hydro Generating Company (FirstLight) encloses for filing this response to comments on FirstLight's Study Reports and meeting summary for the relicensing of the Turners Falls Hydroelectric Project (TF Project, FERC No. 1889) and Northfield Mountain Pumped Storage Project (NMPS Project, FERC No. 2485). The current licenses for the TF and NMPS Projects expire on April 30, 2018.

On March 1, 2016, FirstLight filed 13 study reports (and two addendums[1]) with FERC as follows:

Table 1: Reports filed with FERC on March 1, 2016

Study No.	Name
3.2.1	Water Quality Monitoring Study
3.3.4	Evaluate Upstream Passage of American Eel
3.3.6	Impact of Project Operations on Shad Spawning, Spawning Habitat and Egg Deposition in the Area of the Northfield Mountain and Turners Falls Projects
3.3.8	Computational Fluid Dynamics Modeling in the Vicinity of the Fishway Entrances and Powerhouse Forebays
3.3.9	Two-Dimensional Modeling of the Northfield Mountain Pumped Storage Project Intake/Tailrace Channel and Connecticut River Upstream and Downstream of the Intake/Tailrace
3.3.10	Assess Operational Impacts on Emergence of State-Listed Odonates in the Connecticut River
3.3.11	Fish Assemblage Assessment
3.3.12	Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream from Cabot Station
3.3.20	Ichthyoplankton Entrainment Assessment at the Northfield Mountain Project
3.4.1	Baseline Study of Terrestrial Wildlife and Botanical Resources
3.5.1	Baseline Inventory of Wetland, Riparian and Littoral Habitat in the Turners Falls Impoundment, and

[1] As required by FERC, addendums were filed on Study No. 3.3.2 *Hydraulic Study of Turners Falls Impoundment, Bypass Reach and below Cabot* and Study No. 3.3.18 *Impacts of the Turners Falls Canal Drawdown on Fish Migration and Aquatic Organisms*.

Gus Bakas
Director- Massachusetts Hydro
FirstLight Power Resources, Inc.
99 Millers Fall Road
Northfield, MA 01360
Tel. (413) 422-5915/ Fax (413) 659-4459
E-mail: gus.bakas@na.engie.com

Study No.	Name
	Assessment of Operational Impacts on Special-Status Species
3.6.1	Recreation Use/User Contact Survey
3.6.5	Land Use Inventory

FirstLight held its Study Report meeting on March 16, 2016 and filed its meeting summary on March 31, 2016 per Commission regulations.

Stakeholder comments on the summary were due by April 30, 2016.[2] FirstLight's response to comments were due within 30 days or by May 30, 2016. Comments were received from the following:

- United States Fish and Wildlife Service (USFWS)
- National Marine Fisheries Service (NMFS)
- Massachusetts Division of Fisheries & Wildlife (MADFW)
- Connecticut River Watershed Council (CRWC)
- The Nature Conservancy (TNC)
- Karl Meyer

The purpose of the comment opportunity following the submission of the meeting summary is to give relicensing participants an opportunity to request modifications to approved studies or propose new studies. 18 C.F.R. § 5.15(c)(4). Such requests must demonstrate good cause and meet the criteria of 18 C.F.R. § 5.15(d) and (e), as appropriate. The majority of the comments received on FirstLight's study reports, however, simply disagreed with study results, or sought additional analysis or data collection not specified by the approved study plans. Where commenters requested modifications to approved studies or appeared to propose new studies, they failed to demonstrate good cause and did not otherwise meet the Commission's required criteria—which set a high bar—for making such requests. As reflected in the attached response matrix, FirstLight has agreed to additional data collection in some instances, and is providing additional and/or corrected data and analysis where warranted. Except where noted, however, FirstLight is not planning to revise or revisit its study reports. Should FirstLight determine, once outstanding studies are completed, that additional analysis is required to evaluate Project effects, it will include such analysis in its amended Final License Application.

As to the eleventh hour comments filed on two studies by CRWC on May 25, 2016, they are out of time and should be disregarded for that reason alone. The CRWC comments also lack merit or are otherwise addressed in this filing. Study No. 3.3.6 should not be repeated, as CRWC requests, for the reasons stated in the attached matrix (*see, e.g.*, FirstLight's response to USFWS-1, USFWS-2). CRWC's comments on Study No. 3.3.20 reflect a misunderstanding of the study. The study is based on the density of organisms and flow into the generation facility; Vernon discharge is not a component of the entrainment estimate, and river flow is never a component in this type of entrainment estimate. The amount of water pumped at Northfield during the study period is something that FirstLight has committed to provide, and in fact has included in the new Attachments C and D to Study No. 3.3.20 provided in this filing. As CRWC notes, FirstLight has agreed to repeat—and in fact has already begun—data collection for this study in 2016. A comparison of 2015 and 2016 data, including pumping data, will be provided in a 2016 supplemental report. FirstLight disagrees, however, that there was any expectation that this study would include a long-term comparison of operations with previous years, and as CRWC acknowledges, the Commission-approved study plan certainly did not include any such component. To the extent that CRWC's request for historic pumping data extends to other studies not yet complete, FirstLight's analysis in the amended FLA will discuss historic pumping data to the extent FirstLight deems it to be necessary or relevant to an evaluation of Project effects.

FirstLight is filing this document with FERC electronically. To access the document on FERC's website (http://www.ferc.gov), go to the "eLibrary" link, and enter the docket number, P-1889 or P-2485. FirstLight is also making the document available for download at the following weblink: http://www.northfieldrelicensing.com/Pages/Documents2016.aspx.

In addition to this electronic filing with FERC, a paper copy of the document is available to the public at the Northfield Mountain Visitor Center at 99 Millers Falls Road, Northfield, MA 01360 during regular business hours.

If you have any questions regarding the above, please do not hesitate to contact me. Thank you for your assistance in this matter.

[2] Because April 30, 2016 fell on a Saturday, the deadline shifted to Monday, May 2, 2016.

Sincerely,

Gus Bakas

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Study No. 3.2.1 Water Quality Monitoring

Commenter	Comment	Responses
CRWC-1	TransCanada's Study 6 identified a high temperature-low flow period and looked at results closely during this period. Study 6 also summarized results by month at each site (max, min, mean, and median). FirstLight's study 3.2.1 did not do this, which would have been useful.	CRWC's comment is inaccurate. In its study report filing, FL evaluated temperatures throughout the entire study period, including periods of low flow-high temperatures. More specifically, a high temperature-low flow period was discussed in the report for the impoundment during low flow in August – early September (Figures 3.4.1-1a, 1b & 1c), the bypass reach for low flow in August – September (Figures 3.4.2-4a, 4b, 4c) power canal (Figures 3.4.3-1a, 1b, 1c) and downstream of Cabot Station (Figure 3.4-1a, 1b, 1c, Figure 3.4.5-1 through Figure 3.4.5-7b). Furthermore, FL discussed the temperature rate of change for low flow and high temperature periods in Figures 3.4.5-5 (monthly) through Figure 3.4.5-7b. Monthly trends in DO and temperature against operation flow can also be observed in the appendices E, F and G. A summary of monthly results (min, max, average) by each month was included in the report for water temperature and dissolved oxygen as follows: Temperature: Figure 3.3.2-1, 3.3.2-2, 3.3.2-3 & Table 3.3.2-1, and DO concentration and % sat: Figure 3.3.1-1 and 3.3.1-2, respectively, & Table 3.3.1-1 Monthly trends compared against operations data were also included in Appendix E, F and G.
CRWC-2	The FirstLight study was not conducted in a way that would evaluate surface warming of the impoundment as a project effect. Moreover, the impoundment location had the deepest logger.	CRWC's assertion that FL did not conduct the study in a way to evaluate the impact of the Project on surface warming is inaccurate. Data were collected to evaluate the impact of the Project on temperature. DO and temperature profiles were collected at 3 impoundment locations (Sites 2, 6 and 7-see figures and table discussed in section 3.2 of the report). The water column was generally well-mixed and did not stratify so surface water was not a concern as it was close in value to the bottom of the profile within 0.9ºC. As stated in the report, "Water temperatures followed a typical seasonal pattern, gradually warming throughout the spring and summer. The highest measured temperatures at the three profile locations occurred during August and early September. The maximum temperature was 25.8°C measured at Site 7 on August 18. During this day, Site 7 temperatures only varied 0.3°C from <u>top to bottom</u>. Water temperatures were slightly cooler at upstream locations on this day (24.9°C throughout the water column at Site 2)." Because of the lack of stratification in the impoundment, we conclude there is no Project effect on temperature.
CRWC-3	FirstLight's loggers did not identify water quality problems in the bypass region. It would have been impossible to place loggers in sections that become dry during the season, and CRWC thinks there are locations in the bypass that violate water quality standards for temperature during parts of the summer due to partial or complete dewatering.	CRWC asserts that there are locations in the bypass channel that violate water quality standards. The study findings indicate otherwise. Water quality monitoring equipment was placed at two locations in the bypass reach (Sites 8 and 9) which were located in a shallow riffle less than 2 ft deep during low flow conditions. Throughout the sampling duration, water quality standards were met.

Study No. 3.3.4 Evaluate Upstream Passage of American Eel

Commenter	Comment	Responses
USFWS-1	<u>4.2 Environmental and Operational Conditions</u> FL discussed project generation, but did not present any analysis of a correlation between generation and eel collection rate. FL also did not present any analysis of the effect that spill flows may have on eel collection rate, but made an unsupported statement that "Data suggests that spill at the Turners Falls Dam does not affect collection rate at the traps." Additional analysis of the collected data is needed, although since collections of eels from the traps were done every 2 or 3 days, it is not clear that assessing average conditions over the trapping period will provide meaningful results. In addition, we note that, while average daily river flow may be a relevant metric for large-scale movement cues for juvenile eels, it is not as relevant to near field migration and attraction to the temporary eelways and collection devices.	Generation varied over the course of eel collection and given the temporal scale of eel collection, no valid correlation estimate could be achieved. We agree with the USFWS that assessing eel collection rate in correlation with average generation over a two to three day period would not provide meaningful results; therefore the analysis was not conducted. No statistical test was used to assess correlation between spill and eel collection rate due to the low number of instances in which spill occurred during the study period. However, the eel collection rate was plotted in conjunction with spill (Figure 4.2-6) such that trends could be visualized.
MADFW-1	The Division believes that some additional analysis of the collected data is needed as FL discusses Project generation but does not present any analysis of a correlation between generation and eel collection rate. FL also does not present any analysis of the effect that spill flows may have on eel collection rate, but makes an unsupported statement that "*spill at the Turners Falls Dam does not affect collection rate at the traps.*"	See USFWS-1.

Commenter	Comment	Responses
CRWC-1	Section 4.2 Environmental and Operational Conditions The report states that there is no correlation between river flow, as measured at the Montague USGS gage, and the rate of eel collections. There is no information provided as to the means of calculating the rate of eel collections or the period of time of collection that is used for the evaluation	Eel collection rate was determined by the number of eel collected per sampling event. Forty (40) sampling events occurred between July 9 and November 2, 2015. Sampling time between collection events typically ranged between two (2) and three (3) days.
	A correlation between discharge at Montague and the rate of eel captures is invalid, as most of the eels collected (88%) were at the spillway ladder and 87% of the time when eels were captured at the spillway ladder, there was only minimum flow (125 cfs) in the bypass reach. Eels in the bypass reach are not affected by river flow as measured at the Montague gage, but by generation at Station #1 and spill.	We disagree as river discharge may affect the movement of eel into the bypass reach and the rate of that movement. Therefore those data were included in the analysis. Generation data and spill data were presented in the report in Figures 4.2-5 and 4.2-6, respectively.
	The report also states that, "Data suggests that spill at the Turners Falls Dam does not affect collection rate at the traps." There is limited data to assess the effect of spill on eel captures at the spillway trap, where spill affects collections, but what data there are points to the opposite conclusion. During the period of trapping, there was spill from July 10 to 13 (mean 1,245 cfs), July 22 (1,058 cfs), and beginning on October 1st and lasting (except for one day) for the entire month. During the initial period of spill, 119 eels were collected at the spillway trap. A large number of eels was collected around June 22, but without daily collections it is impossible to determine if eels came into the ladder before, after, or during spill. For the month of October, only 10 eels were collected after the start of significant spill (Oct. 2), and those eels could have already been in the ladder prior to spill. Although eels may be able to enter the spillway ladder when spill is around 1,000 cubic feet per second (cfs), it is likely that spill greater than several thousand cfs prohibits eels from entering the spillway ladder as spill plunges into the bypass at the spillway ladders entrance, creating turbulent conditions with a large amount of entrained air.	We agree that the collection data relative to spill were limited. Much of the monitoring period occurred during the drier summer months when spill is seasonally low. The monitoring period was selected to match the seasonal pattern of eel upstream migration in the Connecticut River. Figure 4.2-6 plots eel collection and spill at the dam. The collection rate began to decrease beginning in mid-September during a time of no spill. This trend was attributed to the end of the migration period which is associated with the time of year and decreasing water temperatures. The occurrence of spill in October is an unlikely contributor to the collection rate during this late season period because migration had already begun to slow.

Study No. 3.3.6 Impact of Project Operations on Shad Spawning, Spawning Habitat and Egg Deposition in the Area of the Northfield Mountain and Turners Falls Projects

Commenter	Comment	Responses
USFWS-1	3.2.3 Canal/Bypass The bypass reach surveys were limited to only three survey locations. Although this was called for in the approved study plan, it is not clear why areas that were safely accessed for the instream flow study transect selections-near the mouth of the Falls River, along the river left side downstream from the spillway ladder, and the area on river left between the Turners Falls Road bridge and Station No. 1-were not assessed as part of this study.	The approved RSP states (Task 4, page 9) "The entire length of the bypass channel will not be walked due to safety concerns at night. Two locations (Rock Dam and Station No. 1) having easier access will be visited in the bypass channel for shad spawning." Other locations were not visited because, unlike the instream flow study, the work was conducted at night and safety was a major concern.
	The study provides extremely limited data that are insufficient to assess the impacts of any bypass flow changes on shad spawning, but also are inadequate to characterize the location, frequency, duration or number of shad attempting to spawn in that reach. In lieu of adequate data, the Service will rely on the results of the instream flow study to discern the relationships between bypass flows and shad spawning.	The shad spawning study was a qualitative assessment of shad spawning and generation changes while the IFIM study will quantify the effects of Project flows on aquatic habitat suitability in the Connecticut River for the aquatic community, including diadromous fish species. These data will then be used in conjunction with hydrologic, operational and other models to evaluate the impact of current and potential future Project operations on aquatic habitat in the study area. The shad spawning study provided information on the locations of the primary shad spawning areas downstream of Cabot Station. Transects for the IFIM study below Cabot were intentionally located to include shad spawning areas to collect habitat data (e.g., depth, velocity, water elevation data, substrate, etc.). The PHABSIM model will be used to simulate shad spawning habitat suitability under a range of operating conditions and operations; these data will be included in the IFIM study report to be filed with FERC on October 14, 2016 and will allow for a more complete assessment of the relationship between shad spawning habitat and Project operations.

Commenter	Comment	Responses
USFWS-2	3.3.3 Habitat Duration Curves Spawning areas were classified as "exposed" when the wetted spawning area of a location was "less than the median water surface elevation (WSEL) for that location." However, there are a number of problems with this analysis. First, the term "exposed" is not appropriate for determining the impact of flow changes on spawning habitat. Spawning habitat for shad is found in moderate to deep water, therefore changes in that habitat can be significant and affect spawning without in any way being "exposed," which infers very shallow or dry conditions. In addition, using the median WSEL for each spawning site as a metric for assessing habitat impacts is not appropriate. While each site may provide suitable spawning conditions at certain flows, habitat may not be unsuitable at other flows. Also, even if there is habitat at certain flows, optimal habitat conditions may not have been available at any flows observed in 2015. In addition, more or less suitable habitat may be available in other years. Using median flow as a benchmark for providing some level of quality habitat, and then defining WSELs below median flow as not suitable, and above median flow as quality habitat, is not supportable. Instead, the assessment should be redone to assess the impacts of flow fluctuations on spawning habitat in relation to the range and frequency of river depths and velocities that were actually observed during spawning in 2015 and may be available based on long-term hydrologic data for the shad spawning period. This concern is addressed further in our comments on section 4.3.2.	Detailed methods for data analyses were not included in the RSP; however, the RSP indicated that modeling would need to be conducted to determine these types of relationships. As indicated in the response to USFWS-1, the IFIM study will provide the needed information to discern relationships between flows and shad spawning habitat. Thus, FL does not agree that the assessment in this study needs to be redone.
USFWS-3	3.3.4 Statistical Analysis Statistical significance was set at p-values of less than 0.05 (report pg. 3-4). The need to design the FERC studies to be able to test for significant differences of 0.05 had not been proposed or established. If the intention was to statistically design this study to meet this level of rigor, it would have required conducting a power analysis in its design and very likely substantially more sampling. This was not done. Individual models were developed to explore the effects of generation, river flow, etc. (report pg. 3-4). There is no mention of what method criteria for model fit, e.g., AIC method, was used.	FL agrees that a power analysis is an appropriate method to determine the number of samples to take a priori; however, without a pilot study or existing information, an appropriate power analysis cannot be performed. The significant result of the Durbin-Watson test indicated that splash counts recorded closer in time were more similar than those recorded further apart in time. In other words, splash counts were shown to vary with time, thus results from any model developed to explore project effects were not valid since the times at which the measurements were recorded influence the number of splashes. Given this, an AIC analysis was not necessary.
USFWS-4	4.1 Historic Operations and Flow Data On page 4-1, it notes that 55 percent of the changes in generation from Cabot Station were in the range of +/- 10 MW (2,630 cfs) and 29 percent were in the range of +/- 20 MW (5,220 cfs). These discharge changes cover approximately 84 percent of the total flow changes during the examined time period, and were chosen as the test scenarios to evaluate impacts of generation changes. Greater fluctuations (those >20MW) that occur 16 percent of the time are likely to result in greater impacts and represent a significant portion of conditions during the shad spawning period. Figure 4.1-2 illustrates instantaneous flow in relation to spawning survey dates and when surveys were conducted in relation to the 18,000 cfs hydraulic capacity of Cabot Station. It therefore also identifies periods when total river flows exceeded that level (generation plus spill flow from Turners Falls Dam). Substantial variability exists in the time series relative to the relationships of spawning, project-controlled flows and flows exceeding project capacity. An appropriate statistical method should examine this covariate (flow outside project effect, flow within project effect), with a structure that would examine how they influence observed spawning data.	The RSP states "*Based on historic generation data at Cabot Station, most changes will be +/- 10 Mw (2,288 fs) followed by 20 Mw (4,576 cfs*) changes." The specific number of Cabot units added or reduced was not stipulated in the RSP. Because historically most adjustments were in the 10-20 MW range, constituting 84% of the time, the study was performed based on these same ranges. The approved RSP did not call out specific statistical methods to assess the data. The suggested analysis is not warranted to meet the study objectives. Further, the IFIM study will examine shad spawning suitability under a range of flow and operating conditions.
USFWS-5	4.2 Spawning Surveys We note that due to weather, flow conditions and equipment failure, all or some of the sampling on 7 sampling days out of the planned 21 days was cancelled. These down days reduced the available data upon which conclusions can be drawn.	Table 4.2-1 in the study report summarizes field activities and provides reasons for early termination or postponement of sampling. FL collected sufficient data to meet the study objectives.
USFWS-6	4.2.3 Canal/Bypass Reach Fourteen days of surveys of the bypass reach and canal were conducted. Spawning was actually only observed at each location on one date, June 18, but no information on canal and bypass flows during the survey on June 18 or on the other 13 nights is provided. Data on the actual canal and bypass reach flows during all 14 survey periods should be provided.	The canal flow on the night spawning was observed was provided in the text on page 4-16 of the report. Attached as Study 3.3.6 Attachment A is Table 4.2.3-1A (a revision to Table 4.2.3-1 of the study report). It includes the minimum, mean, and maximum canal and bypass flows that occurred during the 14 survey periods based on hourly data. The bypass flow was approximately 1,015 cfs on June 18 at 22:15.
USFWS-7	4.3.1 Spawning Activity	

Commenter	Comment	Responses
	Spawning activity was assessed using splash counts, which was reported as average splash counts. Range and measures of variance should be reported, along with the mean splash counts. Changes in project discharge affect water velocity. Data on changes in water velocity were not reported, but should be reported and analyzed for changes in splash count relative to direct and relative change in velocity.	Average was simply calculated as (Observer 1 count + Observer 2 count)/2. Attached as Study 3.3.6 Attachment B is Table 4.3-1A (a revision to Table 4.3-1 of the study report). It includes the actual before and after counts of both observers.
	Table 4.3-1 of the report provides flow data on the paired before/after unit change tests and identifies splash counts, Cabot generation before and after flow changes, time of before/after splash counts, changes in spawning area before and after unit changes and a single instantaneous USGS gage reading.	Velocity data were reported in Tables 4.2.1-2 and 4.2.2-1 and depicted in Figure 4.3.2.-2 of the report. As surface velocity measurements recorded by field crews near the river banks are not representative of the entire spawning area, the spatial relationship between water velocity and shad spawning will be more comprehensively assessed using data from the IFIM model. Because transects for the IFIM study were intentionally located to include shad spawning areas, the PHABSIM model output will be used to simulate shad spawning habitat suitability under a range of operating conditions and flows in the IFIM Study Report to be filed with FERC on October 14, 2016.
	The splash count data should be presented and analyzed based on proportional change in discharge. The operational effects of relative change should be evaluated. It is unclear as written whether the individual-based models addressed this question. Models were developed to explore the effects of generation, river flow, etc., but proportional values were not reported or assessed.	The approved RSP did not specify data analysis methods for assessing proportional or relative changes and FL does not believe this additional analysis is warranted to meet study objectives as it was determined, through the Durbin-Watson test, that splash counts are dependent on time.
	Data should also be provided on Cabot unit discharge, Station #1 discharge, and spill flows over time during the study periods to understand project effects versus natural or Deerfield River flow effects, and the frequency and magnitude of flow fluctuations during the shad spawning period in a "typical" year.	Discharge data for Cabot Station, Station No. 1 and Turners Falls Dam during the 2015 survey period are attached as Study 3.3.6 Attachment C, Figure 4.1-2A.
USFWS-7 (cont)	4.3.1 Spawning Activity (cont) The Service and the National Marine Fisheries Service have reviewed the data in Table 4.3-1 of the report and found a number of problems with the data in the table and the evaluation that was conducted. The USGS flow gage data should be reported with the instantaneous gage data for both "before" and after" splash counts and not one single reading. The USGS gage data reported in Table 4.3-1 of the report for all June samples do not correspond to actual USGS gage readings. This table needs to be corrected. Actual flows before and after unit changes did not, in most instances, reflect the planned and identified changes in Cabot generation (examples were provided, but are not repeated herein).	Attached as Study 3.3.6 Attachment B is Table 4.3-1A (a revision to Table 4.3-1 of the study report). It includes the corrected before and after USGS gage flows.
	The net result of the above problems is that the study provides extremely limited information to evaluate the impacts of flow changes on shad spawning. The causes for the problems noted above are not clear, but appear to be two-fold: Failure to wait long enough after the generation change to conduct the "after" sample such that the flow change from Cabot Station had not yet stabilized at the shad spawning site being assessed. The fact that the May 28 splash counts noted above had the longest time between before and after samples (1 hour 22 minutes) and had "after" flows that were the closest to reflecting the change in generation supports this conclusion. Even with that time delay, however, flows during the "after" count did not fully reflect a full Cabot unit flow change. While the study plan proposed a delay between "before" and "after" counts of 20 minutes to one hour, the intention was to wait until flows stabilized. The basis for the 20 minutes to 1 hour proposal is unknown, but clearly that delay time was insufficient. The "after" count for all but one other generation change test was conducted 30 to 52 minutes after the generation change	These concerns are noted; however, the study was conducted in accordance with the approved RSP. All counts that occurred after the Cabot generation was manipulated occurred within the prescribed time limits set in the study plan (20 minutes to 1 hour). Counts were conducted by biologists on the river in a boat after dark. Besides the prescribed time limits, the biologists had to rely on their best judgment to determine when flows stabilized. In some cases, flows continued to change after the counts had commenced; however the biologists made real time decisions without the retrospection of being able to look at future gage data. Considering the influence of time on daily spawning activity (counts decrease with time since sunset), increasing the duration between before and after counts would not help to discern project effects.

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	The later June splash count events were conducted at flows too high to provide meaningful information on impacts of discharge changes due to baseline high flows that would mask unit changes, and unit changes done at full capacity, where total river flow exceeds project capacity. This study, therefore, provides little data upon which to base conclusions on unit change impacts. The test scenarios in the approved study plan were expected to demonstrate the impacts to shad spawning behavior and habitat in response to one or two units changes (on or off), or increments of 2,288 cfs or 4,576 cfs. No results were obtained that met this study purpose. This is a critical matter, as flows fluctuate at Cabot station almost daily at magnitudes of one or more units. In fact, while the study plan called for evaluation of one or two unit changes, review of the gage data for May 26 to May 29 identifies that actual station operations had far more dramatic changes in discharge during the study period. The splash count sampling regime, even if it had been successful in evaluating one or two unit changes, would not have assessed the more dramatic flow changes that actually occurred during the period of study, as evidenced by USGS flow gage data inserted below as Figure 1 (not included herein) . As we noted in section 4.1 above, even though unit changes greater than one or two unit changes do not occur as frequently, when they do occur, changes in flow can be dramatic. For illustrative purposes, during a sample period from May/June 2014, USGS gage data also identify rapid, dramatic changes on flow releases beyond one or two units, as depicted in Figure 2 (not included herein) inserted below.	The RSP specified conducting surveys through the end of June. Inflow is beyond the control of FL and was typically above average in June. Flow manipulation was being conducted as required for other relicensing studies that stakeholders agreed should be conducted simultaneously. FL disagrees that no results were obtained to demonstrate the impacts to shad spawning behavior in response to one or two units changes. While it may have been expected that splash counts would be influenced by a generation change, our analysis indicates that time, rather than increasing or decreasing generation by 1 or 2 units, has a significant effect on splash counts. FL does not agree that it is appropriate to dismiss results simply because they were “unexpected”.
USFWS-8	4.3.2 Spawning Habitat As noted above, the premise that the dewatering of the spawning areas is an appropriate metric for assessing impacts to spawning habitat is flawed. The sites, both those where spawning was observed, and historically used sites where spawning was not observed during the study period in 2015, represent spawning habitat. As such, impacts of project operations are on spawning at these sites and habitat suitability for spawning. Since shad spawn in moderate to deep water, the impact of different river flows and generation changes would be on depth and velocities and the related impacts on the suitability of used and unused spawning sites. The field studies downstream from Turners Falls in 2015 identified that spawning occurred at depths between 3.3 and 16 feet and water velocities between 0.1 and 2.8 feet per second. Dewatering would be an appropriate criterion for impacts to egg deposition areas, but the location of egg deposition was not assessed and these areas would likely be downstream from the spawning sites. Furthermore, the analysis appears to have used the hydraulic model to evaluate habitat conditions at each spawning site. However, the range of flows evaluated were the flows observed during this specific 2015 study period. Since the spawning study did not span the entire 2015 shad spawning period, and 2015 represented only one year's flow conditions, the limited time frame and associated river flows are not representative of flow conditions shad will likely experience over the course of the next license period. Flow impacts should be assessed using the range of flows and flow frequencies from the extended hydrologic record.	Detailed methods for data analyses were not included in the RSP. As indicated in the response to USFWS-1, the IFIM study (Study No. 3.3.1) will provide the needed information to discern relationships between flows and shad spawning habitat suitability. The report for Study No. 3.3.1 will be filed with FERC on October 14, 2016. Assessing impacts at hypothetical flows other than those observed in the field is a modeling exercise. As indicated above, the IFIM study (Study No. 3.3.1) is an appropriate tool to provide the needed information to discern relationships between flows (typical, as well as extreme or rare conditions) and shad spawning habitat. The report for Study No. 3.3.1 will be filed with FERC on October 14, 2016.
USFWS-9	5. Discussion: Spawning Locations Only habitat in active spawning areas was assessed. As noted in the report, spawning could have occurred at other times than on surveyed dates, and other historically used spawning sites may provide quality spawning habitat under different flow conditions or in different years. It is quite possible that the river flow or project operation conditions in 2015 were not conducive to or precluded spawning at some of these sites and that spawning, and, in tum, the impacts from flow fluctuations at those sites may occur in other years. As such, impacts of flow changes on the suitability of spawning habitat should be assessed at all identified spawning sites whether spawning was observed at these sites during the 2015 study or not.	The RSP did not require data collection in areas where no spawning was observed; rather, observations of shad spawning prompted data collection. Transects for the IFIM study were intentionally sited in, or in proximity to, the areas where observations of shad spawning occurred in the 1970s (transects were selected in consultation with stakeholders including USFWS). Shad spawning habitat suitability at some of the historical spawning areas will be assessed in the IFIM study, and subsequently discussed in the amended Final License Application.
USFWS-10	5. Discussion: Spawning Habitat The report references the maximum ranges of observed water surface elevation (WSE) changes over the entire season and during the study period itself. The report should include the information on the maximum and minimum elevations and elevation changes that were observed at each used and unused spawning site. The first paragraph (carryover from the previous page) on page 5-30 of the study report supports the statement we made in section 4.3.2 above regarding spawning versus egg deposition habitat. It raises, however, the issue that eggs may be deposited in areas	Minimum, maximum and median WSEL data for each of the spawning sites identified in 2015 are included in Appendices A and B in the Study Report. The approved RSP did not require analysis of unused spawning areas. The study objectives in the approved RSP did not require locating areas of egg deposition, rather the focus of the study was to identify and assess impacts to shad spawning habitat and activity.

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	downstream from the spawning sites that may be vulnerable to dewatering. There was no assessment of which locations downstream from the spawning sites could be egg deposition areas or if these areas are impacted by flow fluctuations (shoreline or island shoals).	
	The second paragraph on pg. 5-30 of the study report states "..Cabot generation and effects on downstream habitats in terms of WSEL velocity and depth was determined to be positive. such that ..." The statement that Cabot generation has a "positive effect" should be deleted. It is not supported by the data, as the same section reports that measures of velocity were not appropriately measured to determine an effect. Water velocity is a Habitat Suitability Index variable and Cabot Station discharge would influence that variable, therefore without velocity being assessed, one cannot say whether generation is positive or not. There are data on unit changes and percent change in spawning splash counts that would strongly suggest that generation changes (both up and down) negatively affected spawning behavior and may be tied to changes in habitat variables like depth and velocity. In addition, Cabot generation is only half of the operational effect. Turning off Cabot Station units during the spawning period, which occurs 38 percent of the time, may reasonably be considered a negative impact, as noted earlier.	The use of "positive" was not intended to mean good. Rather, "positive" was meant to refer to the observation that both variables increase concurrently. In other words, as generation increased, so did depth and velocity at the downstream spawning areas, although not necessarily to the same degree.
	This section reiterates a statement in the Results section that photoperiod may be a more critical factor influencing spawning activity, and discounts impacts of generation flow fluctuations, since spawning activity decreased whether generation flows increased or decreased. This conclusion is based in part on the June 9 data of "before" and "after" samples when there were no generation changes, but when there was a 40 percent change in mean splashes. A single date of sampling is insufficient data to base a conclusion that flow changes matter less than the timing of the sampling. We note that in Ross et al. (1993) spawning splash counts are seemingly normally distributed between 2000 and 0100 hours.	As depicted in Figure 4.3.1-3 of the study report, the statement about the influence of photoperiod was not based on a single sampling date. Rather the Phase 1 counts, when no intentional changes to generation occurred, were also included in the photoperiod analysis. The USFWS cites that Ross et al. (1993) reported normally distributed counts between 2000-0100 hours; however, as depicted in Study 3.3.6 Attachment F, 2015 count data exhibit decreasing trends once the photoperiod reaches 14.9 hours and as time since sunset increases.
USFWS-11	5. Discussion: Shad Spawning in TFI The report provides an incomplete assessment of the Stebbins Island area, although there appears to be a means to obtain data from FL's other studies to properly expand the amount of suitable spawning habitat around Stebbins Island. The importance of this single identified spawning habitat area raises this area's importance and raises the need for clearly quantifying habitat changes for shad in that area.	The USFWS did not provide any explanation or justification for deeming the Stebbins Island assessment incomplete. The study was conducted in accordance with the RSP and shad spawning was observed in the vicinity of Stebbins Island. TransCanada conducted an IFIM study in the reach below Vernon Dam, which includes the Stebbins Island area, to assess the relationship between flows and shad spawning habitat.
USFWS-12	Appendix A Appendix A presents a series of maps of "Wetted Area of Shad Spawning Sites in Downstream Reach and TFI." As stated above, "wetted" is not an appropriate metric for assessing impacts to shad spawning habitat. These maps should be redone to depict the areal extent of suitable and unsuitable spawning habitat at various WSEs expected across the shad spawning season, based on long-term flow records and application of minimum depth criteria for shad spawning at that site (based on study site specific data: 3.3 feet at sites downstream from Cabot Station and 6.8 feet at the upper TFI site).	As noted above, FL will be assessing the impact of Project operations on shad spawning habitat suitability as part of the Study No. 3.3.1 IFIM study. FL disagrees there would be any value in repeating the study.
USFWS-13	Service Recommendation As noted above, additional and alternative analyses of the data are needed and should be conducted by FL. However, our overall assessment of this study is that it provides insufficient data to address the central questions of impact of generation flow changes at Cabot Station on shad spawning behavior and shad habitat. There should be some information generated from the Instream Flow Study to assess flows versus shad spawning habitat, and we will review the findings of that study in light of the outstanding questions that remain on this issue. The Instream Flow Study may provide enough information to preclude the need for a repeat of the spawning behavior/flow fluctuation study, but it only addresses habitat and not behavior, therefore that is uncertain.	Sufficient data were collected to address each of the objectives defined in the RSP, therefore, FL disagrees that the study should be repeated. The areas used for shad spawning were identified and defined geospatially based on night-time visual and aural surveys under a range of flow conditions, and physical habitat parameters were measured and reported. Our assessment indicated that splash counts were dependent on time, such that regardless of whether generation increased or decreased, the after counts were always lower than the before counts because the after counts occurred at a later time.
	A repeat of the spawning behavior study, even if warranted, could not be conducted in 2016, given the timing of report filing, comments and a FERC ruling on additional studies. Therefore, while we believe that there is a good chance a repeat of this study will be needed, we are withholding such a request pending the receipt and review of the IFIM study report. We acknowledge that if a repeat of the study is conducted, it would need to be done in 2017.	As noted above, the relationship of flows and shad spawning habitat suitability will be assessed as part of the Study No. 3.3.1 (IFIM).
NMFS-1	Spawning Surveys Section 3.2 of the report contains a narrative which describes where the surveys occurred. However, it does not clearly explain the	The RSP did not require recording launch sites, boat tracks, or the amount of time spent in each location. An estimate of

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	methodology to identify surface spawning activities. The report should include information on launch sites, track taken by the vessel for each sampling event and the amount of time spent in each location. If GPS tracking of the boat surveys occurred, these data should be presented in map form for each night a survey occurred.	the amount of time spent at each location where spawning was observed can be discerned from Table 4.3-1-- a survey crew typically began 15-minute splash counts just after collecting physical parameters at a site, and departed a site approximately 15 minutes after the "after" count began.
NMFS-2	Project Operation and Areas of Spawning One of the objectives of the study was to quantify effects (e.g. water velocity, depths, inundation, exposure of habitats) of project operation on identified spawning areas for a range of conditions. The analysis, in Section 3.3.2, that calculated the wetted surface area at the time of the survey is not relevant for shad spawning. In order to assess habitat impacts, FirstLight should further analyze depths and velocities that are suitable for shad spawning (Hightower *et al*., 2012, Stier and Crance, 1985) under different operating conditions at each identified spawning area. Section 3.3.3 discusses maximum, minimum and median Water Surface Elevations (WSEL) which are not appropriate metrics for assessing whether habitat is suitable for spawning shad. The study report neither discusses nor supports why WSELs above the median provide suitable habitat and WSELs below the median are not suitable.	As indicated in the response to USFWS-1, the relationship between shad spawning habitat suitability (depth, velocity, and substrate) under various Project operations at the spawning locations will be assessed as part of Study No. 3.3.1 IFIM Study.
	Section 4.3.2 of the report does not reference any of the Habitat Suitability Index (HSI) values that were established as part of Relicensing Study 3.3.1 whereby habitat suitability curves were developed for spawning American shad using data from Hightower *et al*., 2012. The HSI data used in Relicensing Study 3.3.1 indicate that velocities in excess of 5.6 feet/second have an HSI value of zero. The report makes no mention of the high velocities shown in the plots for spawning sites 2, 5, 9, 10, 17 and 18 shown in Figure 4.3.2-2. These data suggest that six of the identified spawning sites have mean channel velocities that are unsuitable for spawning under a wide range of total production scenarios. The consistently high velocities at these locations should be discussed in the report in terms of how project operations could be impacting spawning habitat. The report does not analyze or discuss to what degree, if any, the measured surface velocities presented in Table 4.2.1-2 correspond with the estimated mean channel velocities values in Figures 4.3.2-2. The report indicates there was a change in depth and velocities due to changes in project operations for spawning locations in the downstream reach; however these changes are not quantified or discussed in terms of suitable shad spawning habitat. In order to meet the identified study goals and objectives, further analysis should be conducted for this study. That analysis should examine depths and velocities at each spawning site cross section and quantify changes from project operations in terms of suitable shad spawning habitat based on the data in Hightower *et al*., 2012 and Stier and Crance, 1985	Mean channel velocity does not represent the actual velocity across the entire site; therefore if it is too high to support spawning, fish can find relief in areas of lower velocity. The surface velocities measured near the river banks were often lower than the mean channel velocities, which would be expected. Again, as part of Study No. 3.3.1 IFIM Study, the PHABSIM model will account for spatial variability of velocities, and depict the relationship between shad spawning habitat locations (depth, velocity, substrate) and various Project operations at representative spawning sites.
	The report states on page 5-30 "[t]he relationship between Cabot generation and effects on downstream habitats in terms of WSEL velocity and depth was determined to be positive…,". This sentence should be stricken from the report as it cannot be supported. While we agree that all plots in Figures 4.3.2-1, 4.3.1-2 and 4.3.2-3 show that with increased generation, there is a general increase in WSEL, velocity and depth, a great deal of variability occurs for any given total Turners Falls production value. As a result, this statement cannot be supported.	See USFWS-10.
NMFS-3	Project Operation and Spawning Activity In our review of the study report, we found a reporting issue with Table 4.3-1 under the column header 'Instantaneous River Flow Montague Gage USGS Gage (cfs). We obtained 15-minute discharge values from USGS Gage # 01100500 Connecticut River at Montague, MA from May 22, 2015 to May 26, 2015. The reported discharge values in column two of Table 4.3-1 for the May observations agree with the values we obtained (highlighted in green in Table 1), however, for all reported values for observations made in June, the numbers reported in column two of the table appear to be Cabot Station total output discharge values (highlighted in brown in Table 1) (Mark Wamser, personal correspondence). Splash count data should be presented and analyzed based on proportional change in discharge.	Attached as Study 3.3.6 Attachment B is Table 4.3-1A (a revision to Table 4.3-1 of the study report). There was a transcription error which has been revised to include accurate USGS flow data.
	Based the information provided in the study report, we do not agree that FirstLight can conclude project operations are not having an effect on shad spawning. The official USGS reported discharge values indicate the before and after observations made on June 10, June10 & 11, and June 16 were all made at river flows greater than 18,000 cfs (highlighted in light blue in Table 1) which are flows outside Project effects as is clearly depicted in Figure 4.1-2. These three paired observations should not be included in the analysis because turning units on or off at Cabot Station cannot have an observable impact on discharge at spawning sites 16, 17 and 18 at these flows. In addition, operational changes being made at flows over 18,000 cfs are not a likely operational scenario and the ability to detect the impacts of operational changes is very limited, calling into question the usefulness of these three pair observations	This comment is noted; however, the PHABSIM model that will be developed for Study No. 3.3.1 will assess the relationship between shad spawning habitat variables (depth, velocity, substrate) and various flows at representative spawning sites. The report for Study No. 3.3.1 will be filed with FERC on October 14, 2016.

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NMFS-4	Project Operation and Spawning Activity FirstLight reports that "the negative binomial model found no statistical difference (p=.302) in the mean splash counts before …. and after …. changes in generation at Cabot Station." However, the study design does not include a robust sample size (13 treatment observations and only 1 control observation) or a power analysis to detect a change in splash counts at the p=0.05 level. Therefore the study report does not support this analysis.	FL conducted the regression analysis to find the driving causes behind seasonal spawning intensity and found that the counts were dependent upon time (Durbin-Watson test was significant). When this occurs, results from regression analysis are invalid. During questioning at the study report meeting in March 2016, FERC suggested conducting a paired t-test on splash counts before and after operations change for the 28 paired observations. To conform to the assumptions of the test, count data were first transformed with the natural logarithm (see Study 3.3.6 Attachment D, Figure 4.3.1-1A). The resulting mean and variance of the before counts were 3.41 and 0.99 respectively, while the mean and variance of the after counts were 3.02 and 1.18 respectively. Attached as Study 3.3.6 Attachment D is a histogram of the natural log transformed before/after counts. The paired t-test was significant ($t = 4.124$, $df = 27$, $p < 0.001$) suggesting a difference in counts after operational change; however this is expected as the after counts are always recorded at a later time. As this first test incorporated all operational changes, regardless of whether or not there were increases or decreases in generation, we then examined each operational scenario, log transformed the counts, and applied the same paired t-test (see Study 3.3.6 Attachment G). In every case, the after mean was lower than the before mean, even when no change in generation occurred. The data suggest that spawning intensity decreases throughout the night regardless of the operational changes at Cabot Station.
NMFS-5	Project Operation and Spawning Activity The flows highlighted in orange and purple in Table 1 indicate a failure to wait long enough to conduct the 'after' sample so that that project operational effect is observed. While the study plan proposed a delay between 'before' and 'after' counts of twenty minutes to one hour, the intention was to wait until river flows downstream of the project reflected the operational change.	See USFWS-7.
NMFS-6	Project Operation and Spawning Activity Table 4-3-1 should report the 15-minute Montague USGS gage data that most closely corresponds to the time the 'before' observation was made and the 'after' observation made. We note four instances where river flow did not increase when units were turned on (highlighted in purple in Table 1) and two instances of flows increasing when units were turned off (highlighted in orange in Table 1). Had the observer protocol been to wait an hour to an hour and a half, all but one of these discrepancies would have occurred. Because the observations are being made downstream of the confluence with the Deerfield River, the effect of turning units on or off might not be reflected in discharge until at least an hour or more after the change in operation. By making splash count observations too soon after units were turned on or off, these observations further put into question the validity of the statistical tests that were conducted in terms of testing the effects of project operations on spawning downstream of the Turners Falls project.	Table 4.3-1 in the study report contained a transcription error and has been revised to include accurate USGS flow data (see Study 3.3.6 Attachment B Table 4.3-1A).
	Figure 4.1-2 clearly demonstrates rapidly fluctuating flows and numerous flow reversals based on 15-minute flow data (Zimmerman *et al*., 2010). However, the spawning observations were only analyzed by number of splashes and did not take into account the proportional changes in discharge from project operations within the period of observation. An analysis of the proportional change in river flow using the 15-minute USGS flow data at Montague as well as the proportional change in splash counts should be evaluated and discussed in the relicensing study.	See USFWS-7.
NMFS-7	Project Operation and Spawning Activity The report does not take into account the project operations that were occurring as part of Relicensing Study 3.3.2 whereby bypass flows were being altered throughout May and June. On March 8, 2016, a data analysis workshop was held for Relicensing Study 3.3.2. The color coded calendar indicating the bypass flows that occurred during the radio-telemetry study should be included in section 4.2.3 of the shad spawning study. We consider flows in the bypass reach, in addition to how many units at Cabot Station are operating, as an important project operation that was not considered, analyzed or explained in this report.	Minimum, maximum, and mean flow in the bypass reach is provided in Attachment A to Study No. 3.3.6 and reflects the flow manipulations that were being conducted in support of Study No. 3.3.2. Cabot Station, Station No. 1 and Turners Falls Dam Discharge (cfs) throughout the 2015 shad spawning survey period are included as Attachment C of Study 3.3.6.
NMFS-8	Project Operation and Spawning Activity Furthermore, given the limited number of observations, the report should discuss whether reported changes in the number of units operating, the associated river discharge at Montague and the number of observed splash counts increased or decreased. Based on these results, the report should include an analysis of the associated sign changes (positive or negative) under each scenario.	Before and after data were included in Table 4.3-1. The approved RSP did not specify data analysis methods for assessing proportional or relative changes and FL does not believe this additional analysis is warranted to meet study objectives as it was determined, through the Durbin-Watson test, that splash counts are dependent on time.

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NMFS-9	Project Operation and Spawning Activity The report also states on page 5-30 "[w]hile operation of the Turners Falls Project may induce changes at shad spawning sites in the downstream reach, it appears that photoperiod and time since sunset are more influential on spawning activity than physical at spawning sites related to project operation" This statement cannot be supported given that only one observation was made where units in operation were held constant (the June 9, 2015 observations at 20:00 and 20:43) and a 39.7% drop in splash counts was observed.	The photoperiod analysis included data collected during Phase I surveys, in which no intentional changes to generation were initiated.
MADFW-1	Spawning Activity Spawning activity was assessed using splash counts, which was reported as average splash counts. Range and measures of variance should be reported along with the mean splash counts. Changes in Project discharge affect water velocity. Data on changes in water velocity were not reported but should be reported and analyzed for changes in splash count relative to direct and relative change in velocity. Table 4.3-1 provides flow data on the paired before/after unit change tests and identifies splash counts, Cabot generation units running and MW before and after flow changes, time of before/after splash counts, changes in spawning area before and after unit changes and a single instantaneous USGS gage reading. The splash count data should be presented and analyzed based on proportional change in discharge. The operational effects of relative change should be evaluated. It is unclear as written (pg 3-4), whether the individual based models addressed this question. Models were developed to explore the effects of generation, river flow, etc., but proportional values were not reported nor assessed. Data should also be provided on Cabot unit discharge, Station #1 discharge and spill flows over time during the study periods to understand Project effects versus natural or Deerfield River flow effects, and the frequency and magnitude of flow fluctuations during the shad spawning period in a "typical" year.	See USFWS-7.

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MADFW-2	The Division, United States Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service have reviewed the data in Table 4.3-1 of the report and found a number of problems with the data in the table and the evaluation that was conducted. The USGS flow gage data should be reported with the instantaneous gage data for both "before" and after" splash counts and not one single reading. The USGS gage data reported in Table 4.3-1 of the report for all June samples do not correspond to actual USGS gage readings. This table needs to be corrected. Actual flows before and after unit changes did not, in most instances, reflect the planned and identified changes in Cabot generation (examples were provided, but are not repeated herein). The net result of the above problems is that the study provides extremely limited information to evaluate the impacts of flow changes on shad spawning. The causes for the problems noted above are not clear, but appear to be two-fold: Failure to wait long enough after the generation change to conduct the "after" sample such that the flow change from Cabot Station had not yet stabilized at the shad spawning site being assessed. The fact that the May 28 splash counts noted above had the longest time between before and after samples (1 hour 22 minutes) and had "after" flows that were the closest to reflecting the change in generation supports this conclusion. Even with that time delay, however, flows during the "after" count did not fully reflect a full Cabot unit flow change. While the study plan proposed a delay between "before" and "after" counts of 20 minutes to one hour, the intention was to wait until flows stabilized. The basis for the 20 minutes to 1 hour proposal is unknown, but clearly that delay time was insufficient. The "after" count for all but one other generation change test was conducted 30 to 52 minutes after the generation change The later June splash count events were conducted at flows too high to provide meaningful information on impacts of discharge changes due to baseline high flows that would mask unit changes, and unit changes done at full capacity, where total river flow exceeds project capacity. This study, therefore, provides little data upon which to base conclusions on unit change impacts. The test scenarios in the approved study plan were expected to demonstrate the impacts to shad spawning behavior and habitat in response to one or two units changes (on or off), or increments of 2,288 cfs or 4,576 cfs. No results were obtained that met this study purpose. This is a critical matter, as flows fluctuate at Cabot station almost daily at magnitudes of one or more units. In fact, while the study plan called for evaluation of one or two unit changes, review of the gage data for May 26 to May 29 identifies that actual station operations had far more dramatic changes in discharge during the study period. The splash count sampling regime, even if it had been successful in evaluating one or two unit changes, would not have assessed the more dramatic flow changes that actually occurred during the period of study, as evidenced by USGS flow gage data inserted below as Figure 1 (not included herein). As we noted in section 4.1 above, even though unit changes greater than one or two unit changes do not occur as frequently, when they do occur, changes in flow can be dramatic. For illustrative purposes, during a sample period from May/June 2014, USGS gage data also identify rapid, dramatic changes on flow releases beyond one or two units, as depicted in Figure 2 (not included herein) inserted below.	See USFWS-7.
TNC-1	Impacts to spawning habitat were evaluated based on exposure of the habitat, which would imply that habitat is adequate for spawning if wetted. However, according to Hightower et al. 2012 and the habitat suitability curves used in the instream flow study, adequate spawning depths are somewhere in the range of 5 to 15 feet, with suitability declining sharply under depths of 3 feet. Therefore this analysis of impact to shad spawning habitat is inadequate.	Study No. 3.3.1 (IFIM) will provide an assessment of the relationship between depth and shad spawning habitat suitability. A discussion of the relationship between depth and shad spawning habitat will be included in the IFIM report due to FERC no later than October 14, 2016 and subsequently discussed in the amended Final License Application.
TNC-2	The before/after analysis for changes in generation lumped generation increases together with generation decreases. That is, the analysis only considered whether there was a change, not whether it was an increase or decrease in generation. Because we expect that increases in flow would have different effects than decreases in flow, the analysis should separate increases from decreases in order to draw conclusions regarding operational effects.	Attachment G of Study No. 3.3.6 depicts the results of a paired t-tests conducted for each operational scenario separately. In other words, a paired t-test was performed on before and after counts associated with increasing generation by one unit; another paired t-test was performed on before and after splash counts associated with decreasing generation by one unit; another test was performed for increasing generation by 2 units; another test was performed for decreasing generation by 2 units; and tests were also performed for all scenarios in which generation was increasing, as well as for

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		all scenarios in which generation decreased. Overall, regardless of whether generation increased or decreased, the after counts were lower than the before counts.
TNC-3	The methods stated that because "the duration between, before, and after splash count recordings was generally less than one hour, the effect of potential temperature changes on splash counts before, and after, generation changes was not assessed." According to the water quality study results, rates of temperature change can be high in May – in some cases, rates of over 1°C per hour. It is therefore unclear why temperature was not included in this analysis. Temperature changes would also presumably be different whether flows are increasing or decreasing, further justifying why these trends should be examined separately. The differences between increases and decreases in flow might include differences in temperature regimes as well.	Shad spawning occurs over a wide range of temperatures. Stier and Crance (1985) reported that peak spawning occurs within the range of 14-21°C, with temperatures below 8°C and greater than 26°C deemed as unsuitable. Data collected downstream of Turners Falls Dam (Sites 11, 12, and 13) in support of Study No. 3.2.1 throughout the shad spawning survey period indicate the minimum temperature recorded was 15.6°C (May 16) and the maximum was 21.2°C (June 1), which are both within the suitable range that permits shad spawning.
TNC-4	Influence of Deerfield River flows could have also been included in the linear model analysis by subtracting Cabot Station generation flows (and bypass flows) from the Montague gage to determine which factor (Deerfield River or Cabot Station generation) was more or less influential in the model. These models are intended to demonstrate the effects of spawning; eliminating a variable that is hypothesized to influence spawning negates the value of the models (that is, if Deerfield River discharge influences spawning, some other variable in the model will incorrectly account for that variability in the pattern).	Specific data analysis methods were not detailed in the approved RSP. Study No. 3.3.1 (IFIM) will provide an assessment of the relationship between flow and shad spawning habitat suitability.
TNC-5	Since there were multiple negative binomial models developed (as stated in the last paragraph on page 3-4), these models should have been evaluated in a model comparison framework to assess the strength of evidence among them rather than evaluating the significance of model components within a single model. Because variables can confound or conflate each other, it is important to evaluate them in multiple models. A multiple- model framework (see Burnham and Anderson 2010) will allow for a clearer understanding of the weight of variables in determining effects on splash counts.	A multiple model framework could not be supported by the data as it was determined that there was a relationship between consecutive measurements in space and/or time, and as such, the assumption of independent and identically distributed measurements was not met.
TNC-6	The autocorrelation discussion on page 4-20 is confusing. If there is a hypothesis that splash counts are influenced by photoperiod, then a difference in counts over time would not be unexpected. This autocorrelation analysis is for count data that is assumed to be independent of time; as explained in the previous paragraph on page 4-20, time is an important descriptor variable. It follows that the statement in the last paragraph on page 4-20, "the data have not been tested for relationships over time with photoperiod as a predictor" is also confusing – because the previous paragraph stated that photoperiod was included in the regression analysis. The multiple regression analysis described above (the model comparison approach) should demonstrate the strength of evidence of photoperiod for describing the splash count data, and it should not be necessary to judge by "appearances" of the data. That is, there is no clear support for the statement made on page 5-30: "While operation of the Turners Falls Project may induce changes at shad spawning sites in the downstream reach, it appears that photoperiod and time since sunset are more influential on spawning activity than physical changes at spawning sites related to physical operations." This statement cannot be made without an adequate assessment	See USFWS-3. To clarify, photoperiod refers to day length (or light hours) and does not change throughout the course of one day.
CRWC-1	<u>4.3.1 Spawning Activity</u> The USGS Montague gage discharge readings for the before and after times for the splash samples (Table 4.2.1-1 data and USGS downloaded 15 min data are similar) do not show the change in MW's/discharge stated in Table 4.3-1. Each Cabot unit's hydraulic capacity is 2,280 cfs. For the thirteen readings where a change in unit operation is listed, six show a change in discharge opposite of the listed generation change (5/26 twice, 5/27, 6/9 to 6/10, 6/10 to 6/11, & 6/17 to 6/18), one had no change in discharge for a decrease of two units (6/16), five had changes averaging 224 cfs and only one had a change that approximated the listed unit change (5/28, 1,530 cfs). The Deerfield River gage near West Deerfield (#01170000) showed no significant change in discharge during any of the periods of splash count sampling, and as such did not influence the Montague gage. Changes in generation should be readily apparent at the Montague gage due to its close proximity to Cabot station. That the flow did not change as noted in Table 4.3-1 is of serious concern for the accuracy of the study and calls into question any conclusions. As such, this study should be repeated or data need to be corrected (consistent with 18 CFR §5.15(d)(1) and (2)).	See USFWS-7. Table 4.3-1 in the study report contained a transcription error and has been revised to include accurate USGS flow data (see <u>Study 3.3.6 Attachment B</u> Table 4.3-1A).
CRWC-2 3/25/2016 filing	<u>From CRWC 3/25/2015 Comment Letter:</u> Please provide areas identified by HSI curves as suitable aquatic habitat for shad spawning in the Turners Falls impoundment. If this was not done, please identify any areas where it was thought there might be shad spawning habitat. Also provide documentation of the dates and times all survey sites in the impoundment were visited, and the launch location and time each night.	The boat sampling downstream of Turners Falls was launched at Sunderland Bridge and the other boat used to sample the impoundment was launched at either Barton Cove, Pauchaug, or Vernon Dam boat launches. Launch times were not recorded and the RSP did not specify that these be noted. The dates and times of shad spawning sampling are attached in <u>Attachment E of Study No. 3.3.6</u>.

Commenter	Comment	Responses

Study No. 3.3.8 Computational Fluid Dynamics Modeling in the Vicinity of the Fishway Entrances and Powerhouse Forebays

Commenter	Comment	Responses
USFWS-1	Production Runs for Two Additional Bypass Flow Scenarios Assessing fishway attraction in the presence of competing flows (i.e., spill) is critical when evaluating fish passage conditions. The operational scenarios modeled and summarized in the tables on pages iii and iv, while informative, do not reflect operational conditions we anticipate will be required under a new license, as flows for passage, spawning and rearing, and riverine fish habitat are likely to be required. In particular, the Cabot Fishway scenarios (5-x) and the Spillway Fishway models (6-x) need to be run at moderate flows to provide needed clarity on future conditions. While instream flow study and telemetry study reports have not been filed or reviewed, based on what we know at this time from past sturgeon spawning research and the preliminary instream flow study results for reach 2, we request that FL provide the results of two additional production runs: a) a scenario that evaluates hydraulic conditions with a bypass reach flow between scenarios 5-3 and 5-4, or approximately 3,450 cfs; and b) a scenario that evaluates hydraulic conditions with the discharge from Bascule Gate No.1 Flow between the flows modeled in scenarios 6-1 and 6-2, or 2,370 cfs.	FL evaluated the scenarios specified in the RSP, but we agree to simulate the two additional production runs requested by USFWS. The results from these additional runs will be included in a study addendum. Note that reference to an addendum is noted several times in response to comments below. FL will file the addendum with FERC on October 14, 2016.
USFWS-2	Channel Roughness As noted on pg. 2-2 and elsewhere, Gomez and Sullivan Engineers (GSE) have modeled all physical boundary conditions as hydraulically smooth. Implicit in this model simplification is the lack of calibration to real flows (which is distinct from the verification process). Hydraulically smooth boundaries are generally appropriate for shallow, low velocity turbulent flows. However, many of the modeled reaches/locations are of sufficient velocity and depth, with sufficient channel roughness, to be characterized as hydraulically rough. Hydraulically rough surfaces may produce a very different velocity distribution than hydraulically smooth surfaces; and velocity distributions are a key correlation to fish movement (along the bank, throughout the river, in the power canal, and approaching fishway entrances). As an example, this simplification may relate to the discrepancy between measured and simulated velocities downstream of the fishway entrance cited on pg. 6-5 of the study report. Unfortunately, the influence of this simplification on the overall modeling effort cannot be quantified apriori. The Service appreciates that software limitations, as described by GSE staff on a March 31, 2016 conference call on this report, may prevent incorporating accurate roughness elements throughout the model. Nevertheless, additional work is needed to reduce the uncertainty in the 3D distribution of velocity in GSE's model. If GSE believes that the hydraulically smooth assumption has a limited influence on the model results, we request that FL provide a sensitivity analysis that demonstrates this limited influence by comparing a hydraulically smooth boundary to one with appropriate channel roughness on a representative subsection of the overall model.	We agree that conducting a sensitivity analysis is appropriate. FL agreed to do this during the March 31, 2016 conference call and is currently conducting a sensitivity analysis of the Cabot Fishway Entrance model. The sensitivity analysis is based on a hydraulic roughness of 1.635 feet, which is approximately equivalent to a Manning's 'n' roughness of 0.035 assuming an average river depth of 15 feet. The results of the sensitivity analysis will be included in the addendum.
USFWS-3	Intake Rack Approach Velocity GSE provided colorized vector plots of the intake velocities in front of the racks at Station No. 1 and Cabot Station. To better evaluate the hazards of impingement and entrainment, we request that FL provide contour line maps of approach velocities 1 foot in front of the racks for scenarios 1-x and 3-x with color lines clearly labeled in 0.5 fps increments (or finer).	We will generate additional plots showing the velocities in 0.5 fps increments, 1 foot in front of the racks and include them in the addendum. Generating actual contours from the data we have would be difficult, but we can create 0.5 fps "color bins" to achieve the same affect without actually generating contours.
USFWS-4	Station No. 1 Intake Overview Plots To help us better understand the entrainment potential of juvenile alosines, we request that FL produce particle trace plots showing a similar perspective as the flow vector plots in figures 8.2.1-1, 8.2.1-2, 8.2.1-3, 8.2.2-1, 8.2.2-2, 8.2.2-3, 8.2.3-1, 8.2.3-2, and 8.2.3-3. If possible, for clarity, please include at least five seeds in each particle trace plot. It is our understanding that generating these plots will not necessitate new production runs. Cabot Station Intake Overview Plots Similar to the above request, we request that FL produce particle trace plots similar to figures 8.3.1-1, 8.3.1-2, 8.3.2-1, 8.3.2-2, 8.3.3-1 and 8.3.3-2 for the Station No. 1 intake. If possible, for clarity, please include at least five seeds in each particle trace plot. It is our understanding that generating these plots will not necessitate new production runs.	We agree to generate the additional particle trace plots and will include them in the addendum.

Commenter	Comment	Responses
USFWS-5	Fishway entrance velocity The Service evaluates fishway attraction in the context of location, flow, and velocity. While fishway entrance locations are known and flows from the existing fishways were fixed at 318 and 368 cfs, modeled velocities at the entrances (for which the Service has established criteria) are unknown. We request that FL provide tables for all scenarios (involving fishways) that include average entrance velocity as well as the other scenario parameters (i.e., scenario number, station discharge, fishway discharge, total flow).	We will generate the requested tables and will include them in the addendum.
USFWS-6	Station No. 1 Pass-Through Flow Starting on pg. 7-1, scenarios 1-x indicate a high degree of fluctuation in the canal pass-through flow. Is this simply because the pass-through flow was modeled as a pressure boundary (under which some variation is understandable) or is this indicative of a more serious convergence problem that would add uncertainty to the results, or is it something else altogether? In the interest of improving confidence in the model, we request that FL briefly expand the explanation of this variability.	We do not believe that there is a convergence problem with the model. While the magnitude of the fluctuation in the pass-through flows is somewhat high, as a percentage of the total pass-through flows, the volume of fluid in the model is quite stable, and the magnitude of fluctuation is small compared to the flow rates in the rest of the domain. The fluctuations are the result of the pressure boundary used at the pass-through outlet to maintain a fixed tailwater elevation in the canal. The canal inlet and turbine flows are constant, and as a result the velocities in front of the intake racks (most important location) are stable. The variation in the pass-through flows is not believed to affect the results in front of the racks. We will expand on the explanation in the addendum.
USFWS-7	Cabot Fishway CFD Model Bypass Flow Similar to the concerns raised in the section above, we have concerns regarding fluctuations in the bypass flow as described on pg. 7-6. Please provide an explanation on these fluctuations as requested above.	We do not believe that there is a convergence problem with the model and will provide an explanation in the addendum.
USFWS-8	Additional minor comments: • Pg. iv, paragraph 2 : The report indicates that the Computational Fluid Dynamics Model results were assessed relative to "established agency criteria for American shad swim speeds." While 7 fps may be a burst speed for adult shad that is appropriately conservative for this study, it should not be inferred as a uniform value for the species in all regions, or accepted by all agencies. • Pg. 2-2, paragraph 1: "...by hydraulically smooth" should read "...be hydraulically smooth" • Pg. 5-7, Tables 5.4-1 and 5.4-2: These tables should be labelled "Spillway model...," not "Cabot Tailrace model..." • Pg. 5-15: spillway gate "teeth" are more appropriately referred to as nappe spoilers and serve to prevent vibrations in the gate by reducing transience in flow separation over the crest.	FL is not proposing to re-issue the CFD report to correct these minor editorial comments. NMFS is correct that Tables 5.4-1 and 5.4-2 inadvertently referred to the Cabot Tailrace model and should have referenced the Spillway model.
NMFS-1	*NOTE: Numerous editorial comments were provided by NMFS in its comment letter. The summary below addresses only the major comments* Page 1-7, First paragraph states: *Because the approach and sweeping velocities are typically evaluated approximately 1 ft in front of the rack face, and the forebay models already included the trash rack area, it was determined that a highly detailed model of the intake rack was not necessary to meet the CFD study objectives.* We were not notified of this variance from the FERC determination. The computational limitations are understood, but the necessity of modeling a fine scale section (or alternate evaluation) of the intake racks at both Station No. 1 and Cabot Station is required to properly evaluate approach and sweeping velocity. According to our guidelines (NOAA 2011), physical measurements of the velocity components in front of screens should be conducted as close to the rack face as possible without entering the boundary layer turbulence, so the 1 ft spacing suggested in the study may not reflect the best evaluation of velocity components.	FL noted this variance in the Updated Study Report Summary filed in September 2015. This variance was also mentioned in the follow-up Updated Study Report Meeting presentation in September 2015 as well as the Updated Study Report Meeting Summary notes (dated October 2015) during which some discussion about this variance occurred. While we understand the benefits of modeling the intake racks at as fine a scale as possible, using the 1-foot mesh struck a reasonable balance between computational demands and model precision.

Commenter	Comment	Responses
NMFS-2	Page 2-2, First paragraph states: *All bathymetric surfaces and structures were assumed to by hydraulically smooth.* 'By' should be replaced with be. We understand the pragmatism of this assumption but this assumption is not valid for most bathymetric surfaces, particularly in areas with jagged ledge outcroppings which are found throughout the model domains. A sensitivity analysis should be conducted to evaluate the potential effect of this assumption on computed water surface elevations and water column velocities.	As part of the addendum we are conducting a sensitivity analysis for the Cabot Fishway Entrance model to evaluate the effect this assumption has on the water levels and velocities and will include the results in the addendum.
NMFS-3	Page 3-2, Section 3.1.3 states: *These data were supplemented by additional bathymetric data that was collected in Reach 3 for Study No. 3.3.1: Conduct Instream Flow Habitat Assessment in the Bypass Reach and below Cabot Station.* Add text to clarify the extent/scope of this data. The report should make it clear whether the data consisted only of bathymetric survey point or if additional ADCP velocity measurements were also collected What were the flow conditions in the river during this supplemental data collection? Can the collected ADCP data from Study No. 3.3.1 be used as another verification run?	The addendum will clarify the extent and scope of the supplemental bathymetry data. The supplemental data was a combination of survey data collected via RTK-GPS and total station (i.e., bathymetry points only) and bathymetric depths collected via a boat using an ADCP. The boat-collected bathymetric data (with the exception of a couple of transects) was collected using an ADCP, however generally when we are collecting bathymetric data, the boat speeds are much higher than recommended to collect velocity data. The downside of collecting ADCP data at higher boat speeds is that the accuracy of the velocity data is significantly degraded. The ADCP manufacturer generally recommends that the boat travel at speeds equal to or less than the ambient river velocities to obtain accurate velocity data. Therefore when we are intending to collect velocity data, we generally keep the boat speeds targeted between 1-2 ft/s (~1 mph). When collecting only bathymetry data, the target boat speeds are usually in the 4-8 ft/s (~3-5 mph) range, which is higher than we generally prefer if using the data for water velocities. The increased boat speeds (within the range that we travel within) do not meaningfully impact the accuracy of the bathymetric data. Additionally, because of the difficulty in coordinating flow releases, the bathymetry data were collected under a wide range of flows and under conditions that were not necessarily stable. When collecting water velocity data for this study and Study 3.3.1 we were careful to allow enough time (up to 1-2 hours) for the river to stabilize before collecting velocity data. This was not the case when we were collecting bathymetric data. There are 2-3 transects collected at other flows for velocity purposes within the study area that could potentially be used for additional verification. As noted in our response below however, FL does not believe additional model verification efforts are within the scope specified in the RSP.

Commenter	Comment	Responses
NMFS-4	Page 4-1, Fifth paragraph states: *The Station No. 1 Forebay CAD model includes the power canal and forebay walls, trash boom and intake structures up to and including the penstocks.* Based on our conference call with the Licensee's consultant on March 31, 2016, we understand that the intake racks including the bars were not physically included in the model structures. Please clarify. Page 4-1, Eighth paragraph states: *The Cabot Station Forebay CAD model consists of the forebay and power canal walls, log sluice, fish weir and intake structures, including the intake racks and penstocks.* Based on our conference call with the Licensee's consultant on March 31, 2016, we understand that the intake racks including the bars were not physically included in the model structures. Please clarify. Page 4-7 Penstock No. 3 is mislabeled. The intake rack is shown in the figure, but is not actually in the CAD model. Please clarify. Page 4-8 The log boom is depicted in the figure, but there is no discussion of how the floating log boom is accounted for in the model. Page 4-9 The intake rack is shown in the figure, but is not actually in the CAD model. Please clarify. The Cabot Station forebay model extends approximately 700 ft upstream from the power house, but does not include the discharges from the emergency gate used to sluice debris from the log boom and the emergency gate used to provide attraction water for the upstream fishway. Both of these gates are used during regular operations and, thus, should be reflected in the model.	It is correct that the intake racks are not in the model. They were included in the figures for reference, but we agree that it is not as clear as it could be that they are not in the models. We will clarify the status of the intake racks in the text and add annotation to the figures indicating that the intake racks were not modeled in the addendum. A discussion of how the log boom is included in the model will be included in the addendum. A flow scenario including flows through the emergency gates gate used to sluice debris from the log boom and the emergency gate used to provide attraction water for the upstream fishway were not called for in the RSP and were not evaluated.
NMFS-5	Section 6.2 The verification run for the Cabot Station forebay is inadequate. The verification run involved Unit 1, 5, and 6 operating for a total discharge of 6,684 cfs (not including the log sluice at 1,290 cfs). The production runs to evaluate existing conditions at the power house involved Cabot Station flow at 1,700 cfs, 7,500 cfs, and 13,728 cfs with 200 cfs flowing over the fish weir down the log sluice. Therefore, the verification run does not appropriately validate the production runs with the exception of Scenario 3-2 (though different units were generating). In addition, the verification run does not account for discharge over the fish weir, the log boom emergency gate, or the attraction flow emergency gate. A more comprehensive verification approach would have been to collect field data at station capacity and minimum flow with all appropriate gates and weirs set to reflect conditions when downstream passage is occurring	We believe that the selected verification run was appropriate. The methodology and flow rates to be used during field collection were not specified in the RSP. The verification run was conducted for a mid-range flow between the minimum production run flow (1 unit generating) and the maximum production run flow (all units generating). The verification run was intended to verify the model under a single condition, not under every production model run scenario. The log boom emergency gate and the attraction flow emergency gate were not in the production runs per the RSP.

Commenter	Comment	Responses
NMFS-6	Page 6-2, Third paragraph states: *The log sluice gate was open 10 ft during most of the fieldwork and the fishway weir was not installed, resulting in approximately 1,290 cfs (calculated) passing through the log sluice, for a total flow of 7,974.* Therefore, all production runs involving the fish weir are not validated. Additional field data should have been collected with the fish weir installed to validate this model. Page 6-2, Sixth paragraph states: *Based on a comparison of the ADCP and CFD model results it is believed that the results from the CFD model production runs are appropriate for meeting the objectives of this study.* The visual comparison of the verification run and the measured data does look good with the exception of the cross section immediately in-front of the intake racks. This is the most important area to evaluate for this particular model. A quantitative evaluation should be completed to evaluate the validity of the verification run. We recommend developing a grid of the cross section in front of the rack with each grid representing no more than 5% of the total rack area. Calculate the average channel velocity in the grid for the measured and simulated flow and compare the results.	We believe that the selected verification run was appropriate. The methodology and flow rates to be used during field collection were not specified in the RSP, and the RSP did not specify multiple verification runs for any model area. The verification runs were intended to verify the models under a single operating condition, not under every production model run scenario. The log boom emergency gate and the attraction flow emergency gate were not in the production runs per the RSP. The ADCP and CFD model results shown in the figure may need some additional explanation to help clarify what is being shown, and possibly an additional figure or two that show only the transects directly in front of the intake racks. Additional plots will be included in the addendum
NMFS-7	Section 6.3 The verification run for the Cabot Station fishway is inadequate. The flow conditions during the verification run are not similar to any of the production runs with the closest being Scenarios 5-1 and 5-2 which are both over 50% smaller and larger than the verification flow condition. The flow in Scenario 5-5 is nearly six times that of the verification run. This level of extrapolation from the conditions in the verification run does not appropriately validate the model. We recommend collecting additional field data during appropriate flow conditions to further validate the production runs, particularly at a cross section within the fine mesh portion of the model.	We believe that the selected verification run was appropriate. The methodology and flow rates to be used during field collection were not specified in the RSP, and the RSP did not specify multiple verification runs for each model area. The verification run was conducted for a mid-range flow between the minimum production run flow (1 unit generating) and the maximum production run flow (all units generating plus relatively high bypass flow). The verification run was intended to verify the model under a single condition, not under every production model run scenario.

Commenter	Comment	Responses
NMFS-8	Page 7-4, Sixth paragraph states: *The units at Cabot Station are typically operated in sequence from Unit 1 to Unit 6, therefore, if three (3) units were generating, it would most likely be Units 1, 2, 3.* Clarify why Units 1, 5, and 6 were operating during the verification run.	The verification run conditions were not specified in the RSP. Units 1, 5 and 6 were run during field data collection to capture a mid-range flow condition and the high velocities that occur on the inside of the bend in the forebay just upstream of the intake racks.
	Table 7.3.1-2 Briefly explain the flow instability in the left and right, upper and lower channels.	The flow instabilities in Table 7.3.1-2 will be elaborated upon in the study addendum. As noted in the report, each model had a certain amount of flow oscillation. The lower-flow models generally had higher relative amounts of oscillation. The model was run for several of these oscillations until it was clear that it was not dampening out any more, at which time the model was stopped and the results were processed.
	Table 7.3.2-2 Briefly explain the negative 97.5% Exceedance Flow in the lower right channel.	The negative 97.5 exceedance flow in the lower right channel in Table 7.3.2-2 was due to the model oscillations. Because the flow in this channel was relatively low compared to the left channel flow, and the right channel is largely backwatered from downstream, the oscillations can result in short-term flow reversals.
	Table 7.3.3-2, Table 7.3.4-2, & Table 7.3.5-2 Briefly explain why the 2.5% exceedance flow is larger than the 97.5% exceedance flow for the Cabot fishway.	It appears that the Cabot fishway flows were accidentally reversed in the three tables (7.3.3-2, 7.3.4-2, 7.3.5-2) where the 2.5% exceedance flow and 97.5% exceedance flows are noted. This also appears to be the case for table 7.4.1-2.
	Table 7.4.1-2 Briefly explain why the 2.5% exceedance flow is larger than the 97.5% exceedance flow for the left island, right island, and outflow. Also, briefly explain the negative flows for the middle channel and tainter gate channel. Table 7.4.2-2 Briefly explain the negative flows for the middle channel and tainter gate channel.	The middle and tainter gate channel negative flows in Table 7.4.1-2 are a result of small model oscillations causing the instantaneous flows to be slightly positive or negative even though there is no net flow through these areas. As stated in the average flow at these locations, the net flow is 0 and the oscillations (10-20 cfs) are a small percentage of the total model flows (~700 cfs).
	Table 7.4.3-2 Briefly explain the negative flows for the tainter gate channel.	This is also the case for Table 7.4.3-2, where small oscillations a small percentage of the time result in a slight negative flow (97.5% exceedance flow = -78 cfs) for the tainter gate channel. These oscillations are very small (< 1%) compared to the overall model flow of over 14,000 cfs.

Commenter	Comment	Responses
NMFS-9	Page 8-1, Fourth paragraph Our guidelines for approach velocity are species and life stage specific, but in the case of the target species for this reach of the Connecticut River, we agree with USFWS' criterion. Likewise, we are in concurrence that sweeping velocity should exceed approach velocity. We request further explanation on how the component velocities were calculated.	As described in Section 4.1.1, to facilitate the evaluation of the velocity vectors in front of the intake racks the model geometry was rotated such that the intake racks were aligned with the Cartesian coordinate system used for the CFD model. This means that the face of the intake racks is parallel to the x-axis in the model. This simplifies computing the component velocities. To calculate the component velocities across the face of the intake racks, first a grid of x,y,z points was created with approximately a 1 foot spacing, parallel to the rack face and 1 foot in front of the racks. The spacing is approximately 1 foot (and not exactly 1 foot) because when generating the x,y,z points the limits were established (x-min, x-max, y-min, y-max, z-min and z-max) and the distance (e.g. x-max minus x-min) was divided into a whole number of equal increments to come close to the target spacing. This grid is shown (with velocity vectors turned on) in Figures 8.2.1-4, 8.2.1-5 and 8.2.1-6 of the report. These x,y,z points were passed to the CFD model software as a "neutral file" (a specifically formatted text file) and the CFD software post-processed the point data and output the Ux,Uy,Uz component velocities, which are aligned with the Cartesian coordinate system. Using these Cartesian-aligned velocity components, the components that are parallel to the face (sweeping velocities (VS), aligned with the x-axis) and normal to the face (approach velocities (VA), in the y-z plane) based on the orientation and slope of the rack relative to the original model Cartesian coordinate system were calculated as follows: • VS - Because the model domain was aligned with the Cartesian coordinate system such that the rack face is parallel to the x-axis, VS is equal to Ux and no computation is necessary. • VA - The approach velocity is in the y-z plane and based on Uy and Uz. The rack face is sloped with a rise of 19.9 feet and a run of 5.0 feet. Therefore the velocity component normal to the rack face (Un) is equal to: • Un = Uy*Cosine(Arctangent(5/19.9))+Uz* Cosine(Arctangent(19.9/5)) This method for evaluating the velocities at the rack face resulted in a total of 1,920 evenly spaced points across the face of the intake rack. Each point has an x, y and z location, Ux,Uy and Uz component velocities, a velocity magnitude (Umag) and direction, and a velocity component parallel to the face (sweeping velocity (VS)) and a velocity component normal to the face (approach velocity (VA)). These values at each point were used to calculate the statistics to categorize the flows at the rack face. The following were calculated: • The maximum approach velocity (VA) was taken as the single point with the highest computed approach velocity as computed above. • The maximum sweeping velocity (VS) was taken as the single point with the highest computed sweeping velocity as computed above. • The percentage of the rack face that had VA values less than 2.0 fps was calculated as the percentage of the points that meet this criteria. • The percentage of the rack face that had VA values less than 2.0 fps or VA values less than VS values was calculated as the percentage of the points that meet this criteria.
NMFS-10	Page 8-2, Eighth paragraph Our guidelines (NOAA 2011) state that flow distribution across a screen, or in this case rack, should be uniform. In particular, the sweeping velocity should be unidirectional such that downstream migrants are led to a bypass entrance or other point of egress from the forebay. In the case of Scenario 1-1, even though all of the approach and sweeping velocities across the entirety of the rack face met numeric criteria, non-uniform flow distribution will eventually lead to entrainment or impingement, thus not protecting the fisheries resource (See Figure 8.2.1-6). Please provide further detail on how the statistical evaluation was calculated and the component velocities determined from the model output.	See NMFS-9 for further detail on how the statistical evaluation was calculated and the component velocities determined from the model output.

Commenter	Comment	Responses
NMFS-11	Figures 8.2.1-4 to 8.2.1-6; Figures 8.2.2-4 to 8.2.2-6; and Figures 8.2.3-4 to 8.2.3-6 Include additional intake rack figures to display component velocity. For figures showing approach velocity, the scale should have a maximum of 2 fps such that all approach velocities exceeding 2 fps are red. For figures showing the sweeping velocity, the color scale should be binary such that VS>VA is green and VS≤VA is red. The sweeping velocity figures should show directionality.	An additional plot with a binary color scheme such that VS>VA is green and VS≤VA is red will be added to the addendum.
NMFS-12	Figures 8.3.1-3 to 8.2.1-6; Figures 8.2.2-4 to 8.2.2-6; and Figures 8.2.3-4 to 8.2.3-6 Include additional intake rack figures to display component velocity. For figures showing approach velocity, the scale should have a maximum of 2 fps such that all approach velocities exceeding 2 fps are red. For figures showing the sweeping velocity, the color scale should be binary such that VS>VA is green and VS≤VA is red. The sweeping velocity figures should show directionality.	An additional plot with a binary color scheme such that VS>VA is green and VS≤VA is red will be added to the addendum.
NMFS-13	Figure 8.3.1-6; Figure 8.3.2-6; and Figure 8.3.2-6 Include profile views from the forebay across the fish weir to the boundary condition of the model showing acceleration and velocity.	An additional plot across the fish weir to the boundary condition of the model showing velocity will be included in the addendum.
NMFS-14	Production Runs 5-1 through 5-5 Figure 1 shows the area to be revised for several figures in the report whereby each of these types of figures should be zoomed into the yellow box and another cross section at the red line should be added. [See figure in letter]	These type of figures will be modified as requested in the study addendum.

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

Commenter	Comment	Responses
USFWS-1	Magnitude of the Calibrated Roughness Values: The calibrated roughness values (ks) of 0.005 to 1.3 (presented in Figure 3.2-2) correspond to approximate Manning's n values of 0.018 to 0.042. The lower value (ks=0.005) is quite low for a major river such as the Connecticut. Though the model is calibrated (predicted water surface elevations generally to within 0.15 foot of actual measured elevations), this demonstrates that the roughness values that were used predict water surface elevations well. However, the model may not accurately represent localized water velocities, especially in reaches where Acoustic Doppler Current Profiler measurements were not taken.	The section of the Connecticut River with an approximate Manning's n value of 0.018 (i.e. ks value of 0.005) is generally considered to have a relatively consistent cross sectional shape, little to no vegetation, and minimal meandering. Open Channel Hydraulics by Ven Te Chow cites a minor stream (i.e. top width at flood stage of less than 100 feet) matching such a description as have a Manning's n value of 0.025 to 0.033. This reference also indicates that the Manning's n for a major stream should be less than that of a minor stream of the same description, because the banks offer less effective resistance. As such, a Manning's n value on the order of 0.018 is not considered low for this study. It should also be noted that the section of river modeled is impounded, and the backwater may result in a roughness factor which has a smaller role in defining the hydraulics of the reach than in a typical riverine situation. Additionally, the River 2D manual states that an initial estimate for ks between 1 and 3 times the largest grain size is reasonable. While available reservoir sediment data has a relatively small sample size, the grain size distribution suggests that the d85 is between 1 mm and 2.5 mm. This would provide a ks value between 0.001 and 0.0075, suggesting that the 0.005 ks value implemented in the model is not too small. Finally, the HEC-RAS manual also provides the Limerinos equation for estimating Manning's n as seen in Figure 1 below. The section of the Connecticut River utilizing a ks of 0.005 has a channel top width which varies between approximately 450 feet and 800 feet, and a channel depth which varies from approximately 10 to 20 feet on average. Assuming a rectangular channel an average hydraulic radius would be approximately 14 feet (i.e. 600 foot wide by 15 foot deep rectangular channel). For a d84 ranging between 1 mm and 2.5 mm, the Limerinos equation estimates the Manning's n to be between approximately 0.017 and 0.019. This method also suggests that the roughness implemented in the model (i.e. approximate Manning's n value of 0.018) is not too small. **Figure 1: Excerpt from HEC-RAS Manual** Limerinos (1970) related n values to hydraulic radius and bed particle size based on samples from 11 stream channels having bed materials ranging from small gravel to medium size boulders. The Limerinos equation is as follows: $n = \frac{(0.0926)R^{1/6}}{1.16 + 2.0\log\left(\frac{R}{d_{84}}\right)}$ (3-2) Where: R = Hydraulic radius, in feet (data range was 1.0 to 6.0 feet) d_{84} = Particle diameter, in feet, that equals or exceeds that of 84 percent of the particles (data range was 1.5 mm to 250 mm)

Commenter	Comment	Responses
USFWS-2	<u>Variations of Roughness Associated with the Bathymetry, Bed Forms, and Vegetation</u>: Conventional practice in the computational modeling of rivers and streams leads to a lateral and longitudinal (i.e., 2D) partitioning of a river reach according to variations in bed forms and vegetation. These variations are categorized several ways (e.g., channel, overbank, floodway, flood fringe), but are typically described by *associating changes in roughness height* (e.g. ks, Manning's n). This lateral and longitudinal partitioning of roughness values (input into the Bed Load file in River2D) is an essential ingredient–along with variations in bed elevation–in the accurate two-dimensional modeling of river flow. The Revised Study Plan for study 3.3.9, dated August 14, 2013, states that calibration of the model "will primarily consist of adjusting the nodes 'roughness coefficient' within the model to better fit observed water surface elevations and water velocities" and that successful calibration will "show a reasonable match with field-measured velocity profiles." However, as shown in Figure 3.2-2, this report does not account for the dramatic changes in roughness one would expect moving laterally across a stream (e.g., floodplain to main channel). Instead a composite roughness value that only changes longitudinally down the River is used. While changes in bed elevation are modeled in 2D, associated ks values are not. Therefore, while the model predicts water surface elevations well, it may not accurately represent the lateral distribution of velocities which are instrumental in assessing habitat, fish passage, and fish movement through these reaches of the River. In order for the model to be accurate and provide detailed information on passage route velocities across the channel, model recalibration would be needed.	A lateral variation of roughness values between the four major zones (i.e. channel, overbank, floodway, and flood fringe) was not incorporated into this 2D model because the inundation area for the scenarios run existed primarily within the channel. The lack of water encroaching zones other than the channel is exhibited in Figure 1 below. Figure 1 shows that there is only minor encroachment of water into the overbank zone for one of the highest WSEL scenarios evaluated [i.e. Scenario 36: 5% Annual Exceedance Flow, 4 Units Generating, and a water surface elevation of the dam at of 185 (i.e. maximum normal FERC operating level)]. Therefore, only roughness values within the channel are pertinent for this study, and variation of roughness values between these four major zones was not considered to be an issue. Further, adequate information was not available for calibration of roughness values in the overbank, floodplain, or flood fringe zones for this section of river. Bathymetric measurements collected for this study were used to incorporate major bed forms for which a two-dimensional model uses to account for lateral variation in discharge within the channel. The small set of available grain size distributions suggested that the d85 along the edge of water was rather similar to the d85 present in the center of the river, and did not support the use of laterally varying ks values within the channel. Finally, there was no information regarding subsurface vegetation to support the use of laterally varying ks values within the channel. **Figure 1: Example of maximum water surface extents outside of the channel.** 

Commenter	Comment	Responses
USFWS-3	Swim Speed, Fatigue and Passage: Section 6 of the report provides a detailed literature review of the swimming speeds of target species on the Connecticut River characterized into a three-tiered swim speed model: sustained/prolonged/burst. Section 7.3.1 notes that a velocity of 5 fps "does not create a velocity barrier for American Shad passage" because prolonged and burst speeds for this fish are 7 feet per second (fps) and 13 fps, respectively. However, it is important to note that successful passage is related to swimming capacity *and distance*; in other words, one must account for issues of fatigue. This issue is discussed in Section 6 of the report (e.g., Castro-Santos [2005]), but is not taken into account in data analysis. Acceptable methods for evaluating the flow speed *and length* of a velocity barrier do exist. For example, Figure 7.2-3 illustrates the tailrace flow field under full pumping conditions where velocity is 1.5 to 3.0 fps or greater. Assuming those conditions persist outward from the intake for approximately 300 feet, the barrier cannot be traversed by sustained speed alone and an accounting for fatigue must be made. Using the model posed by Haro et. al. (2004), for a 16-inch adult shad encountering a 300-foot-long velocity barrier of 2.5 fps at 18°C, one would expect that only 72 percent of shad would pass the barrier. Predicted success for weaker swimming species like blueback herring would be dramatically lower. Irrespective of any targeted standard for percent passage success, a 5 fps flow over any appreciable distance may indeed be a barrier, and a more in-depth evaluation of this is warranted. There are other models which allow evaluations of fatigue in the presence of velocity barriers (Behlke 1991; Castro-Santos 2005; Bell 1991). The service intends to run such an analysis after the model report is filed and accepted by the Federal Energy Regulatory Commission. In the meantime, Sections 6 and 7.3 should be regarded as informational only; passage efficiency and entrainment potential requires a more in-depth evaluation.	Definitive conclusions pertaining to actual effects on migratory fish are not possible until results from this study can be coupled with empirical fisheries data from other studies.
USFWS-4	Distance Scale: The distance scale on many figures (e.g. 7.2-2 is inaccurate and should be corrected).	The distance scale for Figures 7.2-1, 7.2-2, 7.2-3, and 7.2-4 inadvertently referred to the index map.
NMFS-1	The velocities and flow fields are not compared to non-generation conditions. To determine the effect of Northfield Mountain operation on fish habitat, the Licensee should show the model results for the 5%, 25%, 50%, 75%, and 95% exceedance flows at the high and low impoundment water surface elevation level without generation or pumping to determine the change in velocity and flow field conditions.	The operating scenarios are defined in Table 3.3.9-1 of the RSP, which includes different flows through the TFI (25, 50 and 75% exceedance flows), different Vernon releases and different Northfield pump/gen scenarios. In FERC's September 13, 2013 Determination letter they required additional analysis of flows through the TFI including the 5 and 95% exceedance flows. The study plan did not require simulating conditions with Northfield idle. In addition, the study objectives include assessing velocities and flow fields at the Northfield tailrace/intake, when pumping and generating. None of the study objectives is aimed at evaluating velocities at the Northfield tailrace/intake with Northfield idle.
NMFS-2	The Licensee does not properly synthesize the data to evaluate the effect of Northfield Mountain operations on fish habitat. For example: little discussion of rheotactic delay from the reversal of flow in the river • evaluate the combination of hydraulics that may affect fish habitat (water depth plus depth-averaged velocity) • determine the effect of operations on passage at French King Gorge or below Vernon • the diurnal cycle of pumping and generating that may affect certain life stages or spawning behaviors	This study did not include objectives aimed at evaluating the effects of Northfield Mountain Pumped Storage Project operations on habitat. In contrast, the study objectives pertain to evaluating the impact of Project operations on fish migration (i.e. velocity barriers, flow reversals, false attraction). As stated in the study report, the hydraulic modeling and the associated literature reviewed for this study have revealed the potential for migration delay and entrainment, but definitive conclusions pertaining to actual effects on migratory fish are not possible until results from this study can be coupled with empirical fisheries data from other studies. This study has the potential to inform and strengthen the conclusions of the other studies by delineating the conditions encountered by migratory fish in the vicinity of the Northfield Mountain Pumped Storage Project.
NMFS-3	Figure 3.3-2: The mesh surface comparison to the bathymetric surface near French King Gorge and the TFI impoundment has a large discrepancy. The report should discuss the implications of this on model results.	A number of deep chasms (i.e. in excess of 120 feet deep) exist within the Connecticut River in the vicinity of the French King Gorge and lower TFI (e.g. King Phillips Abyss and French King Hole). The steep nature of the gorge and these chasms lead to difficulty in accurately representing the features (i.e. using a reasonable number of mesh elements), but it is not expected to have a significant impact on the overall river hydraulics, as these areas are generally influenced by backwater from the Turners Falls Dam.
NMFS-4	Figure 4.1.1-1: Figure is missing transect 2b and 3b.	During data collection for the four unit scenarios, the ADCP unit was traversed across the transects twice. However, data quality was poor (i.e. missing data) for one traverse during generating conditions of transects 2 and 3. Therefore, there should not be a Transect 2b or 3b on Figure 4.1.1-1.
NMFS-5	Several specific comments provided on data presentation and analysis.	Additional analysis of the modeling results may be completed once the studies related to migratory fish in the TFI are completed. Specific comments provided by NMFS will be considered.

Study No. 3.3.10 Assess Operational Impacts on Emergence of State-Listed Odonates in the Connecticut River

Commenter	Comment	Responses
MADFW-1	2.2.4 Quantitative Odonate Surveys The FERC Study Plan Determination (p. B-58) stated that FL should "use the quantitative data collected under study 3.1.2, such as frequency, amplitude, and speed of boat wakes when evaluating effects on odonate emergence." However, the report states that "boat traffic was extremely light at all sites on all dates, and no disturbance from boat wakes was ever observed. Thus, this parameter is not discussed further in this report." The Division is concerned by the lack of data and analysis provided by the report on this issue, particularly for Site 5 and the Turners Falls Impoundment, and requests that FERC direct FL to **amend the report to include data supporting FL's claim that the frequency, amplitude and speed of boat wakes does not affect odonate emergence.**	We did record observations of boats and boat wakes at all sites, on all sampling dates, in 2015 and we will include these observations in an updated report. Note that on May 9, 2016, FL had a conference call with MADFW (specifically MA Natural Heritage or NHESP) and FERC to discuss supplemental field work to obtain additional emergence and eclosure data for state-listed odonates species and other species underrepresented in 2015. On May 10, FL emailed the 2016 Field Sampling Plan to NHESP. On May 13, NHESP emailed FL approving the plan with a request to collect information on air temperature, relative humidity and light intensity. In addition, NHESP provided maps showing locations where state-listed odonates had been observed previously. Since additional data will be collected in 2016, FL is proposing to file a supplemental report by December 31, 2016 (hereinafter referred to as the "2016 report") that addresses some of the issues raised in the 2015 report (see response to comments below) and reports on the data collected in 2016.
MADFW-2	2.2.4 Quantitative Odonate Surveys FERC's Study Plan Determination recommended that FL provide justification for conducting or not conducting odonate surveys due to precipitation events. As detailed below, weather conditions in 2015 appear to have been atypical, with frequent cool rainy weather and high-flow events between late May and early July. Additionally, the report confirmed that flow conditions in the Bypassed Reach during May and June 2015 were atypical due to controlled flows in support of other relicensing studies. The report states that surveys were timed to coincide with fair weather (warm air temperatures, dry and sunny days) and flow conditions (average to below- average flows) conducive to emergence. However, it does not provide any justification for conducting or not conducting odonate surveys in relation to atypical weather and flow conditions between late May and early July, sufficient to confirm that data were collected during typical emergence conditions. The Division recommends that FERC direct FL **to revise the report to provide justification for conducting or not conducting odonate surveys relative to weather and flow conditions.**	Weather and flow conditions were recorded on all of the days that were sampled in 2015. Although flows were high on some days (especially in June, when flows were high throughout the entire month), weather was always optimal for emergence. These observations will be included in the 2016 report.
MADFW-3	3.2.5 Emergence and Eclosure Speed The Division believes that anomalous environmental conditions appear to have affected this portion of the study. The report confirmed that cool rainy weather, cool water temperatures and frequent high-flow events from late May to early July – during what should have been the peak emergence period – created "*exceptionally poor emergence conditions for dragonflies*" and may have delayed or possibly prevented emergence. Therefore, the Division requests that FERC direct FL to collect supplemental data re: emergence and eclosure speeds for odonates in 2016	As noted above, FL plans to collect supplemental emergence and eclosure data for state-listed dragonfly species in 2016 in consultation with MADFW (see MADFW-1).
MADFW-4	3.3 Water Surface Elevation Analysis The report provides key summary statistics for WSEL, daily rates of change in WSEL, and maximum rates of change in WSEL between May 15 and September 15. We request that FERC direct FL **to include the following modifications in a revised report,** to be submitted for public review and comment: • WSEL data should be based on period May 15 to August 15 between 4 am and 5 pm. • Develop WSEL statistics for period 2010 to 2015 to determine if 2015 was representative.	We fail to see how omitting the mid-August to mid-September WSEL data from the analysis would improve the analysis or significantly change the outcome. However, FL will comply with this request from MADFW. In addition, the analysis will include only the 4am to 5pm timeframe, as requested. As described further under the response to comment MADFW-10, FL will use the hydraulic model to evaluate potential effects of water level changes on odonates at the 2015 survey locations in the TFI and downstream from Cabot Station as well as at additional locations in the these two reaches. With regard to the bypass reach, as explained in the report, during May and June 2015, FL was providing coordinated flow releases from Turners Falls Dam in the bypass reach in support of other relicensing studies; therefore, the frequency and magnitude of water level fluctuations in the bypass reach during this period were atypical of bypass flow conditions.

Commenter	Comment	Responses
MADFW-5	4.2 Potential Effects of Project Operations The Division requests that FERC direct FL to **include the following modifications in a revised report,** to be submitted for public review and comment: • Use median and quartile vertical crawl distances. • Include additional risk assessment based on the max rate of water level change at each site. • FL provides information regarding the percent of odonates at risk at each of the five quantitative survey sites - a risk assessment for the odonate community as a whole - and argues that "*neither the hourly/daily changes in WSEL nor rates of change appeared to have a strong effect on odonate emergence*" at Sites 1 (Third Island, ~5 miles downstream of Cabot Station) and 2 (Route 116 Bridge, ~10 miles downstream of Cabot Station). It also suggests that at Barton Cove, odonate emergence does not appear to be affected. The data/analysis provided does not support such assertions because the report does not include a risk assessment for each state-listed species or species group at each site.	The species-specific analysis should be possible assuming sufficient sample sizes are collected during supplemental field data collection in 2016, and will be considered in the 2016 report.
MADFW-6	Similarly, FL suggests that water level fluctuations and rates of changes resulting from Project operations may affect odonate emergence at Sites 3 and 4, and therefore in areas of the Connecticut River closer to Cabot Station. However, FL limited the risk assessment for Sites 3 and 4 to the odonate community as a whole, which may mask more severe impacts to specific state-listed species and impede efforts to develop targeted recommendations. Therefore, we request that FERC direct FL to **revise the report to include species specific risk assessments,** particularly for state-listed species or species groups, as suggested below. This will enable the Division and other resource agencies to develop more accurate operational recommendations to help avoid and minimize impacts to both the odonate community, in general, and for each state-listed species specifically.	See MADFW-5.
MADFW-7	Suggested Method for Risk Assessment For a risk assessment across the entire Project area, the **Division recommends analyzing critical height quantiles for each state-listed odonate species.** This assessment should include the additional eclosure time data as requested herein. For purposes of their example, the Division used a more conservative estimate of eclosure time (3 hours).	Based on the supplemental surveys conducted in 2016, FL plans to develop species-specific risk assessments and use real data for eclosure time, rather than the arbitrary 3 hours that MADFW has suggested.
MADFW-8	In the absence of data confirming FirstLight's observations that no disturbance from boat wakes was observed at the monitoring sites, the Division recommends that 0.23 ft be added to the climbing height quantiles to account for effects of average boat wakes.	FL did collect data on boat activity and boat wakes at all of the survey sites in 2015, and FL has some boat wake data for the Turners Falls impoundment. Thus, we will use real data in the analysis rather than the arbitrary 0.23 ft that MADFW has suggested.
MADFW-9	In the absence of additional data on emergence and eclosure speed, as requested herein, the Division does not agree with FL's proposal to use 2 hours as a representative eclosure time.	FL plans to collect supplemental data in 2016 to refine the eclosure times (see MADFW-1).
MADFW-10	The Division requests that FERC direct FL to **use the hydraulic model** - which can accurately predict changes in WSEL and rates of changes to WSEL throughout the Project area - **to assess the effect of WSEL changes on the emergence of state- listed odonates throughout the Project Area.** This will allow comparison of affected areas under alternative flow regimes and help the Division and other resource agencies to develop operations recommendations that avoid and minimize impacts to state-listed odonates.	FERC's February 21, 2014 Study Plan Determination on page B-57 states, "Deployment of four water level loggers (one per survey reach) would provide the data needed to standardize measurements and adequately evaluate odonate emergence success and potential project effects (section 5.9(b)(5) and (7))." Nevertheless, the hydraulic model can be applied to the 2015 study areas in the Turners Falls Impoundment (TFI) and downstream from the Montague USGS Gage using existing models. FL is not proposing to conduct additional modeling in the bypass reach for this issue because the bypass flow regime is likely to change as a result of the licensing process. In addition, FL will use the hydraulic model to evaluate potential effects of water level changes on odonates at additional locations in the TFI downstream from the Montague USGS Gage. This analysis will be provided in the 2016 report.

Commenter	Comment	Responses
TNC-1	Task 4 of the August 14, 2013 Revised Study Plan (RSP) stated that "Water level data will be used to identify the zones along each transect that have low, moderate, to high inundation frequency" (p. 3-241 of the RSP). However, we did not see any assessment of inundation frequency in the Study Report. It follows that further analyses based on inundation frequency were also not included, specifically: "…The abundance, density, and species composition of emerged odonates will be compared along a gradient of inundation frequency. In addition, the influence of water level, habitat characteristics (substrate, vegetation cover, elevation), and weather conditions on emergence distance will be determined using correlation and regression analyses" (p. 3-241 of the RSP). These analyses were not included in the report.	Some of the analyses were not possible or severely limited by low sample sizes. Rather than evaluating zones of inundation frequency at transects, FL proposes to utilize the hydraulic models as explained above to evaluate potential effects of water level changes on odonates.
TNC-2	Task 5 of the RSP states "A hydraulic model, which will be developed for the whole study area independent of the odonate study, will be used to determine if water level fluctuations affect the emergence and eclosure success of state-listed odonates" (p. 3-241 of the RSP). However, the hydraulic model was not used in the analyses. Andrea Donlon of the Connecticut River Watershed Council raised this issue at the March 16, 2016 Study Report Meeting, and FirstLight stated that it would need to review the study plan before responding to her comment. Upon doing so, they stated (as reported in the March 31, 2016 Study Meeting Summary or SMS) that "The FERC study plan determination (pages B-57 and B-58) recommended that FirstLight deploy water level loggers at each of the survey locations to evaluate water levels. Therefore, FirstLight used the empirical water level data collected in 2015 to evaluate the impacts of water level fluctuations on odonates." However, this was not our understanding of FERC's study plan determination (SPD). On page B-48 of the SPD, FERC acknowledges that FirstLight "proposes to utilize results of its proposed hydraulic model (study 3.2.2) to categorize odonate occurrence data along a gradient of inundation frequency…" and makes this acknowledgement again on page B-56: "…FirstLight proposes to compare the abundance, density, and species composition of emerged odonates along a gradient of inundation frequency provided by the hydraulic model (study 3.2.2)." The need for water level data was also indicated in FirstLight's study plan, but methods for its collection were not described explicitly; as stated by FERC: "FirstLight's proposal indicates that it would collect water level data as part of this study. While FirstLight states that it would collect water level data, it does not specifically indicate how it would collect these data…Therefore, we recommend FirstLight deploy a water level logger (with the capability to record temperature) set to record data at 15-minute intervals, at each of the quantitative survey locations to accurately evaluate water levels, standardize field measurements, and describe temperature in relation to odonate emergence behavior." As stated by FERC, the need for the water level data was outlined in FirstLight's study proposal, as was the use of the hydraulic model in the evaluation of water level impact. Therefore, collecting and using the water level logger data does not negate the use of the hydraulic model in the analysis of impact to odonates.	See MADFW-10.
TNC-3	Task 5 of the RSP states "The field data gathered during Task 4, particularly the timing (e.g., when species emerge), distance travelled (both horizontal and vertical), and duration (i.e., speed) of travel and eclosure for species and/or species groups will be used in concert with the hydraulic model to determine which species are most vulnerable to fluctuating water levels, and under what conditions they are most susceptible" (p. 3-241 of the RSP). Whereas some of these analyses were referenced in the discussion, data and results were not included in the results section of the report. Therefore, it was not clear what data and results were being referenced for making statements and conclusions in the discussion. At the Study Meeting Summary on March 16, 2016, FirstLight showed an example of the results of this analysis in a table, yet there were no tables of this analysis included in the report. Tables and figures should be included comparing the field data (i.e., timing, distance, and duration as listed) to the water level and hydraulic data, as stated in Task 5 of the RSP. Similarly, Task 6 of the RSP states that a "Water Level Impact Assessment" would be included in the Results (p. 3-242 of the RSP), but only a "Water Surface Elevation Analysis" that did not include an evaluation of impact to odonates was included in the report Results section.	All materials in the presentation were either taken directly from, or distilled from, the final report and were intended to convey information quickly in a 15-minute oral presentation. FL is targeting the collection of additional species-specific information in 2016 that will help improve that aspect of the analysis. See MADFW-10 for a discussion of water level impact assessment.
CRWC-1	Page 3-28 of the RSP states, "To some extent, a thorough review of existing information will provide adequate biological information for an impact assessment using the hydraulic model, but field observations are planned to fill critical knowledge gaps by conducting surveys in both the Turners Falls Impoundment and downstream from the Turners Falls Dam." The purpose of the field work was to fill in data gaps. However, the Study Report only looked at the gap areas, and did not assess project operations on the Turners Falls impoundment using the existing data as was implied in the RSP.	See MADFW-10.
CRWC-2	Task 1 was to be a review of existing information, and "the life history and ecology of these species and species groups will be summarized." The first paragraph in section 4.1 of the report gives a slight mention of some existing information, but in no way was the existing information summarized. And for some reason, a study conducted in 2011 by Biodrawversity as part of a Massachusetts Department of Environmental Protection (MassDEP) Administrative Consent Order against FirstLight for the 2010 sediment dumping incident was never even mentioned.	The paucity of data on the key parameters for our analysis (climbing height, climbing distance, and eclosure speed) limited this aspect of the final report. FL is expecting some additional data will be available after the 2016 sampling, and can summarize information for species and species groups in the 2016 report.

Commenter	Comment	Responses
CRWC-3	Task 5 was to be a water fluctuation impact assessment using the hydraulic model. No such impact assessment was done using the hydraulic model.	See MADFW-10.
CRWC-4	The FERC study plan determination dated February 21, 2014 stated, "As such, we recommend FirstLight use the quantitative data collected under study 3.1.2, such as frequency, amplitude, and speed of boat wakes when evaluating effects on odonate emergence. We estimate that the cost of including this data in the odonate analysis would be approximately $2,000." The resulting report in section 2.2.3 says merely, "Boat traffic was extremely light at all sites on all dates, and no disturbance from boat wakes was ever observed. Thus, this parameter is not discussed further in this report." Given that the field work was largely done below the Turners Falls dam, in a section that gets almost no motor boat traffic (it's the only section of the Connecticut River in Massachusetts that is actually regulated as a no-wake zone), it's not surprising that no disturbance was observed. However, that is not what FERC asked for. The Turners Falls impoundment gets much boat traffic, enough that the erosion study is looking at it as one of the causes of erosion. The analysis should still be done.	See MADFW-1 and MADFW-8.

Study No. 3.3.11 Fish Assemblage Assessment

Commenter	Comment	Responses
USFWS-1	Boat electrofishing results in the TFI are reported as Catch Per Unit Effort (CPUE) using a "standard" shoreline distance of 500 meters. We understand that FL chose this method of presenting the data in order to allow comparison to historical surveys. However, a consequence of calculating effort based on a set distance is the reported variability in actual electrofishing effort, or seconds that electricity is applied in that sampled distance. This presents difficulties when making comparisons among the data. Based on the data provided in the report (Table 4.2.1-2), actual electrofishing effort was significantly different for early summer versus late summer for the twelve events in both time periods (t-test, $P<0.001$, power at alpha 0.05: 0.996), with a mean effort of 1,456.9 (standard deviation 146.6) seconds vs. 1,873.0 (S.D. 272.2) seconds for the early and late summer periods, respectively. In the early summer samples, the minimum sample effort was 1,119 seconds and the maximum was 1,672 seconds, a difference of 553 seconds of effort, or in relation to the minimum value, a difference of 49.4 percent more effort between the two extremes. In the late summer samples, the minimum effort was 1,439 seconds and the maximum was 2,339, a difference of 900 seconds of effort, or in relation to the minimum value, a difference of 62.5 percent more effort between the two extremes. We request that FL re-analyze and report the data in terms of actual electrofishing effort, to allow for direct comparisons between seasons, among strata, and even within strata. Also, the fish per minute approach could be applied to the 500 meter sections as well. As an example, if 50 fish were sampled in the early summer on the "shortest" timed sample run, that would yield a CPUE of 2.68 fish/min (1,119 seconds). Alternatively, the "longest" timed sample run in the early summer (with 50 fish caught) would yield a CPUE of 1.28 fish/min (1,672 seconds). However, in the current report approach, both catches of 50 fish would be reported as the same, for covering a distance of 500 meters. The report should include results from both methods of analyzing CPUE (set distance and set shock duration).	The attached tables (Study 3.3.11 Attachment A) include Catch Per Unit Effort (CPUE) using time instead of distance.
USFWS-2	According to the study report, QHEI indexes the types and quality of substrate, instream cover, channel morphology characteristics, riparian zone extent and quality, bank stability and condition, gradient, and pool-riffle-run quality and characteristics. The report provides none of the field data that were collected and used to calculate QHEI scores at each station. The Service requests that those data be included in the report and provided on the relicensing website in a spreadsheet format.	The attached matrix table (Study 3.3.11 Attachment B) summarizes the QHEI scoring attributes.
USFWS-3	While lengths and weights were taken on sampled fish, those metrics are not discussed in the body of the report. The only reference to those data is provided in a table on page 128 of the report and the data are presented by species for all stations combined. We request that FL provide length and weight data for each species collected by season and station and make the raw data available on the relicensing website in a spreadsheet format.	The attached tables and figures (Study 3.3.11 Attachment C, Word Document, and Study 3.3.11 Attachment C, Excel) summarize length and weight data. The Word Document, which includes tables and figures was developed from the data contained in the Excel spreadsheet. The Excel spreadsheet is being filed separate from this document.
MADFW-1	Electrofishing catch data should be reported based on shock time not distance as the time it took to shock the "standard" shoreline distance of 500 m varied dramatically in the study (50% in early summer and 60% in late summer according to an USFWS analysis). Data should be re-analyzed to reflect this measure of effort.	The attached tables (Study 3.3.11 Attachment A) include Catch Per Unit Effort (CPUE) using time instead of distance.

Commenter	Comment	Responses
MADFW-2	According to the report, QHEI indexes the types and quality of substrate, instream cover, channel morphology characteristics, riparian zone extent and quality, bank stability and condition, gradient, and pool-riffle-run quality and characteristics. The report provides none of the field data that were collected and used to calculate QHEI scores at each station. The Division requests that those data be included in the report and provided on the relicensing website via spreadsheet format.	The attached matrix table (Study 3.3.11 Attachment B) summarizes the QHEI scoring attributes
MADFW-3	While lengths and weights were taken on sampled fish, those metrics are not discussed in the body of the report. The only reference to those data is provided in a table on page 128 of the report and the data are presented by species for all stations combined. We request that FL provide length and weight data for each species collected by season and station and make the raw data available on the relicensing website in a spreadsheet format.	See USFWS-3.
TNC-1	Our first comment is in response to a statement made at the Study Report Meeting on March 16, 2016. At this meeting, FirstLight stated that some areas where they sampled "didn't meet IBI criteria" (Study Report Meeting Summary, p. 8). The meaning of this statement is unclear, as FirstLight was not asked to conduct an IBI. We are concerned that there were some additional sampling criteria used that were not stated explicitly in the report and that might bias results. For example, if FirstLight only sampled "river bends with stretches of rich, suitable substrate (i.e., gravel/cobble/boulder), object cover or vegetation that provided good fish habitat" when "much of the shoreline in the upper TFI was relatively barren of optimal cover and substrates" (as stated on p. 2-3 of the Study Report), such targeted sampling could severely bias the fish distribution results and negate the intention of the stratified-random sampling design. Only sampling "good" fish habitat when there is little of this habitat will bias results toward over-representing this "good" habitat and therefore the fish community at these sites. We ask that FirstLight please clarify the meaning of these statements and fully document all sampling criteria that were used.	FL did not conduct an IBI study. No IBI metrics have been generated from these data. However, as stated on p 2-3 of the report: *Because one of the study goals was to compare data to historic surveys, methods developed for a recent comprehensive Connecticut River fish assemblage boat electrofishing survey (MBI, 2014; Yoder, et al., 2010; Yoder & Kulik, 2003) were followed*." Although FL was not directed to conduct an IBI study, the licensee <u>was</u> asked to make comparisons to historic data. Since the most recent and quantitative historic study followed IBI sampling protocols, it is logical to use the same or similar methods to provide data that support the requested quantitative comparison. FL did not "only sample river bends with stretches of rich, suitable substrate". As stated on p 2-3 of the report: Yoder (2002) states that "Individual sampling sites are located along the shoreline with the most diverse habitat features in accordance with established methods .... This is generally along the gradual outside bends of large rivers". Seventeen candidate electrofishing stations with these features were identified, with four, four, and nine stations in the upper, middle and lower strata, respectively. For each of the two sampling events, two stations were selected at random from among the candidate sites from each stratum for electrofishing sampling…". Such sites typically have the highest species richness, and therefore were important sources of data for meeting study objective 1 (Document species occurrence, distribution, and relative abundance of resident and diadromous fish within the study area along spatial and temporal gradients), as such sites would optimize species richness and therefore increase the likelihood of detecting the most species present. This strategy benefited this study objective, as evidenced by the fact that this study detected more species than any prior fish surveys of the study area. As further stated on p 2-3 of the report: "Two additional electrofishing stations were randomly selected within each stratum from the remainder of the relatively uniform and barren shoreline areas." Thus the number of stations comprised of relatively barren habitat was equal to those comprised of the richer habitat where generally greater species diversity could be expected. It is therefore unlikely that the sampling site selection biased the results. Appendix A of the report contains additional discussion of sampling station selection.

Commenter	Comment	Responses
TNC-2	The remainder of our comments are primarily related to the second stated objective, particularly the piece related to describing the distribution of fish species in relationship to habitat. FirstLight chose to use an index to describe habitat, the Qualitative Habitat Evaluation Index (QHEI). However, we contend that this index, at least in the way it is presented in the report, obscures the actual habitat qualities such that it is not possible to understand patterns of fish distribution in relationship to habitat characteristics. Biologically speaking, the relationship of fish to habitat is more complex than a single numeric value. Indeed, the QHEI is dependent upon data describing "the types and quality of substrate, instream cover, serval characteristics of channel morphology, riparian zone extent and quality, bank stability and condition, and pool-run-riffle quality and characteristics," as stated in the Study Report. However, it was not clear in the report how the QHEI value was calculated and what it represented, how individual habitat characteristics contributed to the score at each site, or what the distinctions were between sites of "poor" and "rich" habitat quality. As it stands, QHEI is not an adequate representation of habitat since the definition and characteristics of habitat are limited to the view of the biologist developing the index. It therefore does not meet the stated objectives to "describe the distribution of resident and diadromous fish species within the reaches of the river and in relationship to habitat." To do so, FirstLight should evaluate fish distribution by component habitat metrics, and at the very least, provide the data of the component metrics to increase the transparency of the results and conclusions.	The distribution of fish species within reaches and relation to habitat was discussed in section 5 of the report. Information summarizing QHEI components is summarized in the attached table (Study 3.3.11 Attachment B), and copies of individual QHEI raw field data sheets are provided. Regardless of the QHEI, as noted in the report, fish species distribution was related to habitat conditions. There is a gradient of habitat in the TFI from lotic conditions in the upper third to lentic conditions below French King Gorge. The upstream stratum of the TFI was dominated by smallmouth bass and fallfish, whereas the lowermost stratum of the TFI which is lentic in nature is dominated by pond-dwelling species such as bluegill, pumpkinseed and yellow perch. Largemouth bass (another pond-dwelling species) were more common than smallmouth bass in the lower TFI, whereas smallmouth, are more common than largemouth in the upper TFI. Fallfish and smallmouth bass prefer habitat with gravel and cobble substrate, free of fines (Scott & Crossman, 1973), which are more abundant in the upper impoundment, whereas sunfish and largemouth bass prefer lentic conditions (Coble, 1975; Heidinger, 1975; Trial *et al*., 1983), and substrates dominated by fines, as well as aquatic vegetation and dense debris cover, which are characteristic of the lower impoundment but absent further upriver. Habitat generalists, including spottail shiner and yellow perch were both dominant and generally evenly distributed throughout the impoundment area. This pattern of species distribution was consistent with observations by MDFG (1978).
TNC-3	We also request that FirstLight please provide the length and weight data collected for sampled fish in spreadsheet format on the relicensing website.	See USFWS-3.

Study No. 3.3.12 Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream from Cabot Station

Commenter	Comment	Responses
NMFS-1	To better quantify the effects of spillway and log sluice operation on sturgeon spawning, the report should bin velocities (e.g., < 1 ft/sec; 1-4 ft/sec; > 4 ft/sec) vs spawning habitat (square meters) for each model run. To better quantify effects to early life stages, the report should summarize the amount of substrate (square meters) that becomes mobile for each model run.	FL plans to perform these analyses and will include them in the Biological Assessment for Shortnose Sturgeon prepared for the Project.
NMFS-2	The Licensee states: While flow from Turners Falls Dam and other sources have their own accuracy variation and steady-state conditions rarely exist, calibration to measured WSELs were generally in the ± 0.25 ft during the calibration periods (close to steady-state conditions) that were used during model development. The model also achieved a calibration to measured velocities generally in the ± 15% range. While both calibration standards are acceptable, no data is provided to verify the accuracy. Also, both water depth and velocity are directly related to bed shear stress. The report should discuss the implications of these parameters variance on the results from the sediment transport analysis.	Detailed information on the calibration to the measured water depth and velocity will be available in Study Report 3.3.1 which will be filed with FERC on October 14, 2016. The sensitivity of the calibration and the effects on these parameters will be provided in the amended Final License Application.
NMFS-3	The Licensee states: A common way to determine substrate mobilization potential is by comparing a location's shear stress to the critical shear stress of the substrate found at that location. There are numerous ways to evaluate sediment transport. Please provide a citation or further explanation of the methods used in this study.	The basic premise of the methods used in the study methods are: "Critical shear stress is the shear stress required to mobilize sediments delivered to the channel. When the shear stress equals the critical shear stress, the channel will likely be in equilibrium. Where shear stress is excessively greater than critical shear stress, channel degradation will likely result. Where the shear stress is less than critical shear stress, channel aggradation will likely result." See Appendix O of the Stream Geomorphic Assessment Handbook by the VT Agency of Natural Resources which is included as Study 3.3.12 Attachment A.

Commenter	Comment	Responses
NMFS-4	The Licensee states: Critical shear stress is the shear stress at which a particle has a 50% chance of being mobilized from the river channel. This is incorrect. Critical shear stress of a particle is not a probability function. The report should depict the equations that are used to calculate Shear Stress and Critical Shear Stress.	As noted on page 56 of *Sedimentation Engineering* (ASCE Technical Manual 54, Vanoni, updated 2006), "Near critical conditions the motion of grains in any small area of bed occurs in gusts whose incidence increases as the mean shear stress increases. Observation of a large area of a sediment bed when the shear stress is near the critical value will show that the incidence of gusts of sediment motion appears to be random in both time and space. This suggests, as observed by Shields (1936), that the process of initiation of motion is statistical in nature. Einstein (1942) was the first to develop a transport relation based on statistical concepts." Furthermore, as also stated in Vanoni (2006), Gessler (1965 and 1970) found that dimensionless critical shear stress τ_{*c} (which is directly relatable to critical shear stress τ_c) and thus particle movement is a probability function, where critical shear stress τ_c was defined as the value that related to a 50% probability of particle motion. We adopted this definition for our study, and were simply noting that not all particles become immediately mobilized the moment the bed shear stress exceeds the study-identified mobilization thresholds. Particle movement occurs when the directional forces (shear) begin to overcome inertia and frictional forces. The shear stress at this threshold is referred to as critical shear stress. However, it is impractical to provide one critical stress value even for equally sized particles since the position of particles and the fluid force vectors on the particles are not the same. This simplified assumption also does not take into account shear stresses caused by bed forms or bed slope. For simplicity purposes, this study defined critical stress as when a particle has a 50% chance of being mobilized. We also recognize, however, that the sediment transport literature varies and other studies, including some noted in Vanoni (2006) such as White (1940), maintain that there is a single fixed critical shear stress for any given particle. To conclude, we believe that the differing critical shear stress definitions do not materially impact the critical shear stress thresholds that were used in this study.
NMFS-5	The Licensee states: We arbitrarily chose 10 mm as the cutoff point to switch between the two equations. We request further reasoning for this switch to another set of empirical data.	The relation between grain diameter for entrainment and shear stress using the Shields relation used the trendlines as shown in Study 3.3.12 Attachment B. For grain size diameters above 10 mm, the Colorado data trendline was judged to be more accurate than the limited data points above 10 mm for the Leopold, Wolman, and Miller, 1964 trendline. This figure is from Chapter 11 Rosgen Geomorphic Channel Design of the Stream Restoration Design National Engineering Handbook, published by the US Department of Agriculture, Natural Resources Conservation Service. While we recognize our 10 mm cutoff threshold is arbitrary, the 10 mm threshold represented our best attempt at combining multiple potential incipient motion thresholds that were derived from differing datasets.
NMFS-6	Figure 3.3.2-2 There is no mention of how this data was collected in the report. What methods were used? Are there particle size distributions available? More information is necessary to evaluate the adequacy of the sediment transport analysis.	Substrate data were collected as part of the IFIM study. Substrate data were characterized by the dominant substrate at a given location - no particle size distribution data were collected. Sediment size was typically characterized during low flows when much of the reach was wadeable. Some of the deeper areas had to be characterized via boat using a metal probe or a weighted braided line dropped to the riverbed.
NMFS-7	Figures 4.3.1-1 to 4.3.1-9 The difference in velocities for each of the scenarios is apparent, but the effect on shortnose sturgeon habitat is not clear to the reader. The figures should bin velocities based on shortnose sturgeon preferred habitat of 1 to 4 fps. If baseline velocities are within the preferred range and emergency gate spill scenarios are outside the preferred range, the area of potential affect should be shown. In addition, if negative effects are determined, the habitat area change should be quantified.	FL plans to update these figures and include them in the Biological Assessment for Shortnose Sturgeon prepared for the Project.

Commenter	Comment	Responses
NMFS-8	Section 4.3.3 The Licensee states: River 2D model results are representative of conditions throughout the modeled area except in areas within 150 feet of the Cabot Station and the emergency spillway gates. We don't understand the reasoning for this exclusion of results. Please verify that this information will be explained in Study 3.3.1. Does the Licensee mean 150 feet from the gates or the apron of the spillway? If this data is excluded, why is it shown in all the figures?	River2D is a two-dimensional, depth average model resulting in less accuracy in areas where vertical flow distributions are a major component of the velocity field. While the River2D model has less accuracy near the apron of the spillway, the information shown in these areas in the figures is indicative that sediment mobilization would generally occur in this area during the modeled spillway operations.
NMFS-9	Figures 4.3.3-1 to 4.3.3-9 The figures clearly show that spill from the emergency gates increases sediment mobility potential for most, if not all of the scenario comparisons. The Licensee should quantify the affected area to determine the effects of spill from the emergency spillway gates.	FL plans to perform these analyses and will include them in the Biological Assessment for Shortnose Sturgeon prepared for the Project.
NMFS-10	Section 5 The discussion section does not evaluate the lack of sediment input from upstream reaches. The absence of sediment recruitment, other than suspended load, to the spawning beds may exacerbate the effect of mobile sediment during emergency spill gate operations at Cabot Station. In addition, the effects of bedform or sediment composition should be discussed.	Evaluating sediment input from upstream areas is outside of the scope of this study. Additionally, if there is a lack of sediment recruitment from upstream, then there would likely be less area and volume of sediment in the study area, and therefore less potential for sediment mobilization due to emergency spill.

Study No. 3.3.18 Impacts of Turners Falls Canal Drawdown on Fish Migration and Aquatic Organisms- Addendum

Commenter	Comment	Responses
USFWS-1	Based on the approved study plan, only objectives 2 and 3 have been completed to date. Study objective 1 requires results from Study 3.3.3 (Evaluate Downstream Passage of Juvenile American Shad) and 3.3.5 (Evaluate Downstream Passage of American Eel) and those study reports have yet to be issued. Objective 4 calls for evaluating measures to minimize aquatic organism population impacts of the canal drawdown. The March 31, 2015 study report identified two potential measures to enhance aquatic organism survival: (1) conducting the rate of canal drawdown similar to how it occurred in 2014 to allow time for fish to egress the canal and for mussels and sea lamprey ammocoetes to burrow into sediment; and (2) placing cones in areas where heavy machinery travels and directing equipment operators to stay within these established boundaries to minimize the impacts to aquatic organisms due to vehicular traffic. However, these measures do not address the impacts of dewatering more than 90 percent of the canal or stranding in isolated pools. Given the above, the Service requests that FERC direct FL to provide another addendum that addresses study objective 1 and initiate consultation with the agencies on potential minimization or mitigation measures to address impacts of the drawdown to aquatic organisms. For example, report data indicate that hydraulically connected pools had improved fish survival (sampling mortality section); therefore, FL could assess measures to enhance fish survival by increasing pool connectedness. Other means to reduce the impacts of the drawdowns need to be considered, given the large number of impacted organisms resultant from existing drawdown practices.	FL plans to address this evaluation as part of Study Report 3.3.3 (Evaluate Downstream Passage of Juvenile American Shad) and 3.3.5 (Evaluate Downstream Passage of American Eel). These two reports will include a comprehensive analysis of study results from several different species specific studies. Results related to entrainment will also be analyzed in Study Report 3.3.7 Entrainment Study. Once the study results from Studies 3.3.3 (Evaluate Downstream Passage of Juvenile American Shad) and 3.3.5 (Evaluate Downstream Passage of American Eel) are complete, FL will discuss potential mitigation alternatives with the stakeholders, if needed.

Study No. 3.3.20 Ichthyoplankton Entrainment Assessment at the Northfield Mountain Project

Commenter	Comment	Responses
USFWS-1	3. Methods, Analysis The study used the actual water withdrawn by the facility to estimate entrainment during the sampling weeks. Was this water withdrawal profile "typical" of facility pump back and operation during a spawning period? The Service recommends that FL calculate ichthyoplankton entrainment for a number of scenarios, including: (1) entrainment based on the actual pumping operation during the 2015 sample period; (2) entrainment based on "typical historical" pumping operations during the shad ichthyoplankton period (generally calculated from some number of pumping profiles from recent past ichthyoplankton season operation); and (3) entrainment based on pumping operation during the shad ichthyoplankton period under FL's proposed expansion of the Upper Reservoir's operating range.	Note that on April 25, 2016 FL had a conference call with NMFS, USFWS, FERC and MADFW to discuss the 2015 Ichthyoplankton study. FL agreed to conduct additional sampling in 2016 as ichthyoplankton abundance can vary widely year to year. Since additional data will be collected in 2016, FL is proposing to make a supplemental report available no later than December 31, 2016 (hereinafter referred to as the "2016 report") that summarizes the findings collected in 2016. The study will be conducted similar to the 2015 study except sampling will occur once per week at whatever pumping flow occurs that evening and no attempt will be made to manipulate the flows as required in last year's study. FL also agreed to conduct offshore sampling (three tows) every night an entrainment collection is made. As requested by the resources agencies and specified in the RSP, some of the samples collected in 2015 were random (sampled pumping scenario without adjusting) and some were non-random (adjusted pumping for the study). The 2015 entrainment estimate was based on actual pumping in 2015. FL will include the "typical historical" pumping scenario and the pumping based on the proposed expansion of the Upper Reservoir's operating range in the 2016 ichthyoplankton entrainment report.
USFWS-2	3. Methods, Analysis Due to the low numbers of eggs and larvae collected, the two sample locations (service water pipe and at the lower reservoir intake) could not be statistically compared. Therefore, we do not know whether ichthyoplankton densities at the service water pipe were representative of densities at the intake. Further, the intake samples were not collected in the manner described in the Study Plan; rather than doing the approved oblique tows, FL did mid-depth tows. This variance to the Study Plan could be one reason for the very low ichthyoplankton densities observed at the intake over the course of the study.	The report indicated mid-depth tows for the intake samples, however, step-wise oblique tows were actually conducted. These tows consist of deploying the plankton nets for about 2 minutes on the bottom, 2 minutes at mid-depth, and 2 minutes near the surface. A depth meter and an inclinometer were used to insure the nets were towed near the bottom.
USFWS-3	4. Results Table 4.0-1 is consistent with Table 4.1-1 regarding the number of pumps in operation during a given sampling event. However, Table 4.1-2 shows one more pump in operation for sample Nos. 4, 7 and 19, compared with Tables 4.0-1 and 4.1-1. Also, samples 7, 8 and 9 in Table 4.2-1 show a date of June 17, 2015, while the text (Section 4.2) and the other tables show a date of June 18, 2015. These discrepancies should be clarified or corrected.	The discrepancies occurred from the date changing during the sampling period. Corrected Tables 4.1-2 and 4.2-1 can be found in Study 3.3.20 Attachment A and Study 3.3.20 Attachment B.

<table>
<tr><th>Commenter</th><th>Comment</th><th>Responses</th></tr>
<tr><td>USFWS-4</td><td>5. Discussion
FL states that the low shad ichthyoplankton densities at the NMPS Project are most likely explained by the location of the actual spawning area, which was determined to be in the vicinity of Stebbins Island (at the upper extent of the TFI). The Service disagrees with this explanation for the following reasons:

• It does not take into account the results of the 1992 entrainment study conducted by Lawler, Matusky, and Skelly Engineers (LMS 1993). Presumably shad are using the same spawning sites they did in 1992 (Study Report 3.3.6 notes that many of the active spawning sites identified in 2015 downstream of the Turners Falls Dam were sites documented in previous spawning studies conducted decades ago). Therefore, assuming some degree of spawning site fidelity and noting that roughly the same number of adult shad passed Turners Falls gatehouse in 1992 as passed in 2015 (60,089 and 58,079, respectively), it is reasonable to expect that estimated ichthyoplankton entrainment in 2015 should be somewhat similar to what was calculated in 1992. This assumption is also supported by juvenile index values calculated by the Connecticut Department of Marine Fisheries that were similar for both years (7.2 for 1992 and 8.5 for 2015). However, the data we summarize in Table 2 below show a marked difference between the two studies.

Table 2. Comparison of shad egg and larval entrainment at Northfield Mountain Pumped storage project between two studies.
<table><tr><th></th><th>Egg</th><th>Yolk-Sac Larvae</th><th>Post Yolk-Sac Larvae</th></tr><tr><td>LMS Study (1992)</td><td>1,175,900</td><td>744,000</td><td>10,525,600</td></tr><tr><td>FL Study (2015)</td><td>2,481,463</td><td>523,637</td><td></td></tr></table>
• Stebbins Island was documented as a spawning area in Study 3.3.6 through splash counts. While splash counts have been used in past studies as a surrogate for direct spawning observations, below-surface spawning has been documented in other studies (Layzer 1972; TransCanada 2016). Therefore, it is entirely possible that shad are spawning in more downstream locations within the TFI. Just because FL only collected ichthyoplankton data from the Stebbins Island site does not mean eggs and larvae were not present in downstream areas of the impoundment (including in the vicinity of the NMPS intake).

• The above-mentioned delay in starting the sampling and resultant lower egg and larval densities showed that spawning started well before sampling began.</td><td>The USFWS compares results of the 1992 entrainment study conducted by LMS with the 2015 entrainment study conducted by FL. They indicate that the results of the two studies should be similar. However the two studies were not similarly conducted. LMS calculated entrainment based on nearfield sampling with ichthyoplankton nets near the intake, while the 2015 study sampled the actual water pumped as EPA requires to determine ichthyoplankton entrainment at steam electric facilities. LMS specified in their final study report that sampling results indicated that their sampling gear was not as effective in collecting shad eggs and yolk-sac larvae as it was in collection of post yolk-sac larvae and that their assumption that post yolk-sac larvae are entrained in proportion to their concentration in the water column may lead to an overestimation of actual entrainment impact. By sampling the actual water pumped as was done in the 2015 FL study, there was no need to assume that ichthyoplankton densities in the river were similar to densities in the actual pumped water which most likely led to a more accurate ichthyoplankton estimate.</td></tr>
<tr><td>USFWS-5</td><td>Service Recommendations
Given the deviations to the approved study plan (delay in initiating sampling, failure to use oblique tows for intake sampling), the inability to validate that the service water pipe samples are representative of actual entrainment, and the overall low numbers of eggs and larvae collected throughout the study period, particularly at the offshore sampling site, the Service strongly recommends that FERC require FL to conduct a second year of study.</td><td>See USFWS-2. Oblique tows were conducted. FL has agreed and has begun a second year of study. Ichthyoplankton abundance varies widely year to year and the second year of study should provide information on this annual abundance variation.</td></tr>
<tr><td>NMFS-1</td><td>Methods
The Ichthyoplankton Entrainment study was not conducted in accordance with the study plan FERC approved on January 22, 2105. The study deviated from the approved plan in both timing of study commencement and methodology of offshore sampling. Based on the approved study plan, sampling should have commenced once 5,000 shad had passed the Turners Falls Gatehouse fishway or by May 21st, whichever came first. Passage at the Gatehouse fishway reached the 5,000 shad trigger on May 13th, however sampling did not begin until May 28th, with validation sampling at the intake not beginning until June 9th. Daily shad passage counts at the Gatehouse window indicate that cumulatively, 45,377 shad had passed by the time entrainment sampling began on May 28th and 54,010 shad had passed by the time offshore sampling commenced on June 9th (Figure 1). The entire run of American shad counted at the Gatehouse window was 58,079. Therefore, 78% of fish had already passed at Gatehouse by the time the study began and approximately 93% had passed by the time offshore sampling commenced on June 9th. This timing is a significant deviation from the requirements in the approved study plan and resulted in the loss of several weeks of data collection.</td><td>FL acknowledges that the study was begun later than the RSP assumed. Since the sampling was conducted inside of the Northfield Mountain and requires formaldehyde as a preservative, FL safety requirements require a chemical hood for the formaldehyde. The chemical hood was ordered well before the planned start of the study, however it was on back order and did not arrive in time for the start of the study. As soon as the hood arrived it was installed and sampling commenced. The validation samples were collected as outlined in the RSP.</td></tr>
</table>

Commenter	Comment	Responses
NMFS-2	Methods The study also deviated from the approved plan in the sampling method used for offshore ichthyoplankton sampling at the intake channel. The study plan required bongo nets be towed "obliquely, from bottom to surface" for approximately six minutes or until at least 100 cubic meters of river water was sampled. However, bongo net tows were actually conducted at "mid- depth", disregarding data collection throughout the water column as required. This method of sampling could potentially account for the low ichthyoplankton densities in the towed samples. Since this variation in study methodology could potentially have affected the results, we recommend a second year of studies be conducted to ensure sampling is done properly across the entire study period, as required. On the conference call that was held on April 25th, 2016, FirstLight indicated that tows were conducted according to the agreed upon plan. The final report should accurately explain the bongo sampling technique that was used.	See USFWS-2.
NMFS-3	Methods According to the study plan, FirstLight was required to validate that densities collected at the service water pipe were representative of densities at the intake tunnel through paired sampling of both the service water pipe and the intake/tailrace channel. Due to the low number of eggs and larvae collected, the two sample locations could not be statistically compared and this validation could not be made. Over the course of the study, the sample size was relatively low with 23 entrainment samples and 12 validation samples being collected. When the samples are broken down under multiple pumping scenarios, it only allowed for sampling to be conducted for one to three sample dates. We recommend the second year of studies focus on collecting a larger sample size, particularly with the offshore intake samplings. The offshore sampling should be occurring concurrently with service water intake sampling. A larger sample size collected using the proper timing and methodology may allow for a more robust analysis.	As discussed on the conference call on April 25, 2016, FL has agreed to collect 3 intake samples each time the entrainment samples are collected. See USFWS-1.
NMFS-4	Study Report Discussion The study report does not provide any discussion on the Lawler, Matusky, and Skelly 1992 entrainment study (LMS 1993). This study was conducted to estimate the number of juvenile shad the Northfield Mountain Project entrains in order to provide a basis for calculating the impact of the facility on the shad population (LMS 1993). Similar numbers of shad had passed the Turners Falls Gatehouse fishway in 1992 and 2015, 60,089 and 58,079 respectively; however, there were significant discrepancies in estimated ichthyoplankton entrainment, particularly with regards to the number of entrained larvae. The 2015 relicensing study found approximately 500,000 entrained larvae, whereas the 1992 study found 20 times more entrained larvae with an estimate of over 10 million (LMS 1993). The discrepancies between entrainment of shad larvae between the 1992 and 2015 studies should be further evaluated and used to inform a second year of ichthyoplankton entrainment studies.	See USFWS-4.
NMFS-5	Study Report Discussion The study report suggests the lower ichthyoplankton densities can be explained by the location of the spawning area being far upstream of the Northfield Mountain Project, referring to the Relicensing Study 3.3.6, Impacts of Project Operations on Shad Spawning, Spawning Habitat and Egg Deposition in the Area of the Northfield Mountain and Turners Falls Projects (shad spawning study). Based on our review of the shad spawning study, we do not agree that this conclusion is supported. Though the shad spawning study only observed splash counts in the Turners Falls Impoundment immediately downstream of Vernon Dam near Stebbins Island, as stated in our comments in Attachment A, this study can only confirm where spawning activity was observed, and cannot conclude spawning did not occur elsewhere in the river, including in the vicinity of the Northfield Mountain Project. Even the shad spawning study report states that "it is possible, and perhaps likely, that shad spawning occurred at times when no surveys were conducted, as well as at locations that were not identified by field crews". Below-surface shad spawning has been documented (Layzer 1974) and these spawning activities would not have been detectable through the data collection methods used for the shad spawning study. Furthermore, the 1992 study also identified spawning sites near the Northfield Mountain Project (LMS 1993), and shad tend to have some degree of spawning site fidelity (Hollis, 1948, Hendricks, *et al*, 2002, Nichols, 1960). Therefore, we disagree with the report's finding that suggests low shad ichthyoplankton densities were due to the lack of shad spawning in the vicinity of the Northfield Mountain Pumped Storage Project.	See USFWS-4.

Commenter	Comment	Responses
NMFS-6	Proposed Project Operation Modifications Under the Draft License Application, FirstLight proposes to increase year round operating range at the Northfield Mountain Pump Storage Project from a range of 938 ft- 1000.5 ft to a range of 920 ft- 1004.5 feet. This would result in a longer duration of pumping events. The study report neither studies nor evaluates how this new proposed operating range would potentially affect shad ichthyoplankton entrainment. This proposed change was not known during the study plan phase of the project, which may explain why this evaluation is not included in the current study report. This proposed modification to project operations would further support the need for a second year of ichthyoplankton entrainment studies. The second year of studies should include an evaluation of the proposed change in operating range on ichthyoplankton entrainment at the site.	This will be included in the 2016 Ichthyoplankton Study Report.
CRWC-1	The start of the study was well after the initiation of spawning. Ten thousand shad passed the Gatehouse fishway on May 13. Entrainment surveying did not begin until May 28, fifteen days later.	See NMFS-1.
CRWC-2	The number of pumps evaluated was not evenly distributed during the period of the study. To evaluate the effect of pumping, the number of pumps tested (1 to 4) should have been tested equally through the period to account for unequal availability of eggs/larvae.	Sampling was conducted as described in the RSP.
CRWC-3	The report did not relate entrainment in 2015 to the "normal' year of pumping, or river flow.	See USFWS-1.
CRWC-4 3/25/2016 filing	From CRWC 3/25/2015 Comment Letter: Please provide the total time of pumping with 1, 2, 3 and 4 pumps, by week, from May 15 to July 15 for 2015 and for the period from 2006 to 2014 for the equivalent weeks. Please also provide the total time by pump for the nights in 2015 when samples were taken with more than one pump operating.	FL is providing herewith a) the total time of pumping with 1, 2, 3 and 4 units from 5/15-6/15/15 (see Study 3.3.20 Attachment C and b) the total time by pump for the nights in 2015 when samples were taken with more than one pump operating (see Study 3.3.20 Attachment D).

Study No. 3.4.1 Baseline Study of Terrestrial Wildlife and Botanical Resources

Commenter	Comment	Responses
MADFW-1	MADFW provided numerous comments on the list of species in Appendices D.	As part of this filing, FL has corrected the list of species (see Study 3.4.1 Attachment A).

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

Commenter	Comment	Responses
USFWS-1	Invasive Plant Survey According to the approved study plan, aquatic invasive plants were to be documented using a sub-meter GPS unit to delineate the boundary of infestations. The report was to include field data in tabular format, including the species composition and estimated size of infestation. The only tabular summary of the invasive species data collected is a listing of the invasive species found in the TFI (Tables 4.2.2-5 and 4.4-1). While figures showing polygons of aquatic vegetation are provided, they only depict qualitative categories of submerged aquatic vegetation (SAV) density, with no reference to where invasive infestations occur within those beds or what percentage of the bed is comprised of invasives. The report should be revised to include more detailed information on invasive species observed, including figures explicitly showing the locations of invasive SAV beds and a tabular summary of invasives data (i.e., bed size, species composition, etc.).	Survey methods described within the MRSP state that "SAV and EAV beds will be surveyed from a boat with use of look-down buckets to aid in identification. SAV and EAV beds will have their perimeter surveyed or will have a center point GPS with a radius offset that will encompass the entire bed." A table describing the species identified within mapped SAV beds was provided in the current Study Report as well as mapping showing polygons of SAV beds which were field delineated using sub-meter GPS technology during field data collection in 2014 and 2015. The table describes the area occupied by SAV beds which fall into one of three density categories (sparse, medium, and dense). While not required by the MRSP, existing mapping has been modified to show which SAV patches have infestations of exotic SAV. Updated SAV mapping has been included in this response as Study 3.5.1 Attachment A.

Commenter	Comment	Responses
USFWS-2	Puritan Tiger Beetle The language in the report suggests that only 2012 WSE data were used in the analysis of project effects on PTB habitat, even though the hydraulic model was developed using data over a much longer time period. We request that FL clarify how both the 2012 water level logger data and below Cabot Station hydraulic model were used to assess operational impacts on PTB habitat. The Service would support using the 2012 data to validate the hydraulic model (given that the hourly time step of the hydraulic model is somewhat coarser than the 15-minute time step of the water level logger data), but do not believe it is appropriate to analyze impacts based on a single water year.	For the below Cabot Station hydraulic model, the water level just upstream of the Holyoke Dam is the downstream boundary condition. FirstLight tried, but was unable to obtain historical water level data as measured upstream of Holyoke Dam from Holyoke Gas and Electric, the owners and operators of the Holyoke Dam. As shown in Figure 4.6-3 in the study report, the downstream boundary water level used in the hydraulic model can make a difference in the water surface of between 1.2 and 0.5 feet at river flows less than 11,000 cfs at Rainbow Beach, the key location of the Puritan tiger beetles. As shown in Figure 4.6-4, the period of May 1 to October 1, 2012, contained a wide range of daily flow fluctuations as measured at the Montague USGS gage, especially representative of changes that could be controlled by FL. However, at points farther upstream, especially above the Route 116 Bridge, the effects of the downstream boundary becomes much less of an influence and is generally less than 0.10 feet. Due to inability to obtain downstream boundary water levels at the Holyoke Dam and since the 2012 data contained a large number of representative days, the 2012 data was determined to be most accurate and characteristic of the water level changes from flow variations at Rainbow Beach for this study.
USFWS-3	Puritan Tiger Beetle In addition, all models (Figures 4.6-3 through 4.6-11) should be limited to the period May through August. Adult beetles have typically died by late August, therefore inclusion of flow data from September may bias estimates of typical WSEs.	FL has committed to filing an addendum on this study by October 14, 2016 Given this ,FL agrees that the September data from the analysis should be removed from the analysis- this change will be included in the addendum.
USFWS-4	Puritan Tiger Beetle The report only provides figures from four transects. We recommend that FL analyze data from all of the transects to estimate the total amount of suitable habitat and the percent of time that habitat is unavailable based on operations data from May through August of 2008 through 2015.	The RSP did not call for a specific number of survey transects. The transects selected for inclusion were chosen to be representative of the habitat available at Rainbow Beach and a review of surveyed transect elevations at the northern, central, and southern sections of Rainbow Beach. Each representative transect was selected based on the general characteristics of the elevations observed on Rainbow Beach. The three transects used in the analysis cover the range of the vast majority of elevations observed, and therefore additional transects were not developed. Along the beach transect elevations are very similar with elevations ranging from 101.3 feet to 115.9 feet (average elevation of 104.6 feet) and therefore analysis of water levels was completed for a representative transect rather than for all 24 transect locations. All elevation data collected as part of the transect survey have been included as Study 3.5.1 Attachment B (Excel file). The Excel spreadsheet is being filed separate from this document.
USFWS-5	Cobblestone Tiger Beetle According to the approved Modified Revised Study Plan (MRSP), FL was to use a combination of hydraulic modeling and field data to assess effects of project related water level fluctuations on known and potentially suitable habitat for the CTB. However, the report does not include an assessment of water level fluctuation at the Montague site, nor does it provide an explanation for why the assessment was not completed. As the Montague site represents known, suitable habitat (albeit potentially currently unoccupied), the same analysis that was completed at Rainbow Beach and North Bank for the PTB should have been conducted at the Montague site for CTB.	In 2014 additional transects were established at the Rainbow Beach and North Bank locations, as cobblestone tiger beetles are presumed to be extirpated from the habitat near the confluence of the Deerfield and Connecticut River. FL agrees to establish additional transects (6) at the unoccupied habitat near the Deerfield confluence. Data will be collected in a similar manner to Rainbow Beach (i.e., RTK GPS). Transects will be analyzed in the same manner including an analysis of WSEL as well as the duration of inundation. This analysis will be included in the addendum described in USFWS-3.
USFWS-6	Cobblestone Tiger Beetle Re: This omission is a variance to the approved MRSP. In fact, a MRSP was required, in part, to incorporate recommendations of FERC and the NHESP with respect to this very issue. FERC's Study Plan Determination (SPD) confirmed that "assessing impacts on potential unoccupied habitat that might otherwise support viable populations of state-listed invertebrate species under modified flow regimes is just as important as an assessment of occupied habitat because this would allow us to develop appropriate, data-driven flow recommendations that may be needed to protect or enable use of potential unoccupied habitats." Further, the SPD recommended that FL incorporate additional transects in unoccupied areas with suitable habitat sufficient to permit assessment of how the quality and extent of both existing and potentially suitable habitat changes over a range of flows.	See USFWS-5.

Commenter	Comment	Responses
USFWS-7	Cobblestone Tiger Beetle The Service requests that FERC direct FL to collect elevation survey data at no less than six transects placed in suitable habitat at the Montague site during the 2016 field season. These data, in conjunction with the 2-D model developed as part of the IFIM Study No. 3.3.1, the Montague USGS gage water level logger data, and operations data from 2008 through 2015 for the months of May through August, should be used to assess project effects on CTB habitat. Results of the water level fluctuation evaluation at this site, and a discussion of those results, should be included in a revised Study Report submitted for public review and comment.	See USFWS-5.
MADFW-1	Cobblestone Tiger Beetle According to the MRSP, FL proposed to use a combination of hydraulic modeling and field data to assess potential effects of Project related water level fluctuations on known and potentially suitable habitat for the CTB. However, the report does not include an assessment of water level fluctuations at the known CTB site, nor does it provide an explanation for why the assessment was not completed. This is a variance from the MRSP as well as the FERC Study Plan Determination. The FERC Study Plan Determination recommended that FL incorporate additional transects in unoccupied areas with suitable habitat sufficient to permit assessment of how the quality and extent of both existing and potentially suitable habitat changes over a range of flows. Therefore, as this site represents known, suitable habitat for CTB, the same analysis completed at Rainbow Beach and North Bank for PTB should be conducted at this site for CTB. The Division reiterates that assessing how Project operations *have* or *may* potentially affect the quality and extent of habitat at both occupied and suitable, unoccupied sites is critical to developing data-driven flow recommendations. Therefore, the Division requests that FERC direct FL to **complete Task 6b (Water Level Fluctuation Evaluation) for this site per the MSRP.** Additionally, depending on the accuracy of data collected during development of the 2-D model, **collecting additional elevational data via transects placed throughout suitable habitat at this site may be warranted**. Results of the water level fluctuation evaluation at this site, and a discussion of those results, should be included in a revised report submitted for public review and comment.	See USFWS-5.
MADFW-2	Puritan Tiger Beetle According to the MRSP, FL proposed to use unsteady HEC-RAS hydraulic models, developed based on observed conditions that occurred from January 1, 2008 to September 30, 2015 for the reach between the Montague Gage and the Holyoke Dam. FL installed two water level loggers during 2012, one at the Route 116 Bridge in Sunderland and one near Rainbow Beach. FL states that the measured 15-minute interval WSELs in 2012 from the water level logger at Rainbow Beach were used to estimate effects of discharges from the Turners Falls Project on water levels at Rainbow Beach (up to the Project's maximum hydraulic capacity). The Division supports using the 2012 data to validate the hydraulic model for Rainbow Beach and the North Bank, given that the hourly time step of the hydraulic model is coarser than the 15-minute time step of the water level logger data. However, we do not believe it is appropriate to analyze operational impacts based on a single year of data. Use of multiple years will ensure data are fully representative of typical Project operations and weather conditions, capture the full range of variability seen from year to year, and refine model accuracy. Therefore, the Division requests that FERC direct FL to **clarify how both the 2012 water level logger data and the hydraulic model (from below Montague Gage) were used to assess operational impacts on PTB habitat.**	See USFWS-2.
MADFW-3	Puritan Tiger Beetle In assessing operational impacts to PTB, the hydraulic model and all data should be limited to the period spanning May through August of any year.	See USFWS-3.
MADFW-4	Puritan Tiger Beetle The report models the percent of time various WSELs are experienced at Rainbow Beach. We recommend that a similar analysis be provided for the North Bank PTB habitat.	An analysis of WSEL will be completed for the North Bank location, similar to the Rainbow Beach site. In addition, and as described above the analysis will now include a discussion of the duration of inundation. The analysis will be included in the addendum.

Commenter	Comment	Responses
MADFW-5	Puritan Tiger Beetle The report only provides figures for three of the twenty-four transects collected at Rainbow Beach, and one of the four transects collected at the North Bank. We recommend that FL include figures for all transects, and that FL analyze data from all transects to estimate the total amount of suitable habitat that is inundated at each flow at each site. Further, FL should provide estimates of the percent of time habitat is unavailable from May through August of each year from 2008 to 2015 on a monthly, annual and averaged (over 2008-2015) time step for both Rainbow Beach and the North Bank. Similarly, because even one large event during the adult active period may wash away adults and result in mortality and/or displacement of adult beetles, we recommend that the report include an assessment of how many times all or most (greater than 80%) of the suitable habitat at each site was inundated from May through August of each year from 2008 to 2015 when inflow is within Turners Falls generation capacity.	See USFWS-4.
MADFW-6	4.3 RTE Plant Survey- Transects Transects 1, 2 and 3 appear to have been oriented across the river. However, during a site visit conducted on October 22, 2014, representatives from FL and the Division agreed that transects would be oriented parallel to the river so as to capture minimum and maximum elevations of suitable habitat, both occupied and not occupied. It appears that transects were not oriented as discussed. We also agreed that a supplemental transects would be added at Second Island and Fourth Islands (oriented across the current), though it appears that these additional transects were not collected. The Division requests that FERC direct FL to **orient the transects as previously agreed and that associated hydrological assessments be revised.**	FL collected transect data both parallel and perpendicular to flow at locations 1, 2, and 3. While the perpendicular data is not based on a transect location, the lowest and highest locations of mapped RTE species were identified with the RTK GPS. The transect orientations differ from those recommended by the MADFW, however the locations that were selected in 2015 were intended to include as much area occupied by target RTE plant species in consultation with MADFW approved botanist Steve Johnson while in the field during the transect survey. In addition to the transect data, searches were made in 2015 at these three locations to identify the maximum and minimum elevation at which that species occurred. The entire population (i.e., polygon data) for each species was mapped during the 2014 growing season. FL has made all RTE plant transect data available to the MADFW in Study 3.5.1 Attachment C (Excel). The Excel spreadsheet is being filed separate from this document.
MADFW-7	4.3 RTE Plant Survey- Transects Mid-May through October represent the key months of the growing season where state- listed species grow, flower and set fruit. Most populations are mostly or entirely inundated, and are adapted to tolerate the spring freshets and decreasing water levels between June and October and are therefore less affected by flows typically observed during April and early May. Therefore, we request that **all figures showing transect elevational surveys and species distributions (e.g., Figure 4.3-9 and similar) be revised to exclude April and 1-15 May**	The specific timing for the data analysis was not described in the RSP. April was selected to show a high flow event and the relationship to occupied and unoccupied habitats at each of the transect locations. In several cases habitat is fully inundated during the April time frame. The months selected for the analysis were based on the potential of spring high flows as well as covering the majority of the growing season. The months selected for the analysis provide sufficient coverage of the growing season to determine potential Project impacts on targeted RTE plant species.
MADFW-8	4.3 RTE Plant Survey- Transects The Division requests that FERC direct FL to revise the report, and submit it for public review and comment, to provide information on within-day frequencies of WSEL fluctuations and how long each particular WSEL is inundated (e.g., duration of flooding).	This information will be provided in the addendum.
MADFW-9	4.3 RTE Plant Survey- Transects Per the MRSP (p. 12), at established transects, data was to have been collected related to substrate, including particle size, soil texture, and percent cover across the transect. Although the report provides a general description of habitat, it does not include substrate data or an explanation for why the data was not provided. Therefore, we request that FERC direct FL to revise the report, and submit it for public review and comment, **to include this data consistent with the MRSP.**	A qualitative description of substrate was provided for each of the Survey transects, the particle size was not collected as classifications such as silt, sand, cobble, gravel, and bedrock are descriptive of the habitats occupied or unoccupied by the species at each transect location. Based on the habitat observed during the survey, qualitative observations appeared to be sufficient to describe habitats where plants were growing. The RSP does not describe a specific method for determining particle size at the transect location and therefore a qualitative approach was taken to describe the habitat.
MADFW-10	4.3 RTE Plant Survey- Transects MADFW requested several revisions to the report regarding Transects 1-4, T-3, 5A, 5B, 6A-6C, 11A-11D.	This information will be provided in the addendum.

Study No. 3.6.1 Recreation Use/User Contact Survey

Commenter	Comment	Responses
CRWC-1	Accuracy of User Estimates One of the study objectives was to determine the amount of recreation use at the Turners Falls and Northfield Mountain recreation sites. In Study Report 3.6.1, FirstLight has estimated total recreation use to be 152,769 recreation days in 2014. Comparatively, TransCanada estimated recreation use in their Study 30, calculating annual use for the Wilder study area to be 234,400; Bellows Falls 312,531; and Vernon 72,388. Section 4.7.1 states that the user surveys indicate that the large majority of visitors to the Project live within 25 miles of the Project. TransCanada's study 30 also concluded that, "the overwhelming majority of visitors to the recreation facilities originate their trips from the towns immediately adjacent to the Projects." Parts of Hampshire County, including Northampton, are within 25 miles of the Project. Though Hampshire County was not considered to be part of the projection of project recreation days, the area around the Turners Falls and Northfield Mountain projects has a larger population than surrounding most if not all of the TransCanada sites. The estimated yearly use in Study 3.6.1 either indicates that the estimates are too low, or that the facilities are not drawing the kinds of recreational users that are possible for a region of this population.	The results of the FL and TransCanada (TC) recreation use studies are not comparable in the manner suggested by CRWC. The studies employed different data collection and analysis methods, consistent with their respective study plans, the results of which could produce varying estimates. For example, in estimating recreation users at the TC recreation sites, TC's study relied on traffic counters only, with no calibrations. Using traffic counter data without calibrating the recorder to observed use can over-inflate use estimates dramatically. For example, from TC's study text it seems that they have assumed 2 traffic counter counts per vehicle. By contrast, FL's calibration count data, combined with traffic counter data determined that average traffic counter counts per vehicle per visit was much higher than 2. As an example, as described in more detail below, at Pauchaug Boat Launch the summer average was 5.4 times per crossing (10.9 times per visit). That means that every 10.9 counts recorded on the counter accounted for a single vehicle visiting the site. In addition, TC's study used average group size, rather than the number of persons per vehicle (PPV), to estimate site use. The average peak season group size was 3.2 persons for the Vernon Project (group size was not customized by site). In comparison, FL's average PPV numbers were much lower. For example, at Governor Hunt, FL's average persons per vehicle ranged from 1.3-1.9, depending on the season. Combined, TC's higher group size and potential overestimation of vehicle traffic based on the uncalibrated counter data, would produce a much higher estimate of site use than if a lower group size or vehicle counts, based on calibrated traffic counter data, had been used, and suggests that overall TC's use estimates may be high. Further, FL would note that the length of the river reach occupied by the each of the three TC projects and the number of recreation sites and facilities evaluated as part of the TC study are variable and might also produce higher Project use numbers than at the FL projects. The FL projects occupy less than a 25-mile stretch of the Connecticut River, and counts were made at 22 recreation sites. The total river reach occupied by the TC projects is over 100 miles and recreation use was evaluated at nearly 50 sites. For this reason alone, it would be expected that the total recreation use estimated at the three TC projects would be much higher than at the two FL projects.
CRWC-2	Accuracy of User Estimates In some areas, such as Cabot Woods, where a stairway was removed to reduce recreational use of that area, or Poplar Street access site, where the site has been inadequate and allowed to deteriorate for years, or Cabot Camp, which has a building that was formerly used by the public but now is closed to the public, degradation/use restriction no doubt reduces demand.	FL acknowledges that at one time there was a staircase at the Cabot Woods site but there has been no staircase at the site since it was removed sometime before 1987. FL discourages swimming at this site due to dangerous river flow conditions and the fact that there have been previous drownings in this area. The site remains a popular site for anglers and for other uses, and use at this site was evaluated under the existing conditions, consistent with the RSP. Contrary to CRWC's statement, the "camp" building at Cabot Camp has never been available for public use and has generally only been used by the Licensee for business purposes. However, the road and parking area are open to public use and provide public access to the Turners Falls impoundment for a variety of recreation uses. Because there never has been public use of the "camp" building and because the site provides access to Project waters, the restriction on public use of the "camp" building has not reduced demand or use of the site. As set forth in the report for Study No. 3.6.3 Whitewater Boating Evaluation, 91% of participants in the boating evaluation rated the Poplar Street access as moderate/difficult access. In the FLA, FL has proposed to incorporate the Poplar Street Access area into the project boundary as a Project recreation site, and make improvements to the access at this site.
CRWC-3	Accuracy of User Estimates Comparatively, FirstLight's estimated annual use for the Governor Hunt Boat Launch/Picnic Area was 1,812, an order of magnitude lower than TransCanada's estimate (see Table 4.1.3-1 of Study 3.6.1). Table 4.1.3-2 estimates that recreational use at this site was 53% motor boating, 15% non-motor boating, 12% fishing, and 19% "unidentified." Picnicking and fishway viewing got 0%. Swimming was not a category that FirstLight evaluated at /any site, but may be part of the "unidentified" numbers. CRWC views the differences in the information collected about this site to be large, and requests that FERC attempt to evaluate whether each company in fact followed their respective RSP or if the methodology in the RSPs were flawed (particularly for FirstLight's sties that were assessed only by spot counts).	FL's estimates of recreation use at the Governor Hunt site cannot be compared with TC's estimates for this same site. As noted above in response to CRWC-1, the methods for estimating use at Governor Hunt are different, and TC's methods may have produced misleadingly high estimates. In addition, FL's study evaluated only a limited portion of the Governor Hunt site; the portion that lies within the FL Project Boundary. More specifically, FL surveyed and counted users who had boat trailers or boat racks on their vehicles, were launching or retrieving watercraft, or were portaging around the dam. FL did not count or survey users utilizing the picnic area, the picnic area parking lot or the fishway viewing area. This was intentional, and was consistent with the FL RSP. Therefore, comparison of FL's estimates of recreation use at the Governor Hunt site, cannot be compared with TC's estimates for this same site.

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<tr><th>Commenter</th><th>Comment</th><th>Responses</th></tr>
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<td>CRWC-4</td>
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<u>Accuracy of User Estimates</u>
CRWC requested and received traffic counter data used in the study from FirstLight. We looked at three of the popular recreation sites, summed the traffic counter data, and compared that to FirstLight's estimated annual use for these sites. See the table below. We did not evaluate counts at Cabot Woods because there were two entries for that site and we didn't know what that meant (in addition, we weren't sure how they subtracted out vehicles coming in and out of the Conte Fish Lab). We also did not look at the Poplar Street boat launch counter numbers because we believe the counter was put in the wrong location, and did not actually count all vehicles coming in and out of the site.

CRWC comparison of Traffic Counter data vs. estimated annual use
<table>
<tr><th>Site</th><th>Estimated Annual Use (2014) in Table 4.1.3-2</th><th>FirstLight Traffic Counter totals 5/23- 11/14/2014</th><th>CRWC estimated vehicle counts</th><th>CRWC Comments</th></tr>
<tr><td>Pauchaug Boat Launch</td><td>9,630</td><td>70,253</td><td>11,708 [a]</td><td>Our conservatively estimated # of vehicles exceeds FL's annual estimate of the site recreation use.</td></tr>
<tr><td>Boat Tour and Riverview Picnic Area</td><td>13,651</td><td>32,239 [c]is</td><td>8,059 [b]</td><td>Table 4.1.3-1 estimates winter use at this site is 17%, and traffic counter was removed 1 month into fall which gets 21% of use, so FirstLight must have estimated additional numbers.</td></tr>
<tr><td>State Boat Launch (at Barton Cove)</td><td>15,126</td><td>97,482</td><td>16,247 [a]</td><td>Our conservatively estimated # of vehicles exceeds FL's annual estimate of the site recreation use.</td></tr>
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CRWC has utilized FL's raw traffic counter data to make their own estimates of recreation use at several of the FL recreation sites and then has compared their estimates to FL's. In doing so, CRWC has taken only one of several data sources that FL used to develop its use estimates, and has ignored the other data that FL also used to make sound use estimates for each site. FL's estimates are based on a more thorough analysis of the data that includes use of both spot counts and calibration counts, as well as the traffic counter data. As described above in response to CRWC-1, use of traffic counter data without the calibration data is known to produce unreliable vehicle counts and, in turn, inaccurate use estimates. In general, uncalibrated traffic counter data is known to produce misleading recreation use counts. See e.g., Watson, Alan E.; Cole, David N.; Turner, David L.; Reynolds, Penny S., Wilderness Recreation Use Estimation: A Handbook of Methods and Systems (U.S Department of Agriculture, Forest Service: General Technical Report RMRS-GTR-56, October 2000).

For example, at the Pauchaug Boat Launch, CRWC assumed 1 person per vehicle and 6 traffic counter counts per visit. FL's estimates of persons per vehicle varied by season (Spring-1.3, Summer 1.5, Fall 1.5, and Winter-1.2) and in all seasons were higher than 1 person per vehicle. FL's traffic counter data in conjunction with the calibration counts indicated that vehicles were counted an average of 5.4 times per crossing in the summer (10.9 times per visit) and 6.8 times per crossing (13.7 times per visit) in the fall. As a result of these differences, FL's total traffic count estimate for this site was 9,007 for summer and fall (number not published in 3.6.1 report), as compared to CRWC's count of 11,708. Finally, in developing the total use estimate for each site, FL averaged the spot count totals with the traffic counter estimates, to produce a more rigorous estimate. At Pauchaug Boat Launch, FL's spot counts were slightly lower at 8,535 for the summer and fall combined, which produced a seasonal average use estimate that was lower than that produced using the calibrated traffic counter data alone. In short, CRWC's use of uncalibrated traffic counter data in combination with some simplifying assumptions produce different, but less rigorous estimates of the use at these three sites.

Regarding CRWC's question about why there are two traffic counter datasets for the Cabot Woods site, FL would note that two traffic counters were used at the Cabot Woods site because the access road to the parking lots (Migratory Way) is also utilized by the USGS Conte Lab staff. The first was located at the gated entrance to Migratory Way. This counter was intended to record all use traveling along Migratory Way; The second was located just prior to the access road for Conte Fish Lab and was intended to provide a count of Conte Fish Lab and Plant staff. However, in the end, because the traffic counters still only accounted for traffic into one of the two parking lots that serve the Cabot Woods area, use estimates for the Cabot Woods site utilized spot count data, with additional information from the calibrations and recreation user surveys, to estimate recreation use. In reviewing the use calculation for Cabot Woods, however, a calculation error was found and fixed that resulted in use estimates at this site decreasing by a very small amount (177 recreation days out of an annual total of more than 18,000). This resulted in minor corrections to tables in the report for Study No. 3.6.1. FL has provided the revised tables in both redline and clean versions in an attachment. See <u>Study 3.6.1 Attachment A</u>, Tables 4.1.2-1, 4.1.3-2, 4.1.3-3 and 4.7.2-4.

Regarding CRWC's concerns about the Poplar Street Access site traffic counter location and data, FL acknowledges that the traffic counter location at this site was not optimal, but no better site could be located due to the configuration of the site parking lot and entrance. Given the layout of the site entrance and parking area, FL acknowledges that it is possible that some vehicles may have eluded the traffic counter. However, we reviewed the traffic counter data, and felt that given the numbers of vehicles recorded that it provided a good estimate of vehicle use at that site. Moreover, as noted above, FL's site use estimates did not rely solely on the traffic counter data, but also utilized calibration count data to calibrate the traffic counter data, and also included the spot count data. As a result, FL believes that the use estimates for Poplar Street are sound.
</td>
</tr>
</table>

CRWC-5

Study omits one key use of Project Area: Swimming

CRWC suggests one of the major categories is "swimming." Swimming was not listed as a recreational use category in the calibration count sheets, and therefore swimming could not be noted down when observed by personnel conducting the spot count. According to Table 4.2-3, recreation survey respondents did indicate that they were swimming at the sites – 19 indicated that this was the primary activity, and a total of 93 indicated that they swam during their visit (surprisingly, 22 indicated doing so in the winter).

Consistent with the RSP, the recreation use count forms utilized by FL for both spot counts and calibration counts did not specifically list swimming as an activity. This was because for safety reasons, FL generally discourages swimming at the Project, and there are no formal swimming areas or swimming facilities provided at any of the Project recreation sites. However, the spot and calibration count survey forms used by FL did allow those conducting the counts to count swimmers, sunbathers, waders, and those informally using Project waters and record that use in the "other uses" category. So swimmers were accounted for in the recreation use estimates made for each site and in total.

Moreover, the User Survey which was designed to have the recreationists themselves identify which activities they were participating in that day, included swimming as a specified recreation use. The results of the User Survey allowed FL to provide a sound assessment of the portion of recreation users surveyed that did utilize the Project for swimming at each site, in each season, and in total. Of the 934 recreationists that responded to the question about what activities they were participating in that day, 19 included swimming as one of their activities on that day, 22 indicated they swam in spring, 34 in summer, and 15 in Fall (see Table 4.2-3 of the 3.6.1 Study Report). Based on these responses, the survey found that swimming occurred at 9 recreation sites at the FL projects. The table below provides a breakdown of the percentage of respondents that indicated that swimming was an activity they had participated in during their current visit, and in the spring, summer and fall seasons.

Table. Recreation Users Survey Results: Percent of respondents that indicated that they had participated in swimming as a recreational activity, during their current visit, by site and by season

Recreation Site	This Trip (n=19)	Spring (n=22)	Summer (n=34)	Fall (n=15)
Governor Hunt Boat Launch/Picnic Area	0%	11%	11%	0%
Pauchaug Boat Launch	5%	2%	5%	0%
Bennett Meadow Wildlife Management Area	0%	2%	2%	2%
Munn's Ferry Boat Camping Recreation Area	0%	0%	17%	0%
Boat Tour and Riverview Picnic Area	4%	0%	4%	2%
Cabot Camp Access Area	9%	9%	6%	6%
Barton Cove Nature Area	1%	0%	2%	1%
State Boat Launch	1%	1%	2%	2%
Unity Park	0%	0%	1%	0%
Cabot Woods Fishing Access	3%	3%	7%	5%
Total, Project-Wide	2%	2%	4%	2%

As shown in the table, for the current trip, swimming was most often reported at Cabot Camp Access Area (9%) and Pauchaug Boat Launch (5%). Project-wide, 2 percent of recreationists reported swimming on their current trip to the Project. In the spring, swimming was reported most frequently at Governor Hunt Boat Launch/Picnic Area (11%) and Cabot Camp Access Area (9%). Project-wide, 2% of those survey reported swimming in the spring at the site. As expected, summer swimming use as higher, with 17% reporting swimming at Munn's Ferry Boat Camping Recreation Area and 11% swimming at Governor Hunt Boat Launch/Picnic Area. Project-wide, 4% of recreationists surveyed reported swimming during the summer. Swimming responses declined in the fall, with Cabot Camp Access Area (6%) and Cabot Woods Fishing Access (5%) experiencing the highest percentages of reported swimming. Fall swimming was reported by 2% of those surveyed project-wide. . Of the recreation activities included on the Recreation User Survey, swimming ranks as the 13th most frequent response in the summer and the 17th most frequent for "this trip."

No respondents to the user surveys collected by FL reported swimming as an activity they participated in during the winter. The winter swimming use reported in Table 4.2-3, and noted by CRWC was determined to be the result of a spreadsheet calculation error, which has been corrected by FL. FL has provided this corrected table in both redline and final in an attachment. See Study 3.6.1 Attachment B Table 4.2-3

Commenter	Comment	Responses
CRWC-6	Potential error At the Station No. 1 fishing access site, cross country skiing is listed as 14% of the activities at this site in Table. This appears to be an error. The calibration count spreadsheet shows no cross country skiing at this location. This is not a practical activity at the site. It also estimates biking at this site to be 21% of the use. We reviewed the spot count record for this site, and on April 27, 2014, the spot counts indicated that 5 people biked to the site. We do not agree that the means of transportation to the site indicates the recreational use AT the site.	Recreation survey data collected for the Station No. 1 site included observed recreation use (spot counts and calibration counts) not just at Station No.1 but also in the Branch Canal area near Station No.1. The Branch Canal area includes open space, roads and pathways (including an old railroad bed) that are used by recreationists that participate in a variety of non-water-based activities including walking, hiking, jogging, as well as biking and X-C skiing. Recreation activities at this site were recorded, as observed, during both spot counts and calibration counts. Although only small numbers of bikers and X-C skiers were directly observed, because overall use of this site was quite low (1,264 annually), even small numbers of recreationists participating in a particular activity at the site translated into a notable percentage of recreation use for that activity. Hence, even a small number of observed bicyclists and X-C skiers produced the results noted by CRWC; that biking use at this site represented 21% of use and X-C skiing represents 14% of use.
CRWC-7	Assessing User Demand One of the study objectives was to determine the amount of recreation use and *demand* at the Turners Falls and Northfield Mountain recreation sites. Unfortunately, FirstLight only interviewed people who came to the facilities, which indicates that something about that facility appealed to them. They refused to interview people who did not show up because they found the facility faulty and went elsewhere. In contrast, the surveys done on the upper dams by TransCanada included contact with people who did not use the TransCanada facilities.	During Study Plan development CRWC requested that FL conduct a non-user survey of Project recreation use, including specialized user groups. FL disagreed with this approach and ultimately FERC determined that a non-user recreation survey was not needed for the FL Projects (FERC Study Plan Determination Letter dated 9/13/13). Subsequently, following up on a suggestion made by FERC in the SPDL, CRWC conducted its own recreation use study. See response to comment CRWC-8.

Commenter	Comment	Responses
CRWC-8	Survey of Connecticut River Watershed Council and Appalachian Mountain Club Members In an effort to gather additional information who may not use the facilities and/or who use them infrequently, CRWC and AMC developed an online survey using the TransCanada user survey as a starting point. In total we got 321 responses from CRWC and AMC members. Since they are members of the organizations, they are either biased toward an affection for the river or someone who is engaged with the outdoors already. Of our survey respondents, 72% regularly visit the sections of the Connecticut River under relicensing or Northfield Mountain and 27.7% do not. Of those who don't regularly visit this region, 34% said they prefer other areas with better opportunities and 52.9% cited other reasons. Of the 55 people who responded to the question about the kinds of recreational facilities and activities that would make them more likely to recreate on the Connecticut River included, the most popular answer was better and easier access sites and launch facilities for canoes and kayaks, and trails for hiking, biking, and birdwatching. Our survey asked respondents if they had ever portaged around the Wilder, Bellows Falls, Vernon, and/or Turners Falls Dams. Of the 158 people who responded to this question, we got 32 descriptions of the experience. Several of those responses indicated that the Poplar Street access was too steep and was not easily accessible. One respondent indicated a desire for access upstream of the Sunderland Bridge, but an inability to use the steep access at Poplar Street. Other responses pointed at portage length and there was a general comment about not being able to find the put-in and take-out points for any portages. Survey respondents indicated they found the following amenities important if they were made available: parking areas, road access to recreation areas, toilets, trash receptacles, tent campsites, boat access for canoes and kayaks, picnic sites, swimming/beach access, scenic views, wildlife viewing and nature trails, hiking trails, and biking trails. Of the 227 people who answered the question, 73.6% said fluctuating river levels on the Connecticut River have not affected their recreation experience and 23.8% said that river fluctuations have negatively affected their recreation experience. This answer has not been split out by project. Out of 60 people, 51.7% said they would prefer a smaller amount or range of fluctuation of river level and 41.7% said they would prefer more gradual or slower fluctuations.	FL has reviewed the survey and the results of the survey conducted by CRWC. Generally, FL believes the CRWC-AMC survey provides results that are quite consistent with the results of FL's recreation use study. A couple of findings specifically highlighted by CRWC are worthy of comment. First, FL would note that the survey conducted by CRWC was of its own members, as well as members of the AMC. As such, this was not a random survey of regional residents, and therefore (as CRWC acknowledges in its letter) the results are biased. Second, CRWC reports that of the 321 survey respondents, 72% reported that they regularly visit the sections of the Connecticut River under relicensing or Northfield Mountain. This means, that the large majority of the respondents ARE regular visitors to the FL (or TC) projects, and therefore likely would have also been captured in the FL and/or TC recreation use counts and user surveys. Of the 27.7% that do not regularly visit the FL or TC project areas, only 34% indicated that they preferred other areas with better opportunities. That means of the 321 survey respondents, less than 10% indicated that they did not use the FL or TC projects for recreation because they prefer other areas with better opportunities. This also means that approximately two-thirds of the respondents who said they do not recreate at the FL or TC sites didn't recreate at the Projects for reasons that have nothing to do with the recreational opportunities at the FL or TC projects. These results support FL's evaluation of recreation user demand (which incorporated population trends in the Project area) over the term of a new license. With respect to the responses that the Poplar Street access was too steep, we note that in the FLA, FL has proposed to incorporate the Poplar Street Access area into the project boundary as a Project recreation site, and make improvements to the access at this site. Otherwise the CRWC survey results seem generally consistent with those of FL's study. For example, CRWC's survey found that most recreationists using the Connecticut River in the vicinity of the FL and TC projects live in the region and come for the day. CRWC's survey also found that recreationists using the Project area participate in both water based (boating, etc.) and non-water based (hiking, biking, birding, etc.) activities. Respondents to CRWC's survey also indicated satisfaction with the quality of the existing recreation sites and facilities with 82% of respondents reporting that the Connecticut River facilities that they use are adequately maintained and the majority of respondents rating the quality as average or better than average. Other findings that are generally consistent with FL's findings are that among recreationists who participate in water based activities, access for canoes and kayaks and boat ramps are important facilities, while for non-water based activities, the most important facilities/amenities identified were hiking trails, wildlife viewing/nature trails, and scenic views/viewpoints. The CRWC survey results also demonstrated that the large majority of respondents (73.6%) said that water level fluctuations do NOT adversely impact their recreational use of the projects. As CRWC points out, this result has not been split out by project. Thus, of the 23.8% of respondents who said that river fluctuations have negatively affected their recreation experience, the CRWC-AMC does not provide any data to determine what percentage of these respondents felt that water level fluctuations at the FL project detracted from the recreation experience.
CRWC-9	Additional CRWC Observations Table 4.3-10 of that report shows that at Transect 4, which is downstream of the confluence of the Deerfield River near the railroad bridge, the daily change in elevation for the months of June, July, August, and September are 4.0 feet or greater 29%, 36%, 42%, and 38% of the time, respectively. This is the area of most dramatic river fluctuation, and we believe that it impacts recreation use of the river downstream of Cabot. The Recreation Use/User Contact Survey did not survey river users downstream of the project area, and we continue to believe this is an oversight.	During Study Plan development CRWC requested that FL conduct a survey of recreation users downstream of Cabot Station. FL disagreed with this approach and ultimately FERC determined that a user survey for the reach downstream of Cabot Station was not needed (FERC SPDL dated 9/13/13). FL acknowledges that the hydraulic modeling work done for the reach of river downstream of Cabot Station shows that water surface elevations in that reach fluctuate depending on river flows and project operations on both the Connecticut and Deerfield rivers. But as noted by FERC in its SPDL, recreation access points downstream of the Poplar Street access are not integrally connected to the Project because they are affected by other hydropower projects on the Deerfield river. However, it is worth noting that CRWC's own survey of regional recreationists 73.6% reported that fluctuating water levels on the Connecticut River do NOT affect their recreation experience. As noted above, CRWC's survey did not split the responses by Project. Therefore it is impossible to know what percentage of the CRWC-AMC respondents used the reach below Cabot Station and what percentage, if any, felt that fluctuating water levels detracted from their recreation experience.

Study No. 3.6.5 Land Use Inventory

Commenter	Comment	Responses
CRWC-1	The report does not identify ownership and other controls such as FirstLight's flowage rights within the Project boundaries. FirstLight does not own all of the lands within the project boundaries. FirstLight ownership of lands within 200 feet of the Project boundaries is identified in Figure 4.4-1, but nothing indicates ownership within the boundaries. CRWC requests that FirstLight provide information on land it has ownership or any other control over, and the land use associated with those lands, in an addendum to Study 3.6.5.	FL has updated the maps that comprise Figure 4.4-1 in the 3.6.5 study report to show FL land ownership within the project boundary. See Study 3.6.5 Attachment A, Figure 4.4-1. The lands owned by FL shown are fee-ownership. The figures also show other lands within the Project boundary (e.g., flowage rights, easements, leases, etc.). The land uses associated with all lands within the Project boundary are provided in the 3.6.5 study report. An addendum to the 3.6.5 study report is not necessary.
CRWC-2	CRWC received this map [Town of Greenfield] shortly before filing this letter with FERC, and have not been able to determine if Figure 4.2-1 Map 8 is lacking any information about conservation land. We recommend FirstLight look at the attached map, and confirm land use ownership, if it hasn't already.	FL reviewed the tax map provided to CRWC by the Town of Greenfield and was unable to verify the accuracy of the location of any additional conservation lands along this reach of the Project as depicted on the tax map provided to CRWC.

STUDY NO. 3.3.6 ATTACHMENTS

Attachment A to Study No. 3.3.6.
Table 4.2.3-1A. Minimum, maximum and mean flow in the Turners Falls canal and bypass reach throughout the 2015 shad spawning survey period

	Time (EDT)		Canal Flow[2] (cfs)			Bypass Flow[2] (cfs)			
Date[1]	Start	End	Min	Max	Mean	Min	Max	Mean	Notes
5/19/2015	19:58	1:00	3,532	13,322	9,970	4,288	4,503	4,397	no spawning observed
5/20/2015	19:51	1:00	2,507	6,878	3,251	4,281	4,496	4,398	no spawning observed
5/21/2015	20:05	1:00	2,517	8,833	6,980	2,477	4,482	3,492	no spawning observed
5/26/2015	20:30	1:00	2,437	4,908	3,420	2,876	4,229	3,556	no spawning observed
5/27/2015	20:00	1:00	1,712	6,540	4,398	2,365	7,317	5,181	no spawning observed
5/28/2015	20:20	1:00	3,605	8,109	6,425	2,357	2,509	2,437	no spawning observed
6/4/2015	20:30	1:00	6,895	16,353	14,320	2,654	4,824	4,304	no spawning observed
6/8/2015	20:17	1:00	5,735	9,792	8,795	2,426	3,863	2,850	no spawning observed
6/9/2015	20:30	1:00	6,405	14,932	10,453	2,418	2,608	2,527	no spawning observed
6/10/2015	20:30	1:00	12,341	17,163	15,610	4,590	4,861	4,727	no spawning observed
6/16/2015	21:00	0:30	11,998	16,929	15,236	3,186	3,313	3,246	no spawning observed
6/17/2015	20:30	1:00	6,361	13,934	11,301	3,168	3,347	3,235	spawning observed in lower portion of canal, near right bank @ 00:24[3]
6/18/2015	20:30	1:00	10,652	14,115	12,661	985	1,068	1,021	spawning observed below rock dam @ 22:17
6/22/2015	21:00	0:30	16,250	16,511	16,374	8,467	10,281	9,332	no spawning observed

[1]Indicates date survey commenced
[2]Reported flow metrics are for survey period only.
[3]Observation actually occurred early on 6/18

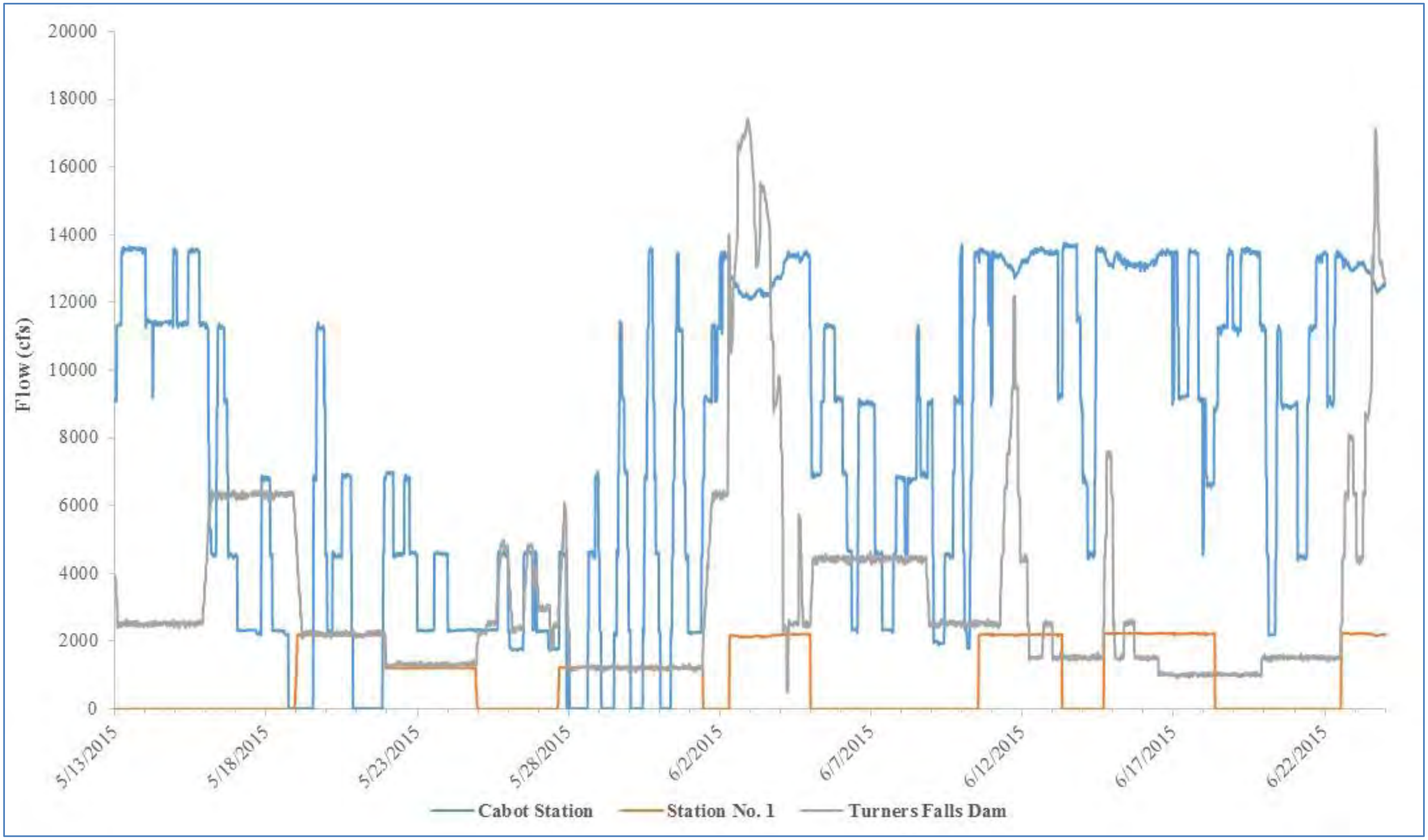
Attachment B to Study No. 3.3.6.
Table 4.3-1A. Summary of data used to Assess Effects of Operations on Shad Spawning (Obs = observer).

Date	Instantaneous River Flow Montague USGS Gage (cfs)		Time (EDT)		Site ID	Cabot Generations (MW)		Number of Units		Splash Counts				Area	
	Before	After	Before	After		Before	After	Before	After	Before		After		Before (acres)	After (% change)
										Obs 1	Obs 2	Obs 1	Obs 2		
5/26/2015	8,310	8,150	20:56	21:34	8	10.5	21.1	1	2	82	71	73	65	4.36	-0.20%
5/26/2015	8,830	9,000	22:10	22:51	9	20.8	10.2	2	1	208	223	203	207	4.68	0.19%
5/27/2015	11,000	9,240	22:50	23:40	10	0.08	10.1	0	1	35	40	22	29	3.34	-1.99%
5/28/2015	8,690	8,190	0:15	0:50	11	10.3	0.08	1	0	53	59	46	46	3.41	0%
5/28/2015	7,710	9,240	20:46	22:08	12	20.5	31.4	2	3	37	26	9	19	5.49	0.12%
5/28/2015	9,760	9,150	23:13	23:57	13	31.5	21.3	3	2	25	35	8	11	4.08	0.09%
6/9/2015*	12,500	12,700	20:00	20:43	14	41.1	41.3	4	4	36	37	24	20	0.68	0.25%
6/9-10/2015	16,000	16,200	23:45	0:30	15	61.7	40.9	6	4	11	8	4	2	9.15	0.14%
6/10/2015	21,300	20,900	22:29	23:22	16	60.7	40.5	6	4	10	12	11	12	0.7	-0.08%
6/10-11/2015	19,400	18,400	23:51	0:27	17	41.3	61	4	6	30	39	33	25	4.85	0%
6/16/2015	20,400	20,400	22:38	23:20	18	61	40.6	6	4	72	72	37	34	5.05	0%
6/17/2015	17,600	18,700	0:24	0:55	19	45	60.6	4	6	4	5	4	4	0.42	0%
6/17/2015	15,800	15,600	22:20	23:07	20	41.2	20.6	4	2	12	9	18	17	1.42	-0.04%
6/17-18/2015	14,100	13,500	23:33	0:15	21	20.7	40.9	2	4	40	43	22	21	3.1	-0.08%
6/22/2015*	26,400	n/a	21:59	n/a	22	58.5	n/a	6	n/a	62	53	n/a	n/a	6.75	n/a

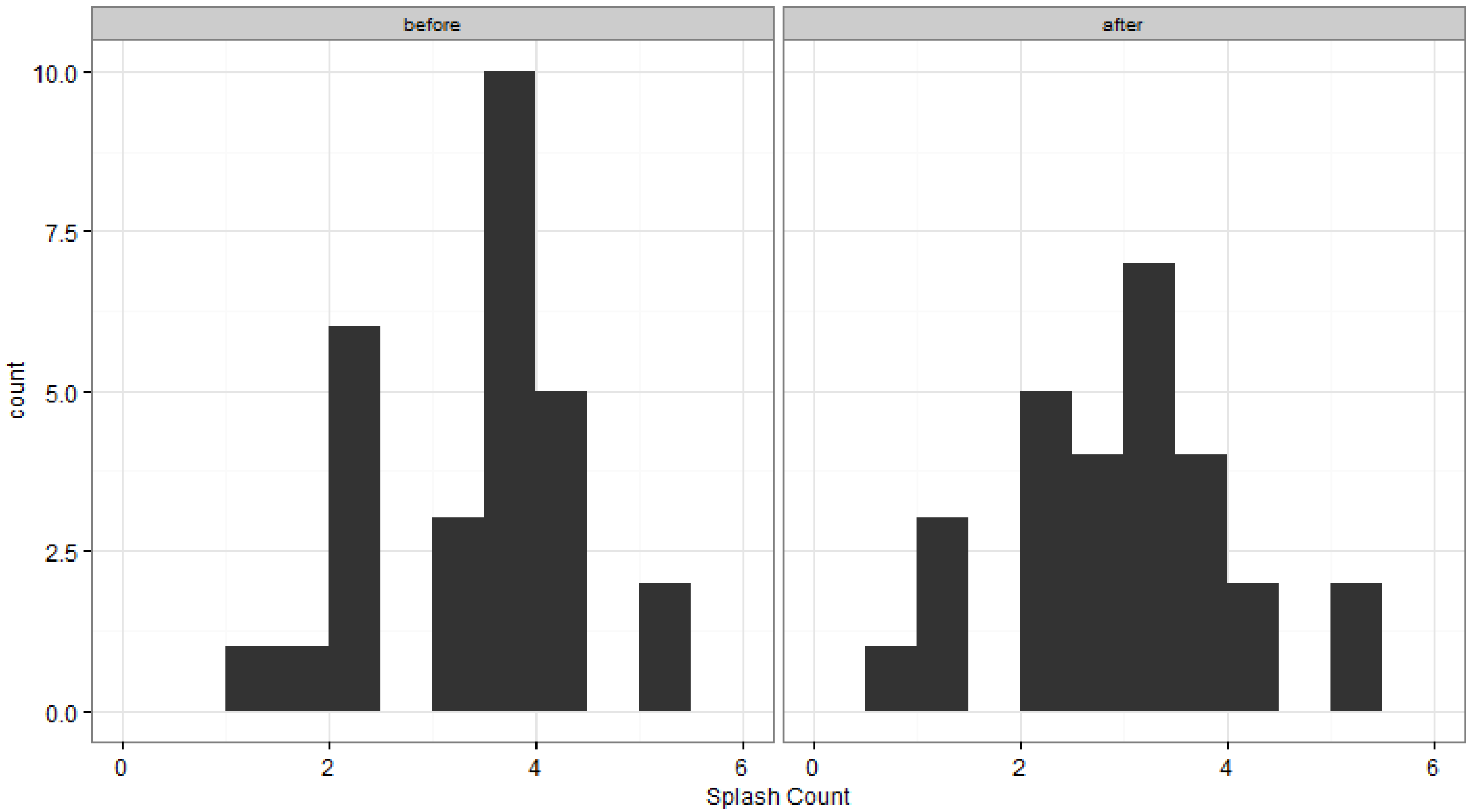
* Ambient conditions did not permit operators to change Cabot generation.

Attachment C to Study No. 3.3.6.

Figure 4.1-2A. Cabot Station, Station No. 1 and Turners Falls Dam Discharge (cfs) throughout the 2015 shad spawning survey period.



Attachment D of Study No. 3.3.6.
Figure 4.3.1-1A: Histogram of log-transformed (ln(x)) splash counts before and after changes in Cabot Station generation.

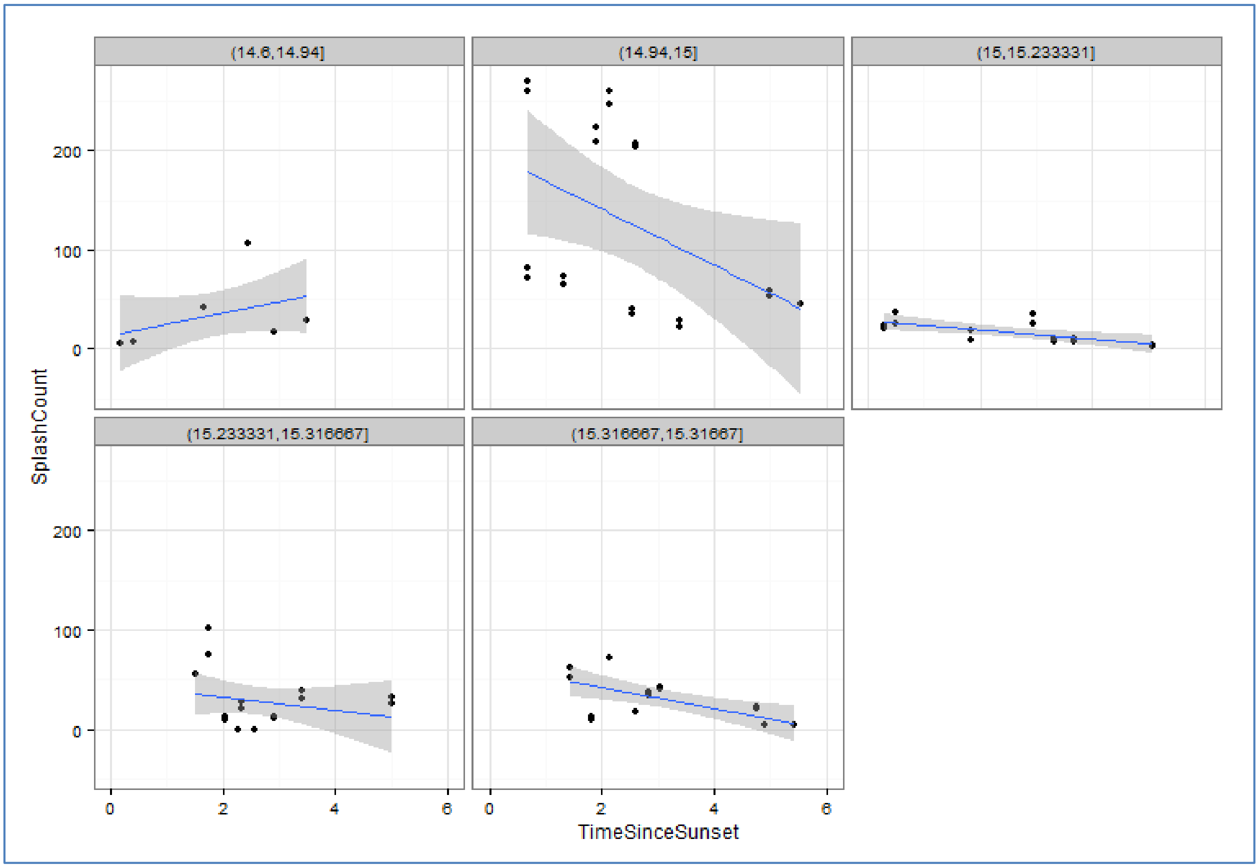


Attachment E of Study No. 3.3.6
Survey location, date and time of spawning observations during the 2015 shad spawning study.

Survey Location	Date	Time of Spawning Observation
Canal	6/18/2015	0:24
Bypass Reach	6/18/2016	22:17
Impoundment	5/19/2016	20:33
Impoundment	5/20/2016	20:21
Impoundment	5/26/2016	20:57
Impoundment	5/27/2016	22:25
Impoundment	6/16/2016	22:00
Impoundment	6/17/2016	22:49
Impoundment	6/18/2016	22:15
Downstream	5/14/2015	21:15
Downstream	5/14/2015	20:18
Downstream	5/19/2015	17:05
Downstream	5/19/2015	23:03
Downstream	5/21/2015	21:51
Downstream	5/21/2015	22:37
Downstream	5/21/2015	23:40
Downstream	5/26/2015	20:56
Downstream	5/26/2015	21:34
Downstream	5/26/2015	22:10
Downstream	5/26/2015	22:51
Downstream	5/27/2015	22:50
Downstream	5/27/2015	23:40
Downstream	5/28/2015	0:15
Downstream	5/28/2015	0:50
Downstream	5/28/2015	20:46
Downstream	5/28/2015	22:08
Downstream	5/28/2015	23:13
Downstream	5/28/2015	23:57
Downstream	6/9/2015	20:00
Downstream	6/9/2015	20:43
Downstream	6/9/2015	23:45
Downstream	6/10/2015	0:30
Downstream	6/10/2015	22:29
Downstream	6/10/2015	23:22
Downstream	6/10/2015	23:51
Downstream	6/11/2015	0:27
Downstream	6/16/2015	22:38
Downstream	6/16/2015	23:20
Downstream	6/17/2015	0:24

Survey Location	Date	Time of Spawning Observation
Downstream	6/17/2015	0:55
Downstream	6/17/2015	22:20
Downstream	6/17/2015	23:07
Downstream	6/17/2015	23:33
Downstream	6/18/2015	0:15
Downstream	6/22/2015	21:59

Attachment F of Study No. 3.3.6.
Splash counts by photoperiod quantiles for data collected during 2015 shad spawning surveys



Note: Brackets at the tops of each subplot indicate the photoperiod (hours) quantile, such that the top left chart includes data collected when photoperiod was greater than or equal to 14.6 hours but less than 14.94 hours.

Attachment G of Study No. 3.3.6.
Results for paired t-test by operational scenario

Scenario	Before Mean	Before Variance	After Mean	After Variance	*n* (pairs)	*n* (obs)	*t*	*df*	*p*
Increase - All	3.39	0.73	2.99	0.72	14	28	3.9884	13	0.002
Decrease - All	3.43	1.32	3.04	1.73	14	28	2.3259	13	0.03
Increase 1	3.79	0.19	3.34	0.62	6	12	2.259	5	0.07
Decrease 1	4.26	0.83	3.79	1.19	6	12	2.1252	5	0.08
Increase 2	3.08	0.97	2.72	0.70	8	16	3.472	7	0.01
Decrease 2	2.81	0.84	2.48	1.01	8	16	1.314	7	0.23

STUDY 3.3.11 ATTACHMENTS

Attachment A to Study 3.3.11.
Detailed Sampling Data
CPUE based on sampling duration
Impoundment June-July 2015

85.5 Electrofishing	Number of Individuals				CPUE/min (1587 sec)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	25	16	9		0.94518	0.6	0.34	0
Largemouth Bass	0				0	0	0	0
White Sucker	2	2			0.075614	0.08	0	0
Yellow Perch	20	18	2		0.756144	0.68	0.076	0
Spottail Shiner	52	40	12		1.965974	1.51	0.454	0
Fallfish	15	1	14		0.567108	0.04	0.529	0
Mimic Shiner	0				0	0	0	0
Golden Shiner	2		2		0.075614	0	0.076	0
Common Shiner	0				0	0	0	0
American Eel	0				0	0	0	0
Walleye	2	2			0.075614	0.08	0	0
Black Crappie	1				0.037807	0	0	0
Rock Bass	11	6	5		0.415879	0.23	0.189	0
Bluegill Sunfish	4	4			0.151229	0.15	0	0
Pumpkinseed Sunfish	0				0	0	0	0
Northern Pike	0				0	0	0	0
Chain Pickerel	0				0	0	0	0
Channel Catfish	1	1			0.037807	0.04	0	0
Brown Bullhead	0				0	0	0	0
Tessellated Darter	0				0	0	0	0
Sea Lamprey	1		1		0.037807	0	0.038	0
American Shad	0				0	0	0	0
Common Carp	0				0	0	0	0
	136	90	45	0	5.141777	3.41	1.702	0

84.5 Electrofishing	**Number of Individuals**				**CPUE/min (1519 sec)**			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	15	8	7		0.5925	0.316	0.2765	0
Largemouth Bass	0				0	0	0	0
White Sucker	4	4			0.158	0.158	0	0
Yellow Perch	5	2	3		0.1975	0.079	0.1185	0
Spottail Shiner	26	26			1.02699	1.027	0	0
Fallfish	14	7	7		0.553	0.2765	0.2765	0
Mimic Shiner	1		1		0.0395	0	0.0395	0
Golden Shiner	0				0	0	0	0
Common Shiner	0				0	0	0	0
American Eel	2		2		0.079	0	0.079	0
Walleye	0				0	0	0	0
Black Crappie	0				0	0	0	0
Rock Bass	3	3			0.1185	0.1185	0	0
Bluegill Sunfish	0				0	0	0	0
Pumpkinseed Sunfish	0				0	0	0	0
Northern Pike	0				0	0	0	0
Chain Pickerel	0				0	0	0	0
Channel Catfish	0				0	0	0	0
Brown Bullhead	0				0	0	0	0
Tessellated Darter	0				0	0	0	0
Sea Lamprey	1		1		0.0395	0	0.0395	0
American Shad	1	1			0.0395	0.0395	0	0
Common Carp	0				0	0	0	0
	72	51	21	0	2.84399	2.0145	0.8295	0

84.3 Electrofishing	Number of Individuals				CPUE/min. (1514 sec)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	15	10	5		0.59445	0.396	0.198	0
Largemouth Bass					0	0	0	0
White Sucker					0	0	0	0
Yellow Perch	3	2	1		0.11889	0.079	0.04	0
Spottail Shiner	4	2		2	0.15852	0.079	0	0.001
Fallfish	4	1	3		0.15852	0.04	0.119	0
Mimic Shiner					0	0	0	0
Golden Shiner					0	0	0	0
Common Shiner					0	0	0	0
American Eel	1		1		0.03963	0	0.04	0
Walleye	2		2		0.07926	0	0.079	0
Black Crappie					0	0	0	0
Rock Bass	2	2			0.07926	0.079	0	0
Bluegill Sunfish	2	2			0.07926	0.079	0	0
Pumpkinseed Sunfish					0	0	0	0
Northern Pike					0	0	0	0
Chain Pickerel					0	0	0	0
Channel Catfish					0	0	0	0
Brown Bullhead					0	0	0	0
Tessellated Darter					0	0	0	0
Sea Lamprey					0	0	0	0
American Shad					0	0	0	0
Common Carp					0	0	0	0
	33	19	12	2	1.30779	0.752	0.476	0.001

82.0 Electrofishing	Number of Individuals				CPUE/ min. (1441 sec)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	25	11	14		1.04094	0.46	0.583	0
Largemouth Bass					0	0	0	0
White Sucker	4	3	1		0.16655	0.12	0.042	0
Yellow Perch	6	3	3		0.24983	0.12	0.125	0
Spottail Shiner	27	27			1.12422	1.12	0	0
Fallfish	14	12	2		0.58293	0.5	0.083	0
Mimic Shiner	6	6			0.24983	0.25	0	0
Golden Shiner					0	0	0	0
Common Shiner					0	0	0	0
American Eel	1		1		0.04164	0	0.042	0
Walleye	1		1		0.04164	0	0.042	0
Black Crappie	1	1			0.04164	0.04	0	0
Rock Bass	3	3			0.12491	0.12	0	0
Bluegill Sunfish					0	0	0	0
Pumpkinseed Sunfish					0	0	0	0
Northern Pike	1	1			0.04164	0.04	0	0
Chain Pickerel	1	1			0.04164	0.04	0	0
Channel Catfish					0	0	0	0
Brown Bullhead					0	0	0	0
Tessellated Darter					0	0	0	0
Sea Lamprey					0	0	0	0
American Shad					0	0	0	0
Common Carp					0	0	0	0
	90	68	22	0	3.74741	2.81	0.917	0

80.1 Electrofishing	Number of Individuals				CPUE/min (1486 sec)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	20	8	11	1	0.808	0.32	0.44	0.04
Largemouth Bass					0	0	0	0
White Sucker	6	4	1	1	0.242	0.16	0.04	0.04
Yellow Perch	8	2	6		0.323	0.08	0.24	0
Spottail Shiner	54	54			2.18	2.18	0	0
Fallfish	19	11	8		0.767	0.44	0.32	0
Mimic Shiner					0	0	0	0
Golden Shiner					0	0	0	0
Common Shiner					0	0	0	0
American Eel					0	0	0	0
Walleye	3		3		0.121	0	0.12	0
Black Crappie					0	0	0	0
Rock Bass	1	1			0.04	0.04	0	0
Bluegill Sunfish					0	0	0	0
Pumpkinseed Sunfish					0	0	0	0
Northern Pike					0	0	0	0
Chain Pickerel					0	0	0	0
Channel Catfish					0	0	0	0
Brown Bullhead					0	0	0	0
Tessellated Darter					0	0	0	0
Sea Lamprey					0	0	0	0
American Shad					0	0	0	0
Common Carp					0	0	0	0
	111	80	29	2	4.481	3.22	1.16	0.08

76.2 Electrofishing	Number of Individuals				CPUE/min. (1310 sec)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	36	16	19	1	1.6489	0.7328	0.87	0.046
Largemouth Bass					0	0	0	0
White Sucker	1	1			0.0458	0.0458	0	0
Yellow Perch	1	1			0.0458	0.0458	0	0
Spottail Shiner	1	1			0.0458	0.0458	0	0
Fallfish	10	6	4		0.458	0.2748	0.183	0
Mimic Shiner					0	0	0	0
Golden Shiner	1		1		0.0458	0	0.046	0
Common Shiner					0	0	0	0
American Eel					0	0	0	0
Walleye					0	0	0	0
Black Crappie					0	0	0	0
Rock Bass	7	4	3		0.3206	0.1832	0.137	0
Bluegill Sunfish	1	1			0.0458	0.0458	0	0
Pumpkinseed Sunfish					0	0	0	0
Northern Pike					0	0	0	0
Chain Pickerel					0	0	0	0
Channel Catfish					0	0	0	0
Brown Bullhead					0	0	0	0
Tessellated Darter	12	11		1	0.5496	0.5038	0	0.046
Sea Lamprey					0	0	0	0
American Shad					0	0	0	0
Common Carp					0	0	0	0
	70	41	27	2	3.2061	1.8778	1.236	0.092

74.3 Electrofishing	Number of Individuals				CPUE/min. (1119 sec)			
Species	Total	ADULT	JUV.	YOY	Total	ADULT	JUV.	YOY
Smallmouth Bass	38	11	27		2.0375	0.5898	1.4477	0
Largemouth Bass					0	0	0	0
White Sucker	5	2	3		0.2681	0.1072	0.1609	0
Yellow Perch	7	6	1		0.3753	0.3217	0.0536	0
Spottail Shiner	8	8			0.429	0.429	0	0
Fallfish	7	4	3		0.3753	0.2145	0.1609	0
Mimic Shiner					0	0	0	0
Golden Shiner					0	0	0	0
Common Shiner					0	0	0	0
American Eel					0	0	0	0
Walleye	1		1		0.0536	0	0.0536	0
Black Crappie					0	0	0	0
Rock Bass	2	1	1		0.1072	0.0536	0.0536	0
Bluegill Sunfish	1	1			0.0536	0.0536	0	0
Pumpkinseed Sunfish					0	0	0	0
Northern Pike					0	0	0	0
Chain Pickerel					0	0	0	0
Channel Catfish					0	0	0	0
Brown Bullhead					0	0	0	0
Tessellated Darter					0	0	0	0
Sea Lamprey					0	0	0	0
American Shad					0	0	0	0
Common Carp					0	0	0	0
	69	33	36	0	3.6996	1.7694	1.9303	0

73.9 Electrofishing	Number of Individuals				CPUE/min (1322 sec)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	17	6	11		0.7716	0.272	0.499	0
Largemouth Bass					0	0	0	0
White Sucker	5	4	1		0.2269	0.182	0.045	0
Yellow Perch	8	6	2		0.3631	0.272	0.091	0
Spottail Shiner	1	1			0.0454	0.045	0	0
Fallfish	1	1			0.0454	0.045	0	0
Mimic Shiner					0	0	0	0
Golden Shiner					0	0	0	0
Common Shiner					0	0	0	0
American Eel	3	2	1		0.1362	0.091	0.045	0
Walleye					0	0	0	0
Black Crappie					0	0	0	0
Rock Bass	5	2	3		0.2269	0.091	0.136	0
Bluegill Sunfish	2	2			0.0908	0.091	0	0
Pumpkinseed Sunfish	1	1			0.0454	0.045	0	0
Northern Pike					0	0	0	0
Chain Pickerel					0	0	0	0
Channel Catfish					0	0	0	0
Brown Bullhead					0	0	0	0
Tessellated Darter					0	0	0	0
Sea Lamprey					0	0	0	0
American Shad					0	0	0	0
Common Carp	1	1			0.0454	0.045	0	0
	44	26	18	0	1.9971	1.179	0.816	0

72.9 Electrofishing	Number of Individuals				CPUE/min (1481 sec)			
Species	Total	ADULT	JUV.	YOY	Total	ADULT	JUV.	YOY
Smallmouth Bass	39	16	23		1.58	0.6482	0.9318	0
Largemouth Bass					0	0	0	0
White Sucker	10	7	3		0.4051	0.2836	0.1215	0
Yellow Perch	7	5	1	1	0.2836	0.2026	0.0405	0.0405
Spottail Shiner	3	2		1	0.1215	0.081	0	0.0405
Fallfish					0	0	0	0
Mimic Shiner					0	0	0	0
Golden Shiner					0	0	0	0
Common Shiner					0	0	0	0
American Eel					0	0	0	0
Walleye					0	0	0	0
Black Crappie					0	0	0	0
Rock Bass	14	3	11		0.5672	0.1215	0.4456	0
Bluegill Sunfish					0	0	0	0
Pumpkinseed Sunfish					0	0	0	0
Northern Pike					0	0	0	0
Chain Pickerel					0	0	0	0
Channel Catfish	1	1			0.0405	0.0405	0	0
Brown Bullhead					0	0	0	0
Tessellated Darter					0	0	0	0
Sea Lamprey					0	0	0	0
American Shad					0	0	0	0
Common Carp					0	0	0	0
	74	34	38	2	2.9979	1.3774	1.5394	0.081

71.1 Electrofishing	Number of Individuals				CPUE/min (1473 sec)			
Species	Total	ADULT	JUV.	YOY	Total	ADULT	JUV.	YOY
Smallmouth Bass	2	2			0.0815	0.081	0	0
Largemouth Bass	3	1		2	0.1222	0.041	0	0.081
White Sucker	6	6			0.2444	0.244	0	0
Yellow Perch	38	36	2		1.5479	1.466	0.081	0
Spottail Shiner	290	290			11.813	11.81	0	0
Fallfish	2		2		0.0815	0	0.081	0
Mimic Shiner					0	0	0	0
Golden Shiner					0	0	0	0
Common Shiner					0	0	0	0
American Eel					0	0	0	0
Walleye	5	5			0.2037	0.204	0	0
Black Crappie	2	2			0.0815	0.081	0	0
Rock Bass					0	0	0	0
Bluegill Sunfish	10	10			0.4073	0.407	0	0
Pumpkinseed Sunfish	17	16	1		0.6925	0.652	0.041	0
Northern Pike					0	0	0	0
Chain Pickerel					0	0	0	0
Channel Catfish					0	0	0	0
Brown Bullhead	1	1			0.0407	0.041	0	0
Tessellated Darter	1	1			0.0407	0.041	0	0
Sea Lamprey					0	0	0	0
American Shad					0	0	0	0
Common Carp	1	1			0.0407	0.041	0	0
	378	371	5	2	15.3976	15.109	0.203	0.081

70.1 (*seine alternative*)	**Number of Individuals**				**CPUE/min (500 sec)**			
Species	**To**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass					0	0	0	0
Largemouth Bass					0	0	0	0
White Sucker					0	0	0	0
Yellow Perch	22	18	2	2	2.64	2.16	0.24	0.24
Spottail Shiner					0	0	0	0
Fallfish					0	0	0	0
Mimic Shiner					0	0	0	0
Golden Shiner	1	1			0.12	0.12	0	0
Common Shiner					0	0	0	0
American Eel					0	0	0	0
Walleye					0	0	0	0
Black Crappie					0	0	0	0
Rock Bass					0	0	0	0
Bluegill Sunfish	7	4	1	2	0.84	0.48	0.12	0.24
Pumpkinseed Sunfish	6	6			0.72	0.72	0	0
Northern Pike					0	0	0	0
Chain Pickerel					0	0	0	0
Channel Catfish					0	0	0	0
Brown Bullhead					0	0	0	0
Tessellated Darter					0	0	0	0
Sea Lamprey					0	0	0	0
American Shad					0	0	0	0
Common Carp	1	1			0.12	0.12	0	0
	37	30	3	4	4.44	3.6	0.36	0.48

69.9 Electrofishing	Number of Individuals				CPUE/min. (1559 sec)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass					0	0	0	0
Largemouth Bass					0	0	0	0
White Sucker	2	2			0.077	0.077	0	0
Yellow Perch	21	20	1		0.8082	0.7697	0.0385	0
Spottail Shiner	2	2			0.077	0.077	0	0
Fallfish					0	0	0	0
Mimic Shiner					0	0	0	0
Golden Shiner					0	0	0	0
Common Shiner					0	0	0	0
American Eel					0	0	0	0
Walleye					0	0	0	0
Black Crappie					0	0	0	0
Rock Bass					0	0	0	0
Bluegill Sunfish	11	11			0.4233	0.4233	0	0
Pumpkinseed Sunfish	1	1			0.0385	0.0385	0	0
Northern Pike					0	0	0	0
Chain Pickerel					0	0	0	0
Channel Catfish					0	0	0	0
Brown Bullhead					0	0	0	0
Tessellated Darter					0	0	0	0
Sea Lamprey					0	0	0	0
American Shad					0	0	0	0
Common Carp					0	0	0	0
	37	36	1	0	1.424	1.3855	0.0385	0

69.6 (*Seine alternative*)	**Number of Individuals**				**CPUE/sec by Time (500 sec)**			
Species	**Total**	**ADUL**	**JUV.**	**YOY**	**Total**	**ADUL**	**JUV.**	**YOY**
Smallmouth Bass					0	0	0	0
Largemouth Bass	2			2	0	0	0.24	0
White Sucker					0	0	0	0
Yellow Perch	23	21	1	1	2.52	0.12	0.12	2.52
Spottail Shiner	25	25			3	0	0	3
Fallfish					0	0	0	0
Mimic Shiner					0	0	0	0
Golden Shiner					0	0	0	0
Common Shiner					0	0	0	0
American Eel					0	0	0	0
Walleye	1	1			0.12	0	0	0.12
Black Crappie					0	0	0	0
Rock Bass					0	0	0	0
Bluegill Sunfish	4	4			0.48	0	0	0.48
Pumpkinseed Sunfish	7	7			0.84	0	0	0.84
Northern Pike					0	0	0	0
Chain Pickerel					0	0	0	0
Channel Catfish					0	0	0	0
Brown Bullhead					0	0	0	0
Tessellated Darter					0	0	0	0
Sea Lamprey					0	0	0	0
American Shad					0	0	0	0
Common Carp					0	0	0	0
	62	58	1	3	6.96	0.12	0.36	6.96

69.5 Electrofishing	Number of Individuals				CPUE/min (1672 sec)			
Species	Total	ADULT	JUV.	YOY	Total	ADULT	JUV.	YOY
Smallmouth Bass	4	2	2		0.0143	0.0072	0.0072	0
Largemouth Bass	2	2			0.0072	0.0072	0	0
White Sucker	7	4	2	1	0.0251	0.0143	0.0072	0.0036
Yellow Perch	74	59	14	1	0.2654	0.2116	0.0502	0.0036
Spottail Shiner	175	125	50		0.6277	0.4484	0.1793	0
Fallfish					0	0	0	0
Mimic Shiner					0	0	0	0
Golden Shiner	1	1			0.0036	0.0036	0	0
Common Shiner					0	0	0	0
American Eel					0	0	0	0
Walleye	2	2			0.0072	0.0072	0	0
Black Crappie	1	1			0.0036	0.0036	0	0
Rock Bass	7	6	1		0.0251	0.0215	0.0036	0
Bluegill Sunfish	63	63			0.226	0.226	0	0
Pumpkinseed Sunfish	6	6			0.0215	0.0215	0	0
Northern Pike					0	0	0	0
Chain Pickerel	1	1			0.0036	0.0036	0	0
Channel Catfish					0	0	0	0
Brown Bullhead	2	2			0.0072	0.0072	0	0
Tessellated Darter					0	0	0	0
Sea Lamprey					0	0	0	0
American Shad					0	0	0	0
Common Carp					0	0	0	0
	345	274	69	2	1.2375	0.9829	0.2475	0.0072

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87.0 Electrofishing	Number of Individuals				CPUE/min (1768 sec)			
Species	Total	ADULT	JUV.	YOY	Total	ADULT	JUV.	YOY
Smallmouth Bass	80	7	33	40	2.7149	0.238	1.12	1.36
Largemouth Bass	2		2		0.0679	0	0.068	0
White Sucker	4	1	3		0.1357	0.034	0.102	0
Yellow Perch	33	6	22	5	1.1199	0.204	0.747	0.17
Spottail Shiner	18	14	3	1	0.6109	0.475	0.102	0.03
Fallfish	23	16	3	4	0.7805	0.543	0.102	0.14
Mimic Shiner					0	0	0	0
Golden Shiner					0	0	0	0
Common Shiner					0	0	0	0
American Eel					0	0	0	0
Walleye	1	1			0.0339	0.034	0	0
Black Crappie					0	0	0	0
Rock Bass	16	5	10	1	0.543	0.17	0.339	0.03
Bluegill Sunfish	2	2			0.0679	0.068	0	0
Pumpkinseed Sunfish	1	1			0.0339	0.034	0	0
White Perch					0	0	0	0
Northern Pike	1	1			0.0339	0.034	0	0
Chain Pickerel					0	0	0	0
Channel Catfish					0	0	0	0
Brown Bullhead					0	0	0	0
Tessellated Darter	1	1			0.0339	0.034	0	0
Sea Lamprey	11			11	0.3733	0	0	0.37
American Shad	1			1	0.0339	0	0	0.03
Common Carp	1	1			0.0339	0.034	0	0
Rosyface Shiner					0	0	0	0
Banded Killifish					0	0	0	0
	195	56	76	63	6.6174	1.902	2.58	2.13

85.2 Electrofishing	Number of Individuals				CPUE/min (1439 sec)			
Species	Total	ADULT	JUV.	YOY	Total	ADULT	JUV.	YOY
Smallmouth Bass	18	5	10	3	0.7505	0.208	0.42	0.1251
Largemouth Bass					0	0	0	0
White Sucker	8	7	1		0.3336	0.292	0.04	0
Yellow Perch					0	0	0	0
Spottail Shiner	2		2		0.0834	0	0.08	0
Fallfish	11	11			0.4587	0.459	0	0
Mimic Shiner	2	2			0.0834	0.083	0	0
Golden Shiner					0	0	0	0
Common Shiner					0	0	0	0
American Eel					0	0	0	0
Walleye					0	0	0	0
Black Crappie					0	0	0	0
Rock Bass	4	2	1	1	0.1668	0.083	0.04	0.0417
Bluegill Sunfish	1	1			0.0417	0.042	0	0
Pumpkinseed Sunfish					0	0	0	0
White Perch					0	0	0	0
Northern Pike					0	0	0	0
Chain Pickerel					0	0	0	0
Channel Catfish					0	0	0	0
Brown Bullhead					0	0	0	0
Tessellated Darter					0	0	0	0
Sea Lamprey	1			1	0.0417	0	0	0.0417
American Shad	19			19	0.7922	0	0	0.7922
Common Carp					0	0	0	0
Rosyface Shiner					0	0	0	0
Banded Killifish					0	0	0	0
	66	28	14	24	2.752	1.167	0.58	1.0007

84.3 Electrofishing	Number of Individuals				CPUE/min (1880 sec)			
Species	Total	ADULT	JUV.	YOY	Total	ADULT	JUV.	YOY
Smallmouth Bass	59	15	26	18	1.883	0.48	0.8298	0.5745
Largemouth Bass	1		1		0.0319	0	0.0319	0
White Sucker	2	1	1		0.0638	0.03	0.0319	0
Yellow Perch	5	3	2		0.1596	0.1	0.0638	0
Spottail Shiner	28	21	7		0.8936	0.67	0.2234	0
Fallfish	31	18	11	2	0.9894	0.57	0.3511	0.0638
Mimic Shiner	2	2			0.0638	0.06	0	0
Golden Shiner	1			1	0.0319	0	0	0.0319
Common Shiner					0	0	0	0
American Eel	1	1			0.0319	0.03	0	0
Walleye	1		1		0.0319	0	0.0319	0
Black Crappie					0	0	0	0
Rock Bass	5	1	1	3	0.1596	0.03	0.0319	0.0957
Bluegill Sunfish	1	1			0.0319	0.03	0	0
Pumpkinseed Sunfish					0	0	0	0
White Perch					0	0	0	0
Northern Pike	1	1			0.0319	0.03	0	0
Chain Pickerel					0	0	0	0
Channel Catfish					0	0	0	0
Brown Bullhead					0	0	0	0
Tessellated Darter	2	2			0.0638	0.06	0	0
Sea Lamprey					0	0	0	0
American Shad	2			2	0.0638	0	0	0.0638
Common Carp					0	0	0	0
Rosyface Shiner					0	0	0	0
Banded Killifish					0	0	0	0
	142	66	50	26	4.5318	2.09	1.5957	0.8297

82.1 (*Virtual Seine*)	Number of Individuals				CPUE/min (1500 sec)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	16	3	10	3	0.64	0.12	0.4	0.12
Largemouth Bass	1		1		0.04	0	0.04	0
White Sucker	11		8	3	0.44	0	0.32	0.12
Yellow Perch					0	0	0	0
Spottail Shiner	108	90		18	4.32	3.6	0	0.72
Fallfish	44		35	9	1.76	0	1.4	0.36
Mimic Shiner					0	0	0	0
Golden Shiner	2		2		0.08	0	0.08	0
Common Shiner					0	0	0	0
American Eel	1	1			0.04	0.04	0	0
Walleye					0	0	0	0
Black Crappie					0	0	0	0
Rock Bass	14	1	2	11	0.56	0.04	0.08	0.44
Bluegill Sunfish	1	1			0.04	0.04	0	0
Pumpkinseed Sunfish					0	0	0	0
White Perch					0	0	0	0
Northern Pike	2	2			0.08	0.08	0	0
Chain Pickerel					0	0	0	0
Channel Catfish	2	1	1		0.08	0.04	0.04	0
Brown Bullhead					0	0	0	0
Tessellated Darter	5	4		1	0.2	0.16	0	0.04
Sea Lamprey					0	0	0	0
American Shad	15			15	0.6	0	0	0.6
Common Carp					0	0	0	0
Rosyface Shiner					0	0	0	0
Banded Killifish	1			1	0.04	0	0	0.04
	223	103	59	61	8.92	4.12	2.36	2.44

82.0 Electrofishing	Number of Individuals				CPUE/min (1491 sec)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	27	6	17	4	1.08652	0.241	0.68	0.161
Largemouth Bass	1		1		0.04024	0	0.04	0
White Sucker	3	2	1		0.12072	0.08	0.04	0
Yellow Perch	7	4	3		0.28169	0.161	0.12	0
Spottail Shiner	7	7			0.28169	0.282	0	0
Fallfish	36	21	15		1.44869	0.845	0.6	0
Mimic Shiner	6	6			0.24145	0.241	0	0
Golden Shiner					0	0	0	0
Common Shiner					0	0	0	0
American Eel	1		1		0.04024	0	0.04	0
Walleye					0	0	0	0
Black Crappie	1	1			0.04024	0.04	0	0
Rock Bass	4		3	1	0.16097	0	0.12	0.0402
Bluegill Sunfish					0	0	0	0
Pumpkinseed Sunfish					0	0	0	0
White Perch					0	0	0	0
Northern Pike	2		2		0.08048	0	0.08	0
Chain Pickerel					0	0	0	0
Channel Catfish					0	0	0	0
Brown Bullhead					0	0	0	0
Tessellated Darter	4	3		1	0.16097	0.121	0	0.0402
Sea Lamprey					0	0	0	0
American Shad	15			15	0.60362	0	0	0.6036
Common Carp					0	0	0	0
Rosyface Shiner					0	0	0	0
Banded Killifish					0	0	0	0
	114	50	43	21	4.58752	2.011	1.72	0.845

80.8 Electrofishing	Number of Individuals				CPUE/min (1880 sec)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	33	6	24	3	1.0532	0.1915	0.77	0.0957
Largemouth Bass					0	0	0	0
White Sucker	2	2			0.0638	0.0638	0	0
Yellow Perch	11	4	5	2	0.3511	0.1277	0.16	0.0638
Spottail Shiner	2	2			0.0638	0.0638	0	0
Fallfish	11	8	3		0.3511	0.2553	0.1	0
Mimic Shiner					0	0	0	0
Golden Shiner					0	0	0	0
Common Shiner					0	0	0	0
American Eel					0	0	0	0
Walleye					0	0	0	0
Black Crappie					0	0	0	0
Rock Bass	3	1		2	0.0957	0.0319	0	0.0638
Bluegill Sunfish					0	0	0	0
Pumpkinseed Sunfish					0	0	0	0
White Perch					0	0	0	0
Northern Pike	1		1		0.0319	0	0.03	0
Chain Pickerel					0	0	0	0
Channel Catfish	1	1			0.0319	0.0319	0	0
Brown Bullhead					0	0	0	0
Tessellated Darter	3	3			0.0957	0.0957	0	0
Sea Lamprey	1		1		0.0319	0	0.03	0
American Shad	1			1	0.0319	0	0	0.0319
Common Carp					0	0	0	0
Rosyface Shiner					0	0	0	0
Banded Killifish					0	0	0	0
	69	27	34	8	2.202	0.8616	1.09	0.2552

80.1 Electrofishing	Number of Individuals				CPUE/min (1856 sec)			
Species	Total	ADULT	JUV.	YOY	Total	ADULT	JUV.	YOY
Smallmouth Bass	12	2	10		0.3879	0.065	0.323	0
Largemouth Bass					0	0	0	0
White Sucker					0	0	0	0
Yellow Perch					0	0	0	0
Spottail Shiner	41	41			1.3254	1.325	0	0
Fallfish	32	19	9	4	1.0345	0.614	0.291	0.129
Mimic Shiner					0	0	0	0
Golden Shiner					0	0	0	0
Common Shiner					0	0	0	0
American Eel					0	0	0	0
Walleye					0	0	0	0
Black Crappie					0	0	0	0
Rock Bass	1			1	0.0323	0	0	0.032
Bluegill Sunfish	2	1		1	0.0647	0.032	0	0.032
Pumpkinseed Sunfish					0	0	0	0
White Perch					0	0	0	0
Northern Pike					0	0	0	0
Chain Pickerel					0	0	0	0
Channel Catfish					0	0	0	0
Brown Bullhead					0	0	0	0
Tessellated Darter					0	0	0	0
Sea Lamprey					0	0	0	0
American Shad	6			6	0.194	0	0	0.194
Common Carp					0	0	0	0
Rosyface Shiner					0	0	0	0
Banded Killifish					0	0	0	0
	94	63	19	12	3.0388	2.036	0.614	0.387

78.2 (*Seine alternative*)	**Number of Individuals**				**CPUE/min (500 sec)**			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	1	1			0.12	0.12	0	0
Largemouth Bass					0	0	0	0
White Sucker					0	0	0	0
Yellow Perch					0	0	0	0
Spottail Shiner					0	0	0	0
Fallfish					0	0	0	0
Mimic Shiner					0	0	0	0
Golden Shiner					0	0	0	0
Common Shiner					0	0	0	0
American Eel					0	0	0	0
Walleye					0	0	0	0
Black Crappie					0	0	0	0
Rock Bass					0	0	0	0
Bluegill Sunfish					0	0	0	0
Pumpkinseed Sunfish					0	0	0	0
White Perch					0	0	0	0
Northern Pike					0	0	0	0
Chain Pickerel					0	0	0	0
Channel Catfish					0	0	0	0
Brown Bullhead					0	0	0	0
Tessellated Darter					0	0	0	0
Sea Lamprey					0	0	0	0
American Shad					0	0	0	0
Common Carp					0	0	0	0
Rosyface Shiner					0	0	0	0
Banded Killifish					0	0	0	0
	1	1	0	0	0	0	0	0

77.0 Electrofishing	Number of Individuals				CPUE/min (2260 sec)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	51	14	21	16	1.35398	0.3717	0.5575	0.4248
Largemouth Bass	2		2		0.0531	0	0.0531	0
White Sucker	1		1		0.02655	0	0.0265	0
Yellow Perch	12	2	5	5	0.31858	0.0531	0.1327	0.1327
Spottail Shiner	164	112	52		4.35398	2.9735	1.3805	0
Fallfish	31	7	15	9	0.82301	0.1858	0.3982	0.2389
Mimic Shiner					0	0	0	0
Golden Shiner					0	0	0	0
Common Shiner					0	0	0	0
American Eel					0	0	0	0
Walleye					0	0	0	0
Black Crappie					0	0	0	0
Rock Bass	7	2	2	3	0.18584	0.0531	0.0531	0.0796
Bluegill Sunfish	5	2		3	0.13274	0.0531	0	0.0796
Pumpkinseed Sunfish					0	0	0	0
White Perch					0	0	0	0
Northern Pike					0	0	0	0
Chain Pickerel					0	0	0	0
Channel Catfish	1			1	0.02655	0	0	0.0265
Brown Bullhead					0	0	0	0
Tessellated Darter	1			1	0.02655	0	0	0.0265
Sea Lamprey					0	0	0	0
American Shad	4			4	0.10619	0	0	0.1062
Common Carp					0	0	0	0
Rosyface Shiner	1			1	0.02655	0	0	0.0265
Banded Killifish	5		5		0.13274	0	0.1327	0
	285	139	103	43	7.56636	3.6903	2.7343	1.1413

76.1 Electrofishing	Number of Individuals				CPUE/min (1849 sec)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	33	11	14	8	1.0708	0.357	0.454	0.26
Largemouth Bass	2		2		0.0649	0	0.065	0
White Sucker	6	3	2	1	0.1947	0.097	0.065	0.032
Yellow Perch	1			1	0.0324	0	0	0.032
Spottail Shiner	18		3	15	0.5841	0	0.097	0.487
Fallfish	19	9		10	0.6165	0.292	0	0.324
Mimic Shiner					0	0	0	0
Golden Shiner					0	0	0	0
Common Shiner					0	0	0	0
American Eel	1		1		0.0324	0	0.032	0
Walleye					0	0	0	0
Black Crappie					0	0	0	0
Rock Bass	8			8	0.2596	0	0	0.26
Bluegill Sunfish					0	0	0	0
Pumpkinseed Sunfish					0	0	0	0
White Perch	1		1		0.0324	0	0.032	0
Northern Pike					0	0	0	0
Chain Pickerel					0	0	0	0
Channel Catfish					0	0	0	0
Brown Bullhead					0	0	0	0
Tessellated Darter	1	1			0.0324	0.032	0	0
Sea Lamprey					0	0	0	0
American Shad					0	0	0	0
Common Carp					0	0	0	0
Rosyface Shiner					0	0	0	0
Banded Killifish					0	0	0	0
	90	24	23	43	2.9202	0.778	0.745	1.395

71.2 Electrofishing	Number of Individuals				CPUE/min (1929 sec)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	45	20	25		1.39969	0.62	0.78	0
Largemouth Bass	10	1	9		0.31104	0.03	0.28	0
White Sucker	1	1			0.0311	0.03	0	0
Yellow Perch	9	1	3	5	0.27994	0.03	0.09	0.156
Spottail Shiner	77	15		62	2.39502	0.47	0	1.928
Fallfish	3	1	2		0.09331	0.03	0.06	0
Mimic Shiner					0	0	0	0
Golden Shiner					0	0	0	0
Common Shiner					0	0	0	0
American Eel					0	0	0	0
Walleye	2		2		0.06221	0	0.06	0
Black Crappie					0	0	0	0
Rock Bass	6	2	3	1	0.18663	0.06	0.09	0.031
Bluegill Sunfish	14	14			0.43546	0.44	0	0
Pumpkinseed Sunfish	1	1			0.0311	0.03	0	0
White Perch					0	0	0	0
Northern Pike					0	0	0	0
Chain Pickerel					0	0	0	0
Channel Catfish	1	1			0.0311	0.03	0	0
Brown Bullhead					0	0	0	0
Tessellated Darter	1	1			0.0311	0.03	0	0
Sea Lamprey					0	0	0	0
American Shad	3			3	0.09331	0	0	0.093
Common Carp					0	0	0	0
Rosyface Shiner					0	0	0	0
Banded Killifish	1	1		1	0.0311	0.03	0	0.031
	174	59	44	72	5.41211	1.83	1.36	2.239

71.1 (*Virtual Seine*)	Number of Individuals				CPUE/min (500 sec)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass					0	0	0	0
Largemouth Bass	1		1		0.12	0	0.12	0
White Sucker					0	0	0	0
Yellow Perch	8		8		0.96	0	0.96	0
Spottail Shiner					0	0	0	0
Fallfish					0	0	0	0
Mimic Shiner					0	0	0	0
Golden Shiner					0	0	0	0
Common Shiner					0	0	0	0
American Eel					0	0	0	0
Walleye					0	0	0	0
Black Crappie					0	0	0	0
Rock Bass					0	0	0	0
Bluegill Sunfish	2	2			0.24	0.24	0	0
Pumpkinseed Sunfish	2	2			0.24	0.24	0	0
White Perch					0	0	0	0
Northern Pike					0	0	0	0
Chain Pickerel					0	0	0	0
Channel Catfish					0	0	0	0
Brown Bullhead					0	0	0	0
Tessellated Darter					0	0	0	0
Sea Lamprey					0	0	0	0
American Shad					0	0	0	0
Common Carp	2	2			0.24	0.24	0	0
Rosyface Shiner					0	0	0	0
Banded Killifish	2	2			0.24	0.24	0	0
	17	8	9	0	2.04	0.96	1.08	0

70.5 Electrofishing	**Number of Individuals**				**CPUE/min (1929 sec)**			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	12	7	5		0.37325	0.218	0.16	0
Largemouth Bass	13		9	4	0.40435	0	0.28	0.124
White Sucker	5	4	1		0.15552	0.124	0.03	0
Yellow Perch	68	16	27	25	2.11509	0.498	0.84	0.778
Spottail Shiner	320*				9.95334	0	0	0
Fallfish					0	0	0	0
Mimic Shiner	2		2		0.06221	0	0.06	0
Golden Shiner	2			2	0.06221	0	0	0.062
Common Shiner					0	0	0	0
American Eel					0	0	0	0
Walleye					0	0	0	0
Black Crappie	1	1			0.0311	0.031	0	0
Rock Bass	5	3	1	1	0.15552	0.093	0.03	0.031
Bluegill Sunfish	44	38	4	2	1.36858	1.182	0.12	0.062
Pumpkinseed Sunfish	18	15	3		0.55988	0.467	0.09	0
White Perch					0	0	0	0
Northern Pike					0	0	0	0
Chain Pickerel					0	0	0	0
Channel Catfish					0	0	0	0
Brown Bullhead					0	0	0	0
Tessellated Darter					0	0	0	0
Sea Lamprey					0	0	0	0
American Shad	10			10	0.31104	0	0	0.311
Common Carp					0	0	0	0
Rosyface Shiner					0	0	0	0
Banded Killifish					0	0	0	0
	500	84	52	44	15.55209	2.613	1.61	1.368

*not sorted by lifestage

70.0 Electrofishing	Number of Individuals				CPUE/min (1674 sec)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	3	1	2		0.10753	0.03584	0.0717	0
Largemouth Bass	12	3	6	3	0.43011	0.10753	0.2151	0.10753
White Sucker	4		4		0.14337	0	0.1434	0
Yellow Perch	45	12	10	23	1.6129	0.43011	0.3584	0.82437
Spottail Shiner	211	70		141	7.56272	2.50896	0	5.05376
Fallfish					0	0	0	0
Mimic Shiner	3			3	0.10753	0	0	0.10753
Golden Shiner	6	6			0.21505	0.21505	0	0
Common Shiner					0	0	0	0
American Eel					0	0	0	0
Walleye					0	0	0	0
Black Crappie	2	1	1		0.07168	0.03584	0.0358	0
Rock Bass	3	2	1		0.10753	0.07168	0.0358	0
Bluegill Sunfish	17	14	2	1	0.60932	0.50179	0.0717	0.03584
Pumpkinseed Sunfish	7	6	1		0.2509	0.21505	0.0358	0
White Perch					0	0	0	0
Northern Pike	1	1			0.03584	0.03584	0	0
Chain Pickerel	1	1			0.03584	0.03584	0	0
Channel Catfish	1	1			0.03584	0.03584	0	0
Brown Bullhead					0	0	0	0
Tessellated Darter					0	0	0	0
Sea Lamprey					0	0	0	0
American Shad	1			1	0.03584	0	0	0.03584
Common Carp					0	0	0	0
Rosyface Shiner					0	0	0	0
Banded Killifish	12	8		4	0.43011	0.28674	0	0.14337
	329	126	27	176	11.79211	4.51611	0.9677	6.30824

69.5 Electrofishing	Number of Individuals				CPUE/min (2116 sec)			
Species	Total	ADULT	JUV.	YOY	Total	ADULT	JUV.	YOY
Smallmouth Bass	4	2		2	0.11342	0.06	0	0.0567
Largemouth Bass	8		5	3	0.22684	0	0.142	0.0851
White Sucker	13	1	12		0.36862	0.03	0.34	0
Yellow Perch	58	11	6	41	1.64461	0.31	0.17	1.1626
Spottail Shiner	271	64	207		7.68431	1.81	5.87	0
Fallfish					0	0	0	0
Mimic Shiner	1		1		0.02836	0	0.028	0
Golden Shiner	1			1	0.02836	0	0	0.0284
Common Shiner					0	0	0	0
American Eel					0	0	0	0
Walleye	1	1			0.02836	0.03	0	0
Black Crappie	2	2			0.05671	0.06	0	0
Rock Bass	2	2			0.05671	0.06	0	0
Bluegill Sunfish	24	20	1	3	0.68053	0.57	0.028	0.0851
Pumpkinseed Sunfish	14	5	9		0.39698	0.14	0.255	0
White Perch					0	0	0	0
Northern Pike					0	0	0	0
Chain Pickerel					0	0	0	0
Channel Catfish					0	0	0	0
Brown Bullhead	1	1			0.02836	0.03	0	0
Tessellated Darter	2	1		1	0.06	0.03	0	0.03
Sea Lamprey					0	0	0	0
American Shad	20			20	0.56711	0	0	0.5671
Common Carp	1	1			0.02836	0.03	0	0
Rosyface Shiner					0	0	0	0
Banded Killifish	4	2		2	0.11342	0.06	0	0.0567
	427	113	241	73	12.10777	3.19	6.833	2.0701

Bypass Reach September 2015

Plunge Pool Below Dam	Number of Individuals				CPUE/min (2601 sec)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	48	19	22	7	1.10727	0.44	0.507	0.161
Largemouth Bass	1		1		0.02307	0	0.023	0
White Sucker	10	10			0.23068	0.23	0	0
Yellow Perch					0	0	0	0
Spottail Shiner					0	0	0	0
Fallfish					0	0	0	0
Mimic Shiner					0	0	0	0
Golden Shiner					0	0	0	0
Common Shiner					0	0	0	0
American Eel	16		8	8	0.36909	0	0.185	0.185
Walleye	1		1		0.02307	0	0.023	0
Black Crappie					0	0	0	0
Rock Bass					0	0	0	0
Bluegill Sunfish	12	9		3	0.27682	0.21	0	0.069
Pumpkinseed Sunfish	8	4	4		0.18454	0.09	0.092	0
White Perch					0	0	0	0
Northern Pike					0	0	0	0
Chain Pickerel					0	0	0	0
Channel Catfish					0	0	0	0
Brown Bullhead					0	0	0	0
Tessellated Darter	4	4			0.09227	0.09	0	0
Sea Lamprey	1			1	0.02307	0	0	0.023
American Shad					0	0	0	0
Common Carp					0	0	0	0
Rosyface Shiner					0	0	0	0
Banded Killifish					0	0	0	0
Hybrid Sunfish					0	0	0	0
Longnose Dace					0	0	0	0
	101	46	36	19	2.32988	1.06	0.83	0.438

Pool-Run Above Station No. 1	Number of Individuals				CPUE/min (1609 sec)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	67	5	39	23	2.498446	0.1865	1.454	0.86
Largemouth Bass					0	0	0	0
White Sucker					0	0	0	0
Yellow Perch					0	0	0	0
Spottail Shiner					0	0	0	0
Fallfish					0	0	0	0
Mimic Shiner					0	0	0	0
Golden Shiner					0	0	0	0
Common Shiner					0	0	0	0
American Eel	1	1			0.03729	0.0373	0	0
Walleye					0	0	0	0
Black Crappie					0	0	0	0
Rock Bass					0	0	0	0
Bluegill Sunfish	9	1	1	7	0.335612	0.0373	0.037	0.26
Pumpkinseed Sunfish	8	1	3	4	0.298322	0.0373	0.112	0.15
White Perch					0	0	0	0
Northern Pike					0	0	0	0
Chain Pickerel					0	0	0	0
Channel Catfish					0	0	0	0
Brown Bullhead					0	0	0	0
Tessellated Darter	2	1		1	0.07458	0.0373	0	0.04
Sea Lamprey					0	0	0	0
American Shad					0	0	0	0
Common Carp					0	0	0	0
Rosyface Shiner					0	0	0	0
Banded Killifish					0	0	0	0
Hybrid Sunfish*	1				0.03729	0	0	0
Longnose Dace					0	0	0	0
	88	9	43	35	3.28154	0.3357	1.603	1.31

* Lifestage not specified

Riffle-Run Bellow Station No.1	Number of Individuals				CPUE/min (1709 sec)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	30	10	15	5	1.6682	0.5561	0.834	0.278
Largemouth Bass					0	0	0	0
White Sucker	2	2			0.1112	0.1112	0	0
Yellow Perch					0	0	0	0
Spottail Shiner					0	0	0	0
Fallfish					0	0	0	0
Mimic Shiner					0	0	0	0
Golden Shiner					0	0	0	0
Common Shiner					0	0	0	0
American Eel	7		4	3	0.3892	0	0.222	0.167
Walleye					0	0	0	0
Black Crappie					0	0	0	0
Rock Bass					0	0	0	0
Bluegill Sunfish					0	0	0	0
Pumpkinseed Sunfish					0	0	0	0
White Perch					0	0	0	0
Northern Pike					0	0	0	0
Chain Pickerel					0	0	0	0
Channel Catfish					0	0	0	0
Brown Bullhead					0	0	0	0
Tessellated Darter	2	2			0.1112	0.1112	0	0
Sea Lamprey	1		1		0.0556	0	0.056	0
American Shad					0	0	0	0
Common Carp					0	0	0	0
Rosyface Shiner					0	0	0	0
Banded Killifish					0	0	0	0
Hybrid Sunfish					0	0	0	0
Longnose Dace	1	1			0.0556	0.0556	0	0
	43	15	20	8	2.391	0.8341	1.112	0.445

Rock Dam Pool	Number of Individuals				CPUE/min (1800 sec)			
Species	Total	ADULT	JUV.	YOY	Total	ADULT	JUV.	YOY
Smallmouth Bass	23	6	9	8	0.7667	0.2	0.3	0.2667
Largemouth Bass					0	0	0	0
White Sucker	1		1		0.0333	0	0.0333	0
Yellow Perch	1			1	0.0333	0	0	0.0333
Spottail Shiner	1		1		0.0333	0	0.0333	0
Fallfish					0	0	0	0
Mimic Shiner	1		1		0.0333	0	0.0333	0
Golden Shiner					0	0	0	0
Common Shiner					0	0	0	0
American Eel	2		2		0.0667	0	0.0667	0
Walleye					0	0	0	0
Black Crappie					0	0	0	0
Rock Bass					0	0	0	0
Bluegill Sunfish	1	1			0.0333	0.033	0	0
Pumpkinseed Sunfish					0	0	0	0
White Perch					0	0	0	0
Northern Pike	1	1			0.0333	0.033	0	0
Chain Pickerel					0	0	0	0
Channel Catfish					0	0	0	0
Brown Bullhead	1			1	0.0333	0	0	0.0333
Tessellated Darter	4	3		1	0.1333	0.1	0	0.0333
Sea Lamprey	1			1	0.0333	0	0	0.0333
American Shad					0	0	0	0
Common Carp					0	0	0	0
Rosyface Shiner					0	0	0	0
Banded Killifish					0	0	0	0
Hybrid Sunfish					0	0	0	0
Longnose Dace					0	0	0	0
	37	11	14	12	1.2331	0.366	0.4666	0.3999

Attachment B of Study 3.3.11.
Good and poor QHEI habitat attributes for the Connecticut River sampled by MBI during 2015

			Good Habitat Attributes											Poor Habitat Attributes															
River Mile	Date	QHEI	No Channelization	Boulder, Cobble, Gravel	Silt Free	Good-Excellent Development	Five or More Substrate Types	Moderate-Extensive Cover	Fast Flow w Eddies	Little to No Embeddedness	Max Depth > 100 cm	No Riffle Embeddedness	"Good" Habitat Attributes	Impounded	Channelized or No Recovery	Silt/Muck Substrates	Sparse No Cover	Max Depths <70 cm	Recovering from Channelization	Mod-High Silt Cover	Fair- Poor Development	≤ 2 Cover Types	Slow or No current Flow	Mod-Extensive Embeddedness	Mod-Extensive Riffle	No Riffle	Poor Habitat Attributes	Ration of Good (High) to Poor	Ration of Poor (All) to Good
87	21-Sep-15	80.8	■	■		■		■	■	■	■	■	8														0	9	0.11
85.5	22-Jun-15	68	■	■				■			■		4								●			●	●		3	1.25	0.8
85.2	21-Sep-15	54		■				■			■		3	●							●			●		●	3	1	1
84.5	22-Jun-15	54		■				■			■		3	●							●			●		●	3	1	1
84.3	21-Sep-15	60		■				■		■	■	■	5	●							●						1	3	0.33
84	22-Jun-15	55		■				■			■		3	●							●			●		●	3	1	1
82.1	21-Sep-15	53.8		■				■			■		3	●							●			●		●	3	1	1
82	22-Jun-15	54		■				■			■		3	●							●		●	●		●	4	0.8	1.25
80.8	23-Sep-15	52.5		■				■			■		3	●							●			●		●	3	1	1
80.1	08-Jul-15	52.5		■				■			■		3	●			●				●		●	●		●	5	0.67	1.5
78.2	22-Sep-15	46.5		■							■		2	●			●				●		●	●		●	5	0.5	2
77.6	07-Jul-15	43									■		1	●			●				●	●	●	●		●	6	0.29	3.5
77	22-Sep-15	56.8		■				■			■		3	●							●		●	●		●	4	0.8	1.25
76.2	18-Jul-15	59.5		■				■		■	■		4	●							●			●		●	3	1.25	0.8
76.1	22-Sep-05	48						■			■		2	●			●				●		●	●		●	5	0.5	2
74.3	07-Jul-15	47.5						■			■		2	●			●				●		●	●		●	5	0.5	2
73.9	07-Jul-15	53.5		■				■			■		3	●							●		●	●		●	4	0.8	1.25
72.9	08-Jul-15	57.3		■				■			■		3	●							●		●	●		●	4	0.8	1.25
71.2	23-Sep-15	60						■			■		2	●							●		●	●		●	4	0.6	1.67
71.1	23-Sep-15	53.5		■				■			■		3	●						●	●		●	●		●	5	0.67	1.5
71.1	08-Jul-15	56						■			■		2	●						●	●		●	●		●	5	0.5	2
70.5	23-Sep-15	49						■			■		2	●						●	●		●	●		●	5	0.5	2
70.1	08-Jul-15	50.5						■			■		2	●							●		●	●		●	4	0.6	1.67

River Mile	Date	QHEI	Good Habitat Attributes											Poor Habitat Attributes														Ration of Good (High) to Poor	Ration of Poor (All) to Good
			No Channelization	Boulder, Cobble, Gravel	Silt Free	Good-Excellent Development	Five or More Substrate Types	Moderate-Extensive Cover	Fast Flow w Eddies	Little to No Embeddedness	Max Depth > 100 cm	No Riffle Embeddedness	"Good" Habitat Attributes	Impounded	Channelized or No Recovery	Silt/Muck Substrates	Sparse No Cover	Max Depths <70 cm	Recovering from Channelization	Mod-High Silt Cover	Fair- Poor Development	≤ 2 Cover Types	Slow or No current Flow	Mod-Extensive Embeddedness	Mod-Extensive Riffle	No Riffle	Poor Habitat Attributes		
70	23-Sep-15	49.5						■			■		2	●						●	●		●	●		●	5	0.5	2
69.9	08-Jul-15	44.5						■			■		2	●		●				●	●		●	●		●	6	0.43	2.33
69.6	08-Jul-15	46						■			■		2	●		●				●	●		●	●		●	6	0.43	2.33
69.5	23-Sep-15	53						■			■		2	●							●		●	●		●	4	0.6	1.67
69.5	09-Jul-15	43						■			■		2	●		●				●	●		●	●		●	6	0.43	2.33
67.8	24-Sep-15	77.5	■	■		■		■	■	■	■	■	8														0	9	0.11
67.5	24-Sep-15	80.5	■	■		■		■	■	■	■	■	8														0	9	0.11
67	24-Sep-15	88	■	■		■		■	■	■	■	■	8														0	9	0.11
66.5	24-Sep-15	84.5	■	■		■		■	■	■	■	■	8														0	9	0.11

Attachment C of Study 3.3.11.
Length and Weight and Length Frequency Data for Fish Sampled in The Turners Falls Project

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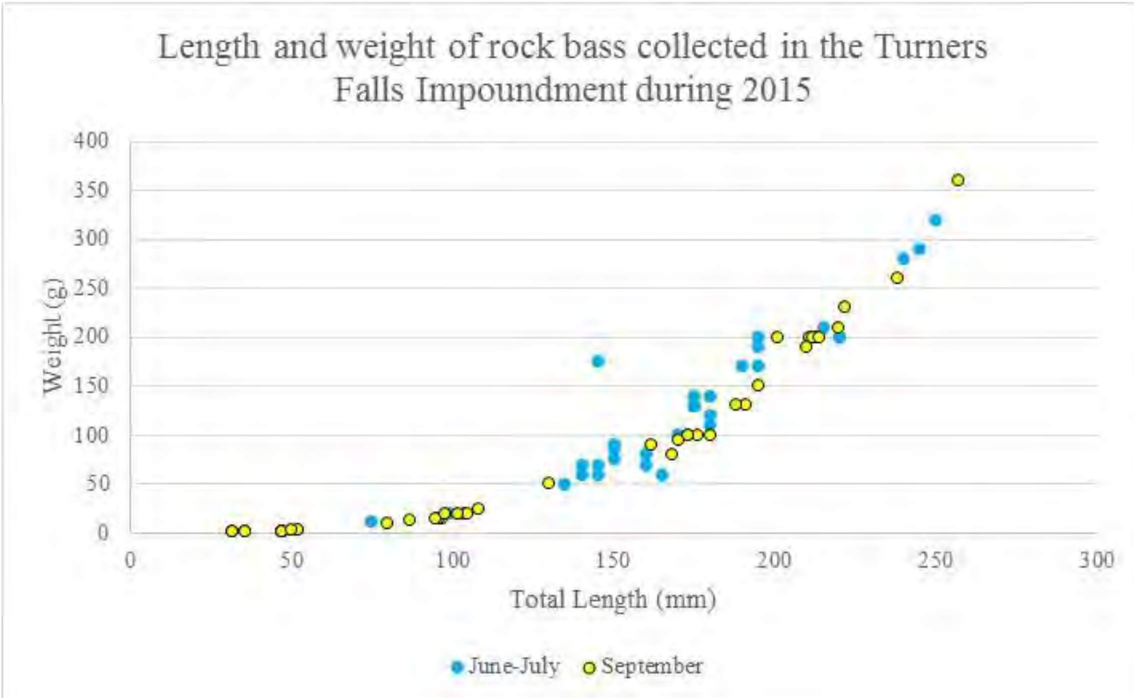
1.0 ROCK BASS

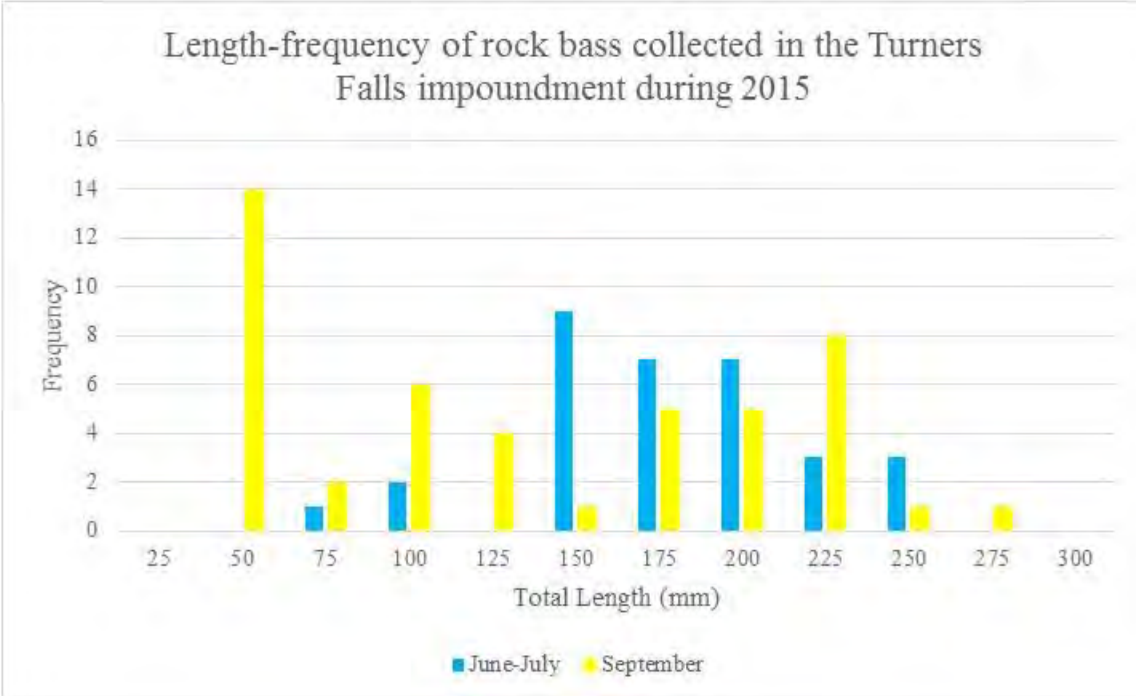
1.1 Length and weight of rock bass collected in the Turners Falls Impoundment during 2015

Rock Bass			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
99	20	191	130
96	15	195	150
140	70	173	100
145	60	170	95
180	110	222	230
140	60	168	80
145	70	162	90
135	50	176	100
245	290	180	100
220	200	211	200
145	175	173	100
160	70	213	200
240	280	188	130
160	80	220	210
180	140	238	260
220	200	130	50
165	60	257	360
170	100	212	200
195	190	214	200
175	130	201	200
215	210	210	190
175	130	97	15
250	320	96	15
175	140	104	20
190	170	95	15
195	170	87	12
150	85	105	20
150	75	98	20
195	200	52	3
180	120	52	3
150	90	47	1
75	12	47	1
		47	1
		47	1
		47	1
		47	1
		47	1
		47	1
		36	1
		32	1
		36	1
		47	1
		50	3
		32	1
		102	20
		108	25
		80	10



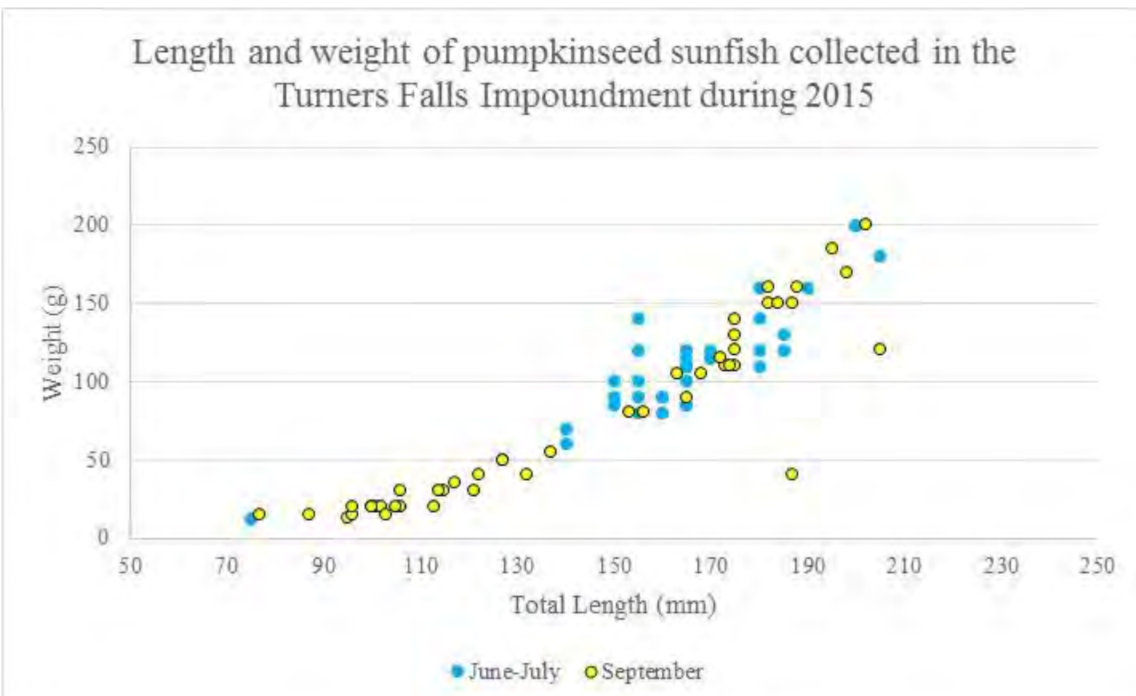
1.2 Length-frequency of rock bass collected in the Turners Falls impoundment during 2015

Rock Bass		
Length Class (mm)	**June-July**	**September**
25	0	0
50	0	14
75	1	2
100	2	6
125	0	4
150	9	1
175	7	5
200	7	5
225	3	8
250	3	1
275	0	1
300	0	0



2.0 PUMPKINSEED SUNFISH

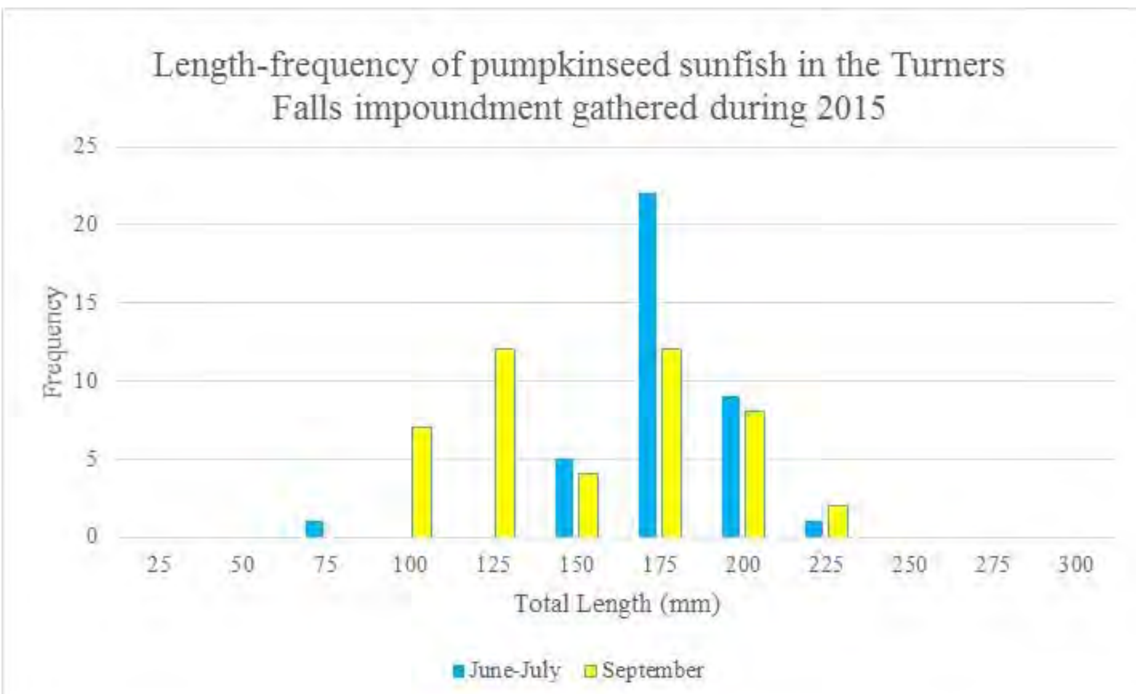
2.1 Length and weight of pumpkinseed sunfish collected in the Turners Falls Impoundment during 2015



2.2 Length-frequency of pumpkinseed sunfish collected in the Turners Falls impoundment during

2015

Pumpkinseed Sunfish		
Length Class (mm)	June-July	September
25	0	0
50	0	0
75	1	0
100	0	7
125	0	12
150	5	4
175	22	12
200	9	8
225	1	2
250	0	0
275	0	0
300	0	0



3.0 YELLOW PERCH

3.1 Length and weight of Yellow Perch collected in the Turners Falls Impoundment during 2015

Yellow Perch			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
190	80	165	50
185	70	230	140

Yellow Perch			
June-July		**September**	
Length (mm)	**Weight (g)**	**Length (mm)**	**Weight (g)**
250	190	200	80
180	60	170	50
170	40	166	45
160	60	187	70
175	70	199	80
210	100	159	45
180	80	167	50
195	100	179	50
190	90	185	70
170	60	162	40
175	70	219	100
180	70	217	120
165	50	210	100
230	160	205	90
190	80	220	110
215	120	170	50
210	120	176	55
160	45	188	60
175	70	174	50
215	110	205	100
200	90	137	30
205	110	180	60
205	90	185	65
165	50	170	50
180	75	168	50
175	65	136	40
150	50	241	150
210	110	212	100
120	70	163	40
165	60	223	120
145	30	158	40
165	50	177	55
255	190	195	70
175	70	177	50
220	140	180	50
195	100	130	20
195	70	130	25
210	100	173	50
185	60	185	70

Yellow Perch			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
195	80	170	50
270	230	150	30
175	70	267	250
185	70	191	90
180	70	170	60
210	100	160	50
155	50	235	160
205		156	45
160	50	140	30
175	90	142	30
155	60	151	45
160	50	223	140
195	70	150	45
105	15	246	220
180	70	225	150
200	90	183	80
165	70	162	50
205	100	155	50
165	70	147	40
175	60	123	20
180	80	116	15
155	50	127	20
180	70	108	10
125	100	116	15
190	80	116	15
190	90	120	18
125	20	120	18
195	100	120	18
230	160	134	20
215	120	83	10
240	180	132	25
160	60	123	20
180	70	130	25
185	95	87	10
165	65	115	16
180	75	115	16
215	125	115	16
175	80	115	16
200	100	115	16

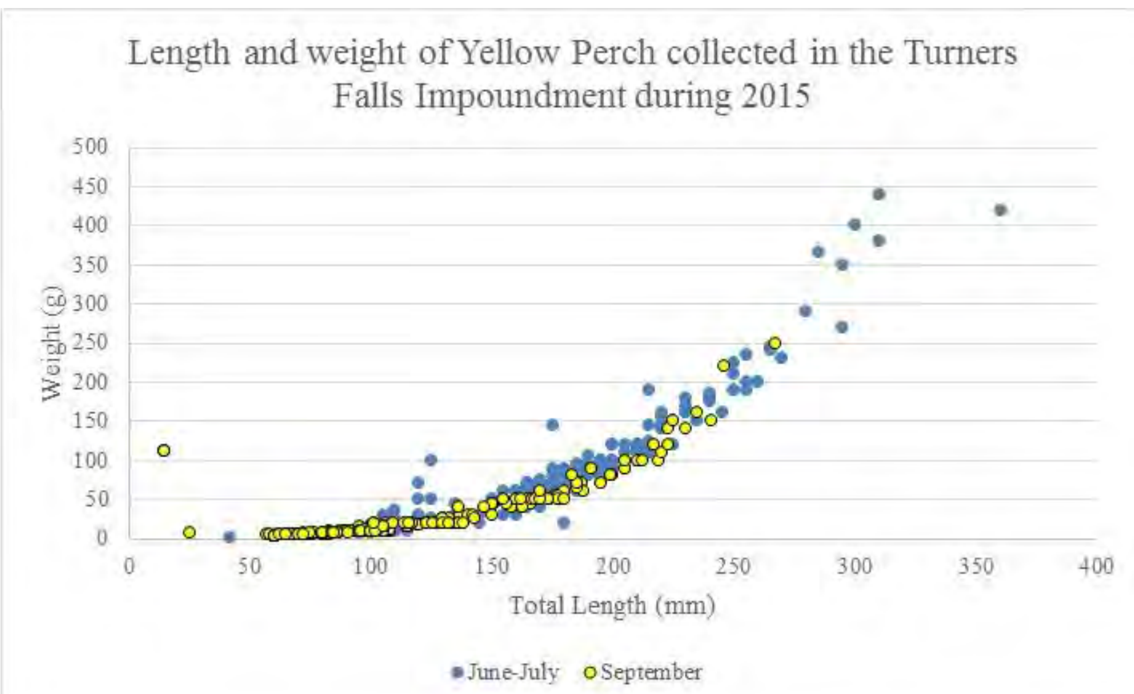
Yellow Perch			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
170	65	115	16
170	65	115	16
170	70	115	16
180	90	115	16
195	100	115	16
205	100	115	16
255	200	115	16
205	100	115	16
170	70	115	16
195	90	115	16
190	90	115	16
180	70	115	16
200	100	115	16
360	420	115	16
120	30	115	16
240	175	115	16
225	120	115	16
180	75	115	16
125	50	115	16
195	80	115	16
200	120	117	20
165	60	123	20
195	90	126	20
190	85	90	10
165	60	136	20
250	210	132	20
175	60	83	10
205	120	117	20
175	145	89	10
165	40	90	10
165	50	138	20
195	80	130	20
235	150	143	25
160	40	132	20
180	60	99	10
160	40	93	10
235	150	89	10
210	100	89	10
170	75	100	15

Yellow Perch			
June-July		**September**	
Length (mm)	**Weight (g)**	**Length (mm)**	**Weight (g)**
185	80	90	10
200	100	95	10
190	95	95	10
170	70	92	10
180	70	108	10
210	110	108	12
160	50	105	10
210	100	116	20
180	80	114	20
210	110	15	112
190	85	15	112
185	70	15	112
260	200	15	112
195	100	97	10
295	270	105	15
225	150	95	15
260	200	101	20
220	140	106	20
165	70	106	15
170	50	95	10
160	40	97	12
245	160	95	10
160	60	100	10
215	110	109	20
170	70	116	20
190	85	96	10
200	85	100	10
170	65	103	12
165	55	101	10
210	120	100	10
150	45	105	15
180	20	100	10
180	70	102	10
160	40	105	15
150	50	101	20
180	70	57	5
235	150	58	5
265	240	68	6
120	50	71	5

Yellow Perch			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
200	95	70	5
185	80	70	5
190	95	76	6
185	70	67	5
190	105	70	5
210	110	65	5
230	170	69	5
210	115	61	6
210	120	75	6
170	70	60	4
160	60	60	4
165	60	60	4
295	350	60	4
200	95	60	4
210	120	60	4
310	440	60	4
220	160	60	4
195	100	60	4
300	400	60	4
170	60	60	4
220	145	60	4
265	245	60	4
210	115	60	4
180	80	60	4
185	90	60	4
170	65	60	4
180	55	60	4
210	120	60	4
280	290	60	4
215	190	60	4
240	185	60	4
285	365	60	4
310	380	60	4
255	235	60	4
225	150	60	4
200	120	60	4
250	225	60	4
165	70	67	5
215	145	67	5

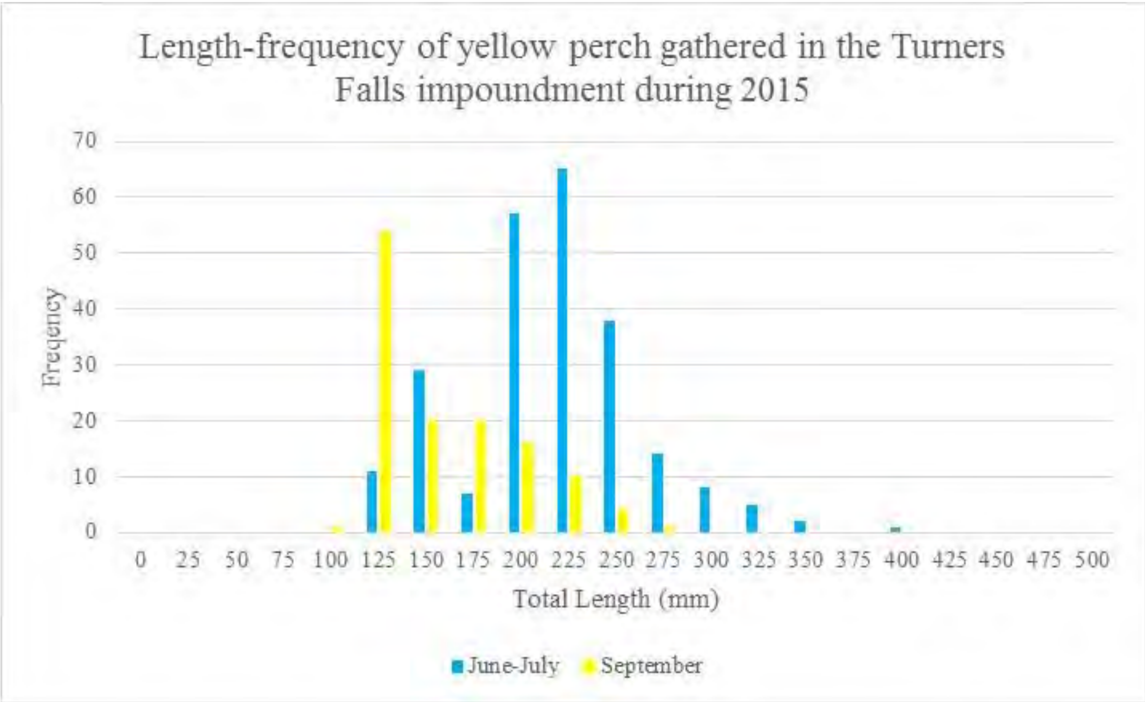
Yellow Perch			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
230	180	67	5
220	155	67	5
115	10	67	5
95	10	67	5
105	20	67	5
95	8	67	5
105	15	67	5
100	18	67	5
145	20	67	5
110	20	67	5
160	30	67	5
95	8	67	5
110	10	72	6
110	10	73	6
100	15	83	6
105	15	80	8
105	10	82	8
100	10	85	8
155	30	72	8
115	20	25	8
105	18	70	5
95	10	70	5
110	20	70	5
110	10	70	5
100	10	70	5
120	20	70	5
125	25	70	5
125	25	70	5
125	20	70	5
135	30	70	5
90	10	70	5
100	10	70	5
105	10	70	5
110	25	70	5
100	8	63	6
110	35	83	6
105	30	74	6
135	45	75	6
120	28	67	6

Yellow Perch			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
104	10	62	5
42	2	71	6
		65	6
		70	6
		77	8
		75	8
		87	8
		80	8
		81	8
		86	8
		72	6
		84	8
		80	5
		84	7
		80	5
		91	8
		80	7
		84	8
		85	8
		88	8



3.2 Length-frequency of yellow perch collected in the Turners Falls impoundment during 2015

Yellow Perch		
Length Class (mm)	**June-July**	**September**
25	0	0
50	0	0
75	0	0
100	0	1
125	11	54
150	29	20
175	7	20
200	57	16
225	65	10
250	38	4
275	14	1
300	8	0
325	5	0
350	2	0
375	0	0
400	1	0
425	0	0
450	0	0
475	0	0
500	0	0



4.0 WHITE SUCKER

4.1 Length and weight of white sucker collected in the Turners Falls Impoundment during 2015

White Sucker			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
480	1300	480	1260
485	1340	415	950
485	1500	415	890
500	1520	394	680
530	1580	473	1120
435	980	420	1170
465	1240	483	1200
390	700	442	900
505	1660	450	1010
520	1530	395	630
495	1490	393	710
405	880	470	1160
435	990	495	1090
450	1070	406	780
430	920	465	1370
430	1080	470	1210
435	950	404	800
425	920	487	1260
460	1080	495	1280
390	850	451	1080
370	600	460	1150
475	1250	502	1310
395	680	444	1000
475	1230	456	1100
460	1080	430	910
445	800	386	720
265	270	132	25
280	280	100	20
160	45	118	20
130	30	109	15
175	40	112	20
290	280	102	15
330	420	74	10
35	3.6	120	25
35	3.6	105	20
35	3.6	83	10
35	3.6	91	10

White Sucker			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
35	3.6	91	10
35	3.6	95	10
35	3.6	111	12
35	3.6	94	10
35	3.6	112	15
35	3.6	122	20
35	3.6	271	220
35	3.6	226	250
35	3.6	276	240
35	3.6	101	10
35	3.6	119	20
35	3.6	204	80
35	3.6	105	12
35	3.6	105	12
35	3.6	111	15
35	3.6	103	10
35	3.6	116	15
35	3.6	113	20
35	3.6	103	10
35	3.6	123	20
35	3.6	315	390
35	3.6	155	50
35	3.6	133	30
35	3.6	113	20
35	3.6	72	4
35	3.6	82	6
35	3.6	90	8
35	3.6	95	8
35	3.6		
35	3.6		
35	3.6		
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35	3.6		
35	3.6		
35	3.6		
35	3.6		
35	3.6		
35	3.6		

White Sucker			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
35	3.6		
35	3.6		
35	3.6		
35	3.6		
35	3.6		
35	3.6		
35	3.6		
35	3.6		
35	3.6		
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35	3.6		

White Sucker			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
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35	3.6		

White Sucker			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
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35	3.6		

White Sucker			
June-July		**September**	
Length (mm)	**Weight (g)**	**Length (mm)**	**Weight (g)**
35	3.6		
35	3.6		
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35	3.6		

White Sucker			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
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35	3.6		

White Sucker			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
35	3.6		
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35	3.6		
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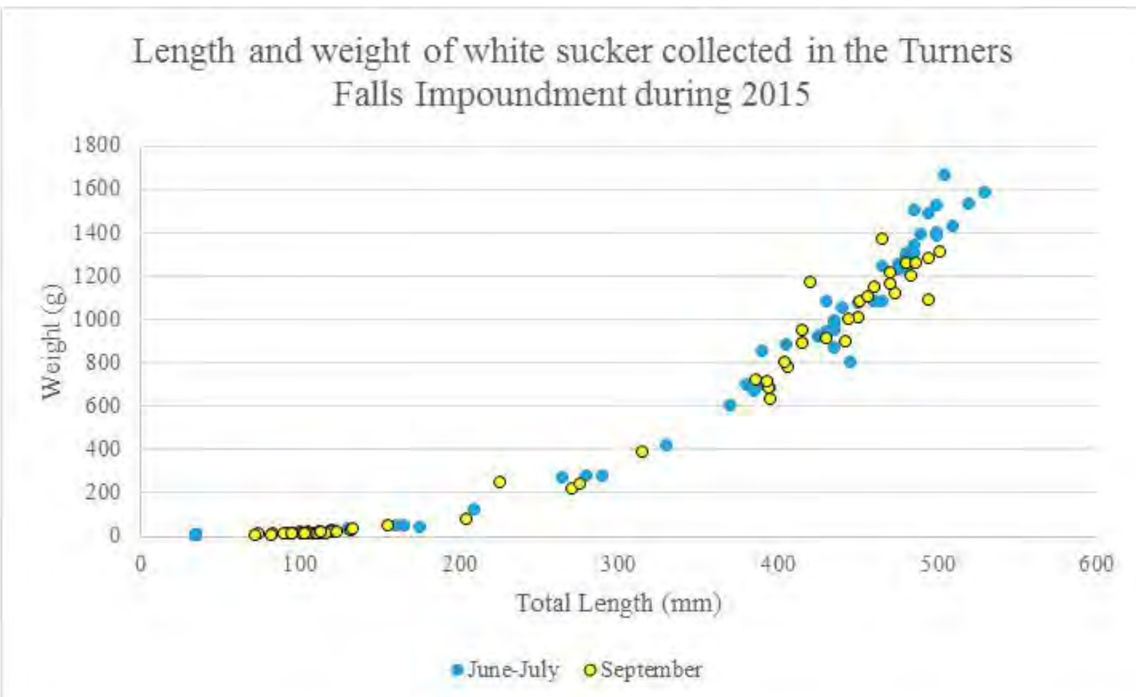
35	3.6		
35	3.6		

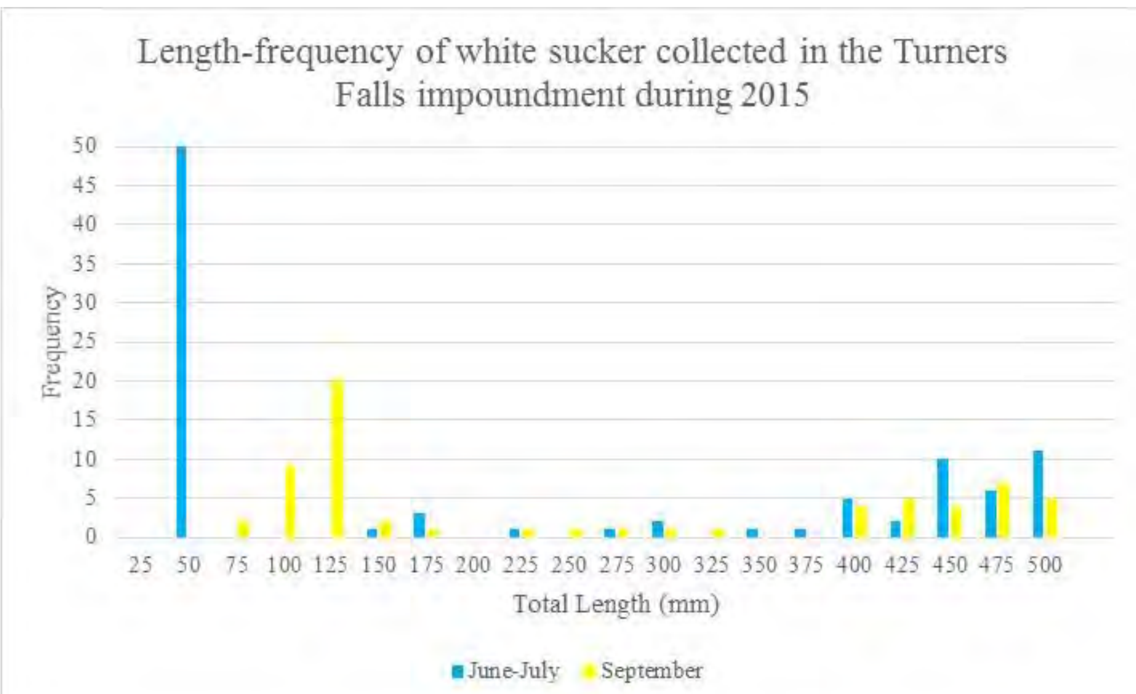
White Sucker			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
500	1400		
490	1390		
510	1430		
440	1050		
480	1280		
430	940		
500	1380		
485	1300		
480	1230		
465	1080		
385	670		
435	870		
380	700		
165	50		
210	120		



4.2 Length-frequency of white sucker collected in the Turners Falls impoundment during 2015

White Sucker		
Length Class (mm)	September	June-July
25	0	0

White Sucker		
Length Class (mm)	**September**	**June-July**
50	0	277
75	2	0
100	9	0
125	20	0
150	2	1
175	1	3
200	0	0
225	1	1
250	1	0
275	1	1
300	1	2
325	1	0
350	0	1
375	0	1
400	4	5
425	5	2
450	4	10
475	7	6
500	5	11

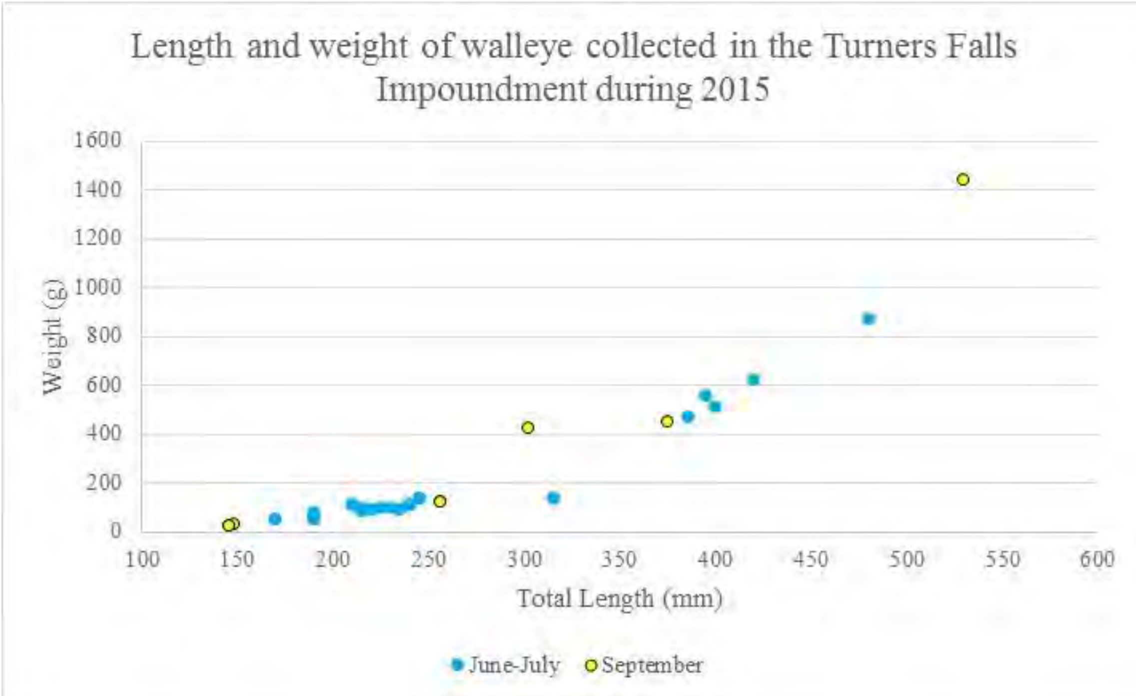


Note: n = 200 for 50mm length class

5.0 WALLEYE

5.1 Length and weight of walleye collected in the Turners Falls Impoundment during 2015

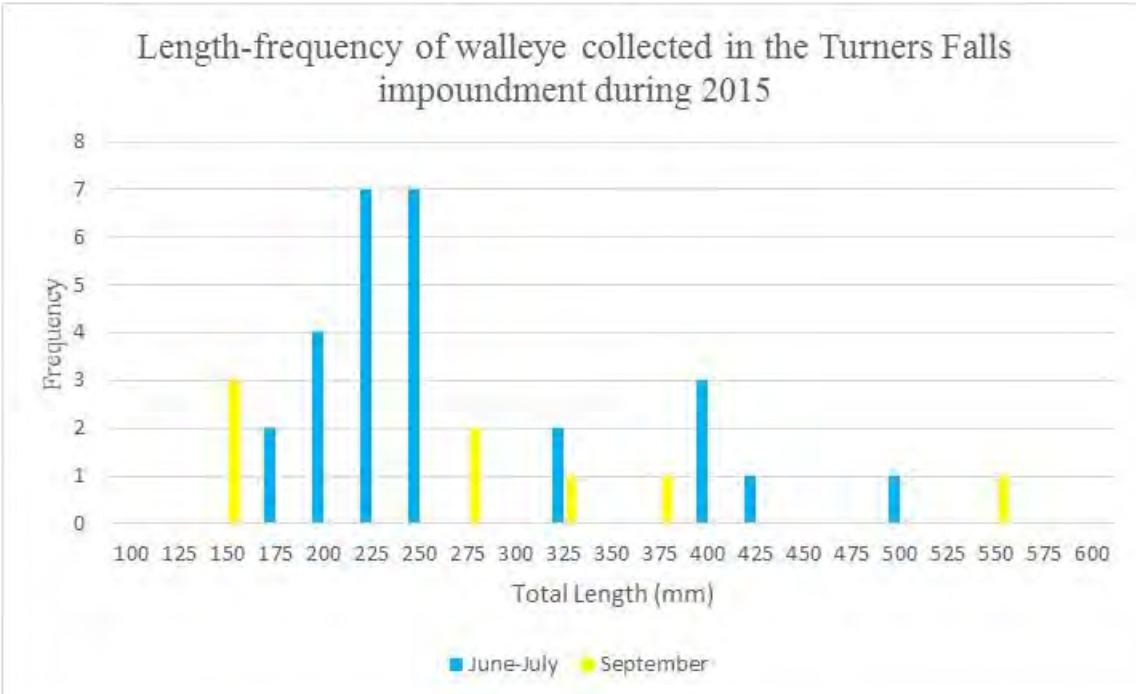
Walleye			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
400	510	530	1440
225	100	302	422
420	620	148	30
215	100	375	450
385	470	256	120
230	100	146	25
215	85	256	120
480	870	146	25
395	560		
170	50		
240	110		
245	140		
190	50		
220	90		
210	110		
235	90		
315	140		
190	80		
170	50		
240	110		
245	140		
190	50		
220	90		
210	110		
235	90		
315	140		
190	80		



5.2 Length-frequency of walleye collected in the Turners Falls impoundment during 2015

Walleye		
Length Class (mm)	**September**	**June-July**
100	0	0
125	0	0
150	3	0
175	0	2
200	0	4
225	0	7
250	0	7
275	2	0
300	0	0
325	1	2
350	0	0
375	1	0
400	0	3
425	0	1
450	0	0
475	0	0
500	0	1
525	0	0
550	1	0

Walleye		
Length Class (mm)	**September**	**June-July**
575	0	0
600	0	0



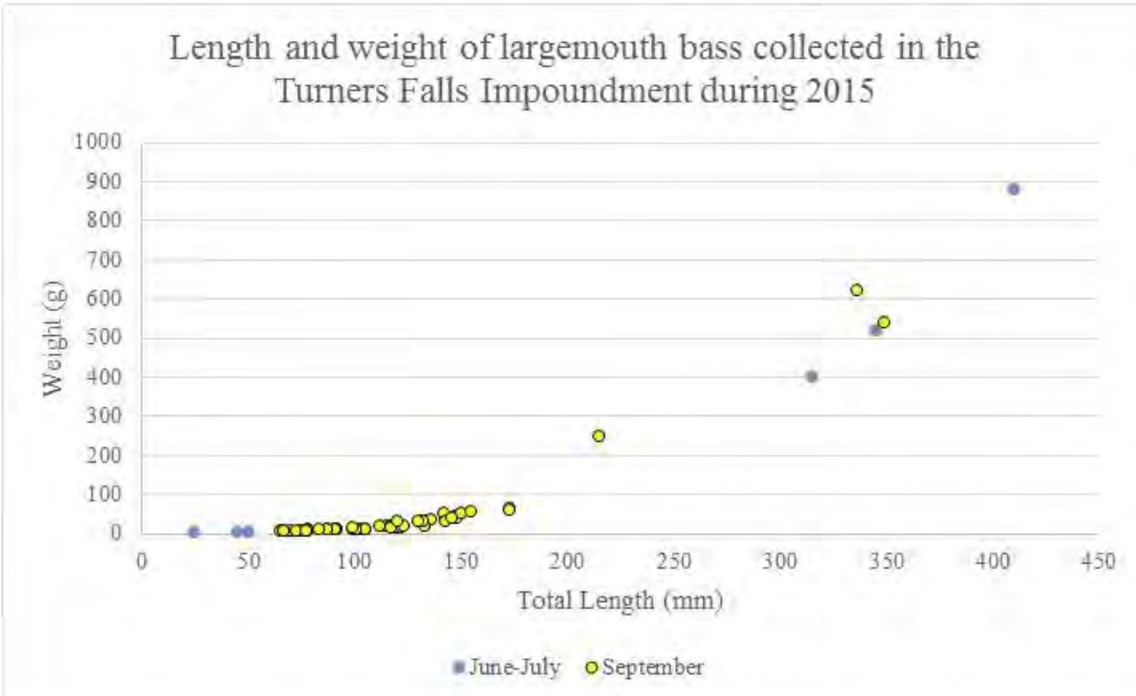
6.0 LARGEMOUTH BASS

6.1 Length and weight of largemouth bass collected in the Turners Falls Impoundment during 2015

Largemouth Bass			
June-July		**September**	
Length (mm)	**Weight (g)**	**Length (mm)**	**Weight (g)**
315	400	349	540
410	880	336	620
345	520	173	65
50	2	147	45
50	4	173	60
25	1	215	250
45	2	122	15
		99	10
		115	20
		105	12
		78	10
		133	30

Largemouth Bass			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
		92	10
		103	10
		105	12
		143	45
		142	50
		119	20
		136	35
		92	10
		133	20
		120	15
		118	20
		112	20
		91	10
		91	10
		117	20
		148	40
		150	50
		132	30
		101	10
		119	15
		87	10
		87	10
		117	15
		143	30
		146	40
		155	55
		130	30
		123	20
		120	30
		99	15
		75	8
		66	8
		78	8
		70	6
		65	6
		67	6
		83	9
		73	8
		77	8

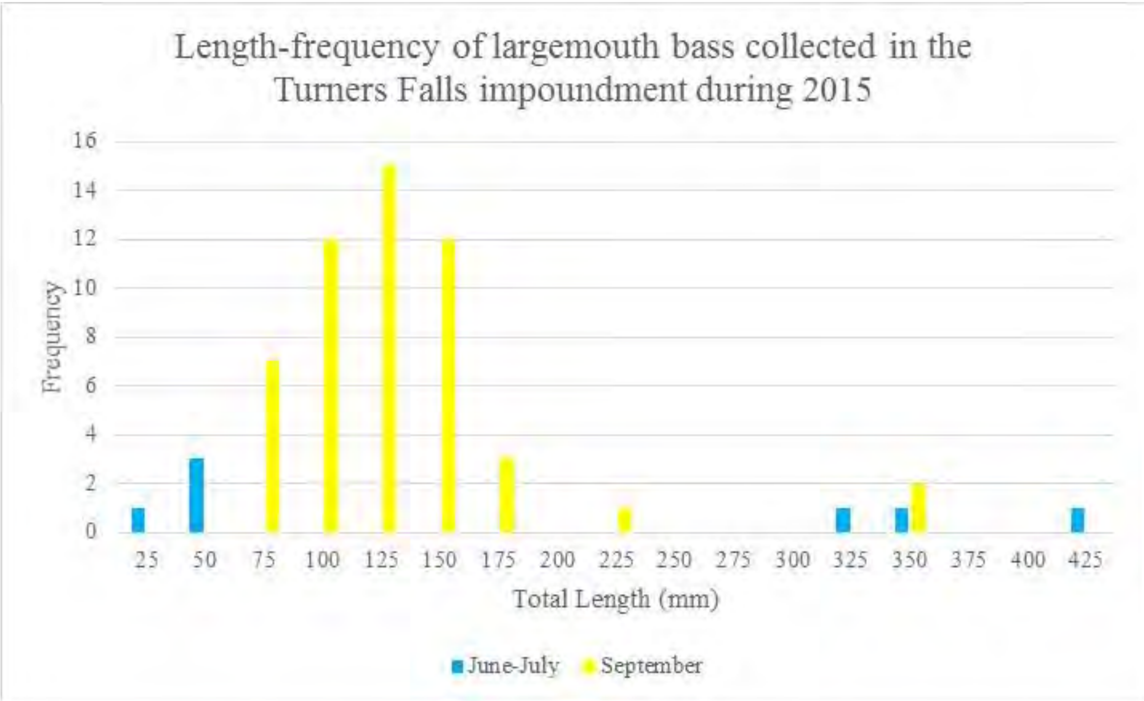
Largemouth Bass			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
		67	7



6.2 Length-frequency of largemouth bass collected in the Turners Falls impoundment during 2015

Largemouth Bass		
Length Class (mm)	September	June-July
25	0	1
50	0	3
75	7	0
100	12	0
125	15	0
150	12	0
175	3	0
200	0	0
225	1	0
250	0	0
275	0	0
300	0	0
325	0	1
350	2	1
375	0	0

Largemouth Bass		
Length Class (mm)	**September**	**June-July**
400	0	0
425	0	1



7.0 BLUEGILL SUNFISH

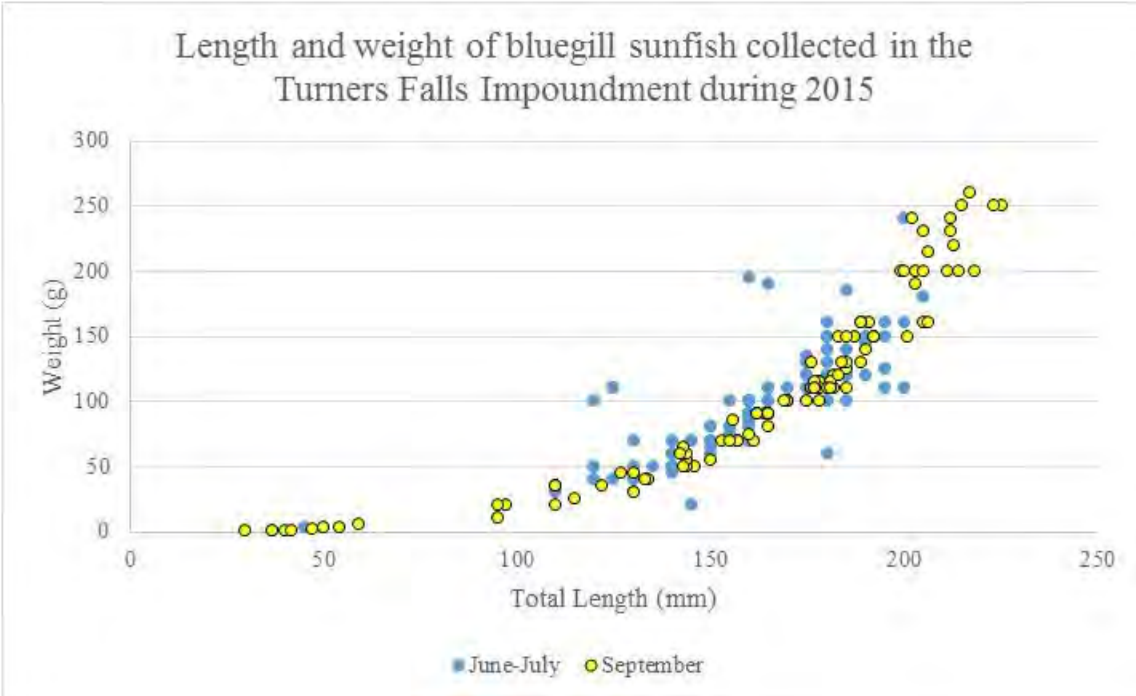
7.1 Length and weight of bluegill sunfish collected in the Turners Falls Impoundment during 2015

Bluegill Sunfish			
June-July		**September**	
Length (mm)	**Weight (g)**	**Length (mm)**	**Weight (g)**
160	100	165	80
135	50	164	90
155	75	182	110
125	40	192	150
150	70	205	160
180	100	201	150
160	90	178	100
165	100	150	55
120	50	134	40
125	110	181	110
125	110	146	50
170	100	157	70
145	70	185	110

Bluegill Sunfish			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
150	80	144	50
160	90	170	100
160	70	161	70
120	40	144	55
170	100	130	30
200	110	115	25
140	50	160	75
195	110	143	60
160	90	187	150
160	80	191	160
130	70	214	200
185	120	162	90
180	60	183	150
125	110	165	90
160	100	144	60
155	80	143	65
140	50	178	115
145	20	176	110
145	70	170	100
125	110	130	45
180	120	127	45
165	100	165	90
175	100	157	70
180	100	189	160
160	80	157	70
130	45	162	90
185	140	176	110
120	100	189	160
190	120	165	90
160	80	165	90
150	60	178	115
180	130	176	110
160	85	170	100
200	160	165	90
155	70	165	90
140	60	185	125
160	90	178	110
185	120	175	100
180	140	199	200

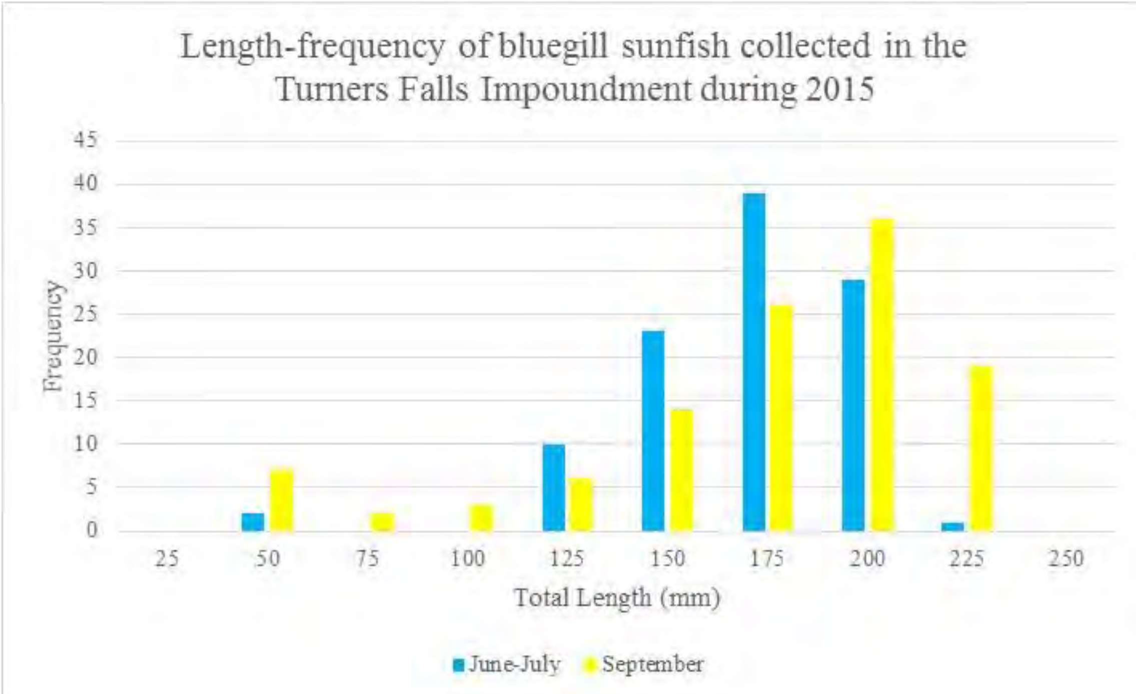
Bluegill Sunfish			
June-July		**September**	
Length (mm)	**Weight (g)**	**Length (mm)**	**Weight (g)**
130	30	189	130
120	40	192	150
130	40	203	200
150	70	190	140
160	90	192	150
140	70	153	70
155	80	143	50
150	80	206	215
140	50	122	35
155	70	182	120
160	100	176	110
185	120	155	70
160	195	181	115
180	150	177	115
165	190	180	110
180	160	212	240
190	145	177	110
190	160	170	100
180	110	176	130
175	120	142	60
165	110	165	90
160	100	183	120
180	150	185	130
195	160	177	110
165	110	184	130
175	120	185	150
195	125	203	190
140	45	213	220
185	100	200	200
140	60	181	110
145	70	205	230
160	90	225	250
170	110	169	100
175	110	206	160
155	75	162	90
130	50	211	200
160	90	156	85
160	100	217	260
150	65	223	250

Bluegill Sunfish			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
155	100	205	200
175	130	133	40
190	150	215	250
190	160	218	200
190	150	212	230
200	240	202	240
185	185	95	10
175	135	97	20
195	150	95	20
205	180	110	35
110	30	110	35
50	3	110	35
45	3	110	20
		54	3
		47	2
		50	3
		59	6
		37	1
		37	1
		40	1
		30	1
		42	1



7.2 Length-frequency of bluegill sunfish collected in the Turners Falls Impoundment during 2015

Bluegill Sunfish		
Length Class (mm)	**September**	**June-July**
25	0	0
50	7	2
75	2	0
100	3	0
125	6	10
150	14	23
175	26	39
200	36	29
225	19	1
250	0	0



8.0 FALLFISH

8.1 Length and weight of fallfish collected in the Turners Falls Impoundment during 2015

Fallfish			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
115	25	372	510
180	70	334	350
130	30	405	520
215	120	406	550
175	50	370	430
155	45	150	30
215	115	176	50
280	240	164	40
265	210	158	40
210	110	148	30
200	90	152	30
97	10	175	50
170	60	165	40
140	30	160	40
180	60	135	25
190	90	139	30
190	80	136	20

Fallfish			
June-July		**September**	
Length (mm)	**Weight (g)**	**Length (mm)**	**Weight (g)**
135	25	264	170
150	30	232	130
145	30	150	30
180	70	245	130
195	90	255	170
175	60	135	20
115	30	216	100
150	35	155	35
180	70	143	30
185	60	166	40
160	60	162	40
200	100	150	35
145	40	157	40
170	50	150	30
430	760	148	30
180	70	159	35
210	110	150	40
200	100	169	50
190	95	150	30
170	65	147	30
280	270	245	150
155	50	234	110
200	40	230	120
90	7	245	150
80	5	147	30
100	6	136	20
90	12	149	30
75	10	146	30
105	15	153	30
100	10	158	40
100	20	158	40
100	12	241	140
110	15	239	130
95	8	232	120
110	12	223	120
110	20	236	130
95	15	135	25
105	10	133	25
115	20	167	40

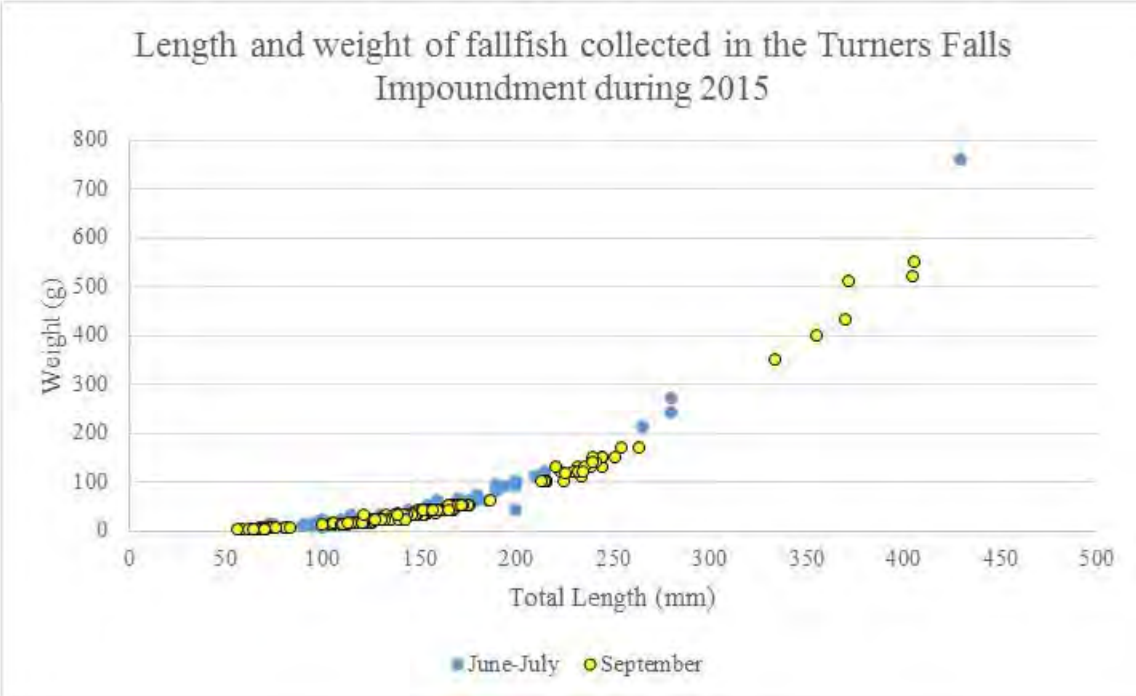
Fallfish			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
105	10	131	25
90	8	152	30
90	8	135	20
90	8	159	40
90	8	187	60
105	15	153	40
105	8	159	40
100	10	166	50
100	10	144	30
75	6	166	45
73	10	138	25
73	10	166	40
73	10	150	30
73	10	128	20
73	10	151	30
73	10	221	130
73	10	216	100
105	10	216	100
75	6	216	100
75	6	216	100
75	6	165	40
75	6	135	20
75	6	150	30
75	6	140	30
75	6	152	30
75	6	235	120
75	6	137	25
75	6	168	40
75	6	167	40
75	6	156	40
75	6	143	30
		161	40
		151	40
		160	40
		133	30
		149	30
		149	30
		145	30
		355	400

Fallfish			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
		240	150
		240	140
		251	150
		215	100
		225	100
		154	40
		147	30
		155	40
		148	30
		165	50
		226	115
		128	20
		213	100
		165	50
		173	50
		152	40
		172	50
		146	35
		170	50
		139	35
		146	30
		165	40
		144	30
		142	30
		172	50
		137	30
		126	20
		136	20
		142	20
		127	20
		140	20
		105	10
		126	15
		130	20
		127	20
		105	10
		118	15
		104	10
		128	20

Fallfish			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
		132	20
		119	15
		115	15
		143	20
		130	20
		126	15
		157	40
		139	30
		139	30
		125	15
		128	20
		123	15
		105	12
		105	12
		105	12
		105	12
		105	12
		105	12
		105	12
		105	12
		105	12
		106	15
		117	15
		117	15
		117	15
		117	15
		117	15
		117	15
		117	15
		117	15
		117	15
		117	15
		117	15
		117	15
		117	15
		117	15
		117	15
		117	15
		117	15

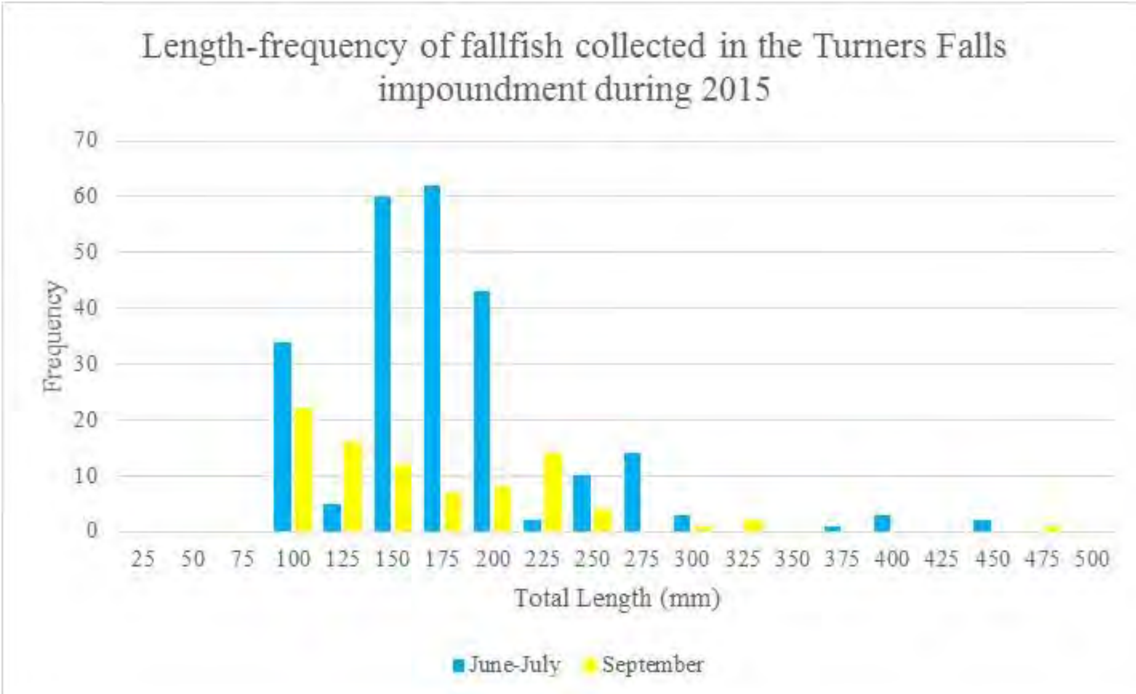
Fallfish			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
		117	15
		117	15
		117	15
		117	15
		117	15
		117	15
		117	15
		117	15
		117	15
		117	15
		117	15
		117	15
		117	15
		117	15
		110	12
		110	12
		110	12
		100	10
		113	10
		122	15
		111	10
		115	15
		113	15
		122	15
		121	15
		122	30
		131	20
		127	20
		67	3
		70	4
		68	3
		68	4
		81	5
		73	4
		74	4
		74	4
		68	3
		63	3
		59	2

Fallfish			
June-July		**September**	
Length (mm)	**Weight (g)**	**Length (mm)**	**Weight (g)**
		70	3
		65	3
		56	2
		65	3
		68	3
		70	3
		68	3
		65	3
		65	3
		68	3
		70	3
		68	3
		70	3
		70	3
		70	3
		70	3
		70	3
		70	3
		70	3
		70	3
		70	3
		65	3
		62	3
		65	3
		81	4
		76	4
		84	4



8.2 Length-frequency of fallfish collected in the Turners Falls impoundment during 2015

Fallfish		
Length Class (mm)	**September**	**June-July**
25	0	0
50	0	0
75	0	0
100	22	34
125	16	5
150	12	60
175	7	62
200	8	43
225	14	2
250	4	10
275	0	14
300	1	3
325	2	0
350	0	0
375	0	1
400	0	3
425	0	0
450	0	2
475	1	0
500	0	0



9.0 SMALLMOUTH BASS

9.1 Length and weight of smallmouth bass collected in the Turners Falls Impoundment during 2015

Smallmouth Bass			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
240	160	248	200
210	130	183	70
225	150	175	70
180	80	170	70
220	145	238	150
290	370	182	80
275	250	222	135
310	400	170	55
190	100	179	75
220	150	176	55
200	100	307	300
250	200	225	120
225	150	232	120
220	150	158	60
230	150	189	70
235	170	245	150
270	235	251	155

Smallmouth Bass			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
200	200	247	160
215	130	225	130
170	70	236	160
250	210	272	240
230	170	235	155
295	350	230	150
250	235	166	55
240	190	160	50
270	235	176	65
225	130	162	50
210	115	165	50
220	160	163	50
220	155	173	60
215	140	284	260
220	150	272	210
255	220	286	260
210	160	229	150
310	365	288	290
225	180	171	70
225	140	195	80
210	110	174	50
220	145	171	60
210	120	163	60
260	210	160	50
290	310	281	300
240	170	378	600
230	150	360	540
330	460	303	330
230	160	168	50
240	210	180	70
245	200	181	65
260	230	163	50
275	300	170	65
270	270	166	55
260	235	184	80
230	170	178	70
310	360	171	70
255	210	160	55
280	290	287	250

Smallmouth Bass			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
270	250	160	50
270	300	220	120
275	300	325	450
290	300	320	430
265	150	162	50
470	1315	162	50
280	310	180	80
350	640	162	50
240	220	412	810
345	510	177	70
210	160	197	80
230	180	195	100
240	210	175	65
210	160	177	65
240	200	161	50
175	80	205	100
240	190	373	560
425	860	458	1200
340	520	379	730
260	280	412	850
230	200	286	300
245	220	380	600
245	205	352	500
250	230	327	420
225	150	306	350
190	80	295	350
240	200	219	120
290	320	263	170
280	360	165	50
305	380	186	80
415	960	166	50
235	200	165	50
305	410	420	870
210	125	370	550
440	1150	308	320
280	350	285	270
225	195	299	300
240	220	382	705
255	245	330	420

Smallmouth Bass			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
420	960	279	240
305	390	301	300
265	255	273	240
300	410	232	160
345	560	274	240
270	265	242	180
375	650	168	50
225	150	108	15
225	160	86	10
200	195	159	45
225	140	100	10
120	25	92	12
95	15	85	10
110	12	157	45
120	20	150	35
95	12	103	10
95	15	139	30
95	18	148	30
100	18	103	10
110	12	137	30
100	12	149	40
90	10	143	35
115	12	150	40
115	20	142	30
110	15	110	12
95	15	92	10
90	12	145	30
105	15	133	25
100	10	142	30
110	15	96	10
120	45	149	30
110	15	145	30
100	15	133	40
110	30	113	20
95	20	92	10
105	15	127	20
130	28	147	40
120	20	139	30
110	15	106	15

Smallmouth Bass			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
110	15	100	12
125	45	89	10
135	45	152	50
95	25	103	15
125	50	103	10
105	30	98	10
110	25	148	30
90	15	151	30
95	10	94	10
80	5	96	10
105	10	97	10
105	15	105	12
90	20	102	12
110	25	100	10
100	25	103	12
115	30	92	10
105	18	150	30
115	25	145	40
100	20	152	50
95	18	93	10
105	22	95	10
95	20	143	40
100	20	145	50
110	22	156	50
95	12	113	20
105	18	102	15
110	20	150	50
120	20	156	50
95	15	158	50
90	15	112	20
100	18	156	50
115	35	142	45
95	15	105	15
110	30	100	12
100	22	86	10
130	40	151	40
80	10	148	35
80	10	106	10
95	15	100	10

Smallmouth Bass			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
95	15	91	10
90	15	107	12
120	20	98	10
120	22	96	10
85	10	153	50
105	20	107	20
95	12	121	30
90	10	145	30
105	15	156	50
110	20	107	20
110	20	100	15
100	15	100	15
80	12	97	15
115	25	101	15
90	12	106	15
110	20	95	15
110	20	108	15
95	15	111	20
120	30	91	10
110	15	95	10
105	12	88	10
125	20	94	12
105	20	87	10
115	20	90	10
105	20	97	12
110	20	85	10
110	10	90	10
110	20	102	20
130	40	90	10
110	15	109	15
105	20	118	20
85	10	100	10
145	20	153	50
140	30	89	10
95	10	152	50
100	8	106	15
100	10	155	50
125	30	95	10
90	7	112	20

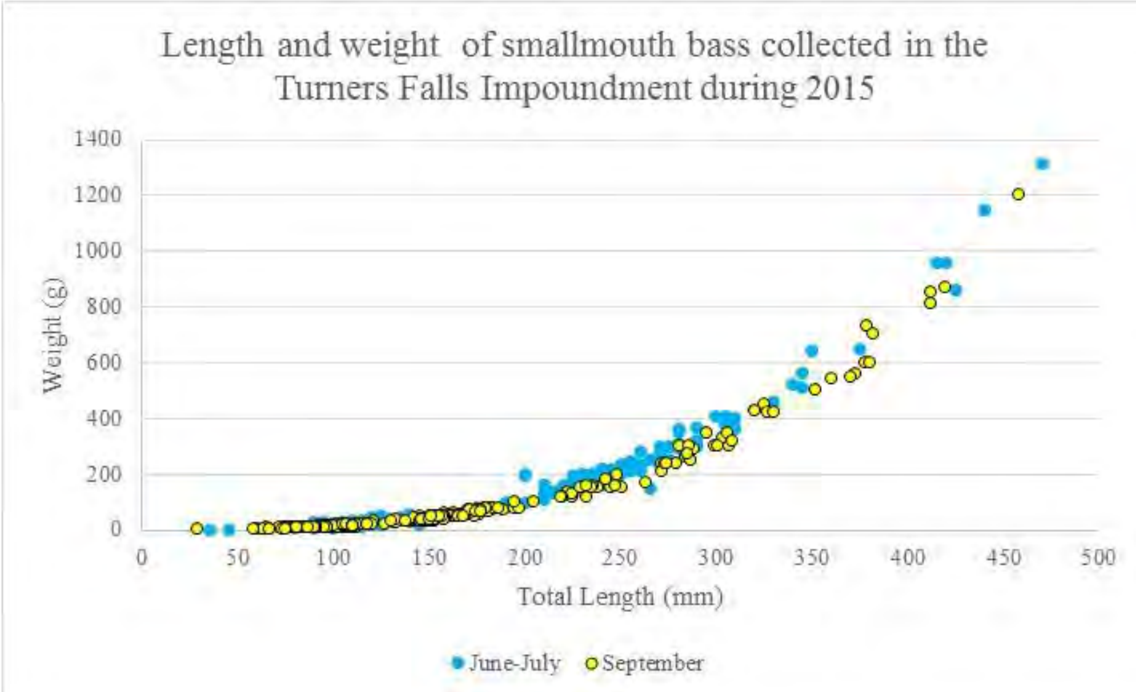
Smallmouth Bass			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
95	10	100	10
120	40	89	10
120	40	95	10
150	50	94	10
100	10	100	10
100	12	109	15
110	20	93	10
110	25	150	40
110	35	120	20
95	28	101	10
140	55	95	10
90	28	112	10
115	25	115	20
115	25	104	15
100	10	96	10
95	25	92	10
100	10	100	10
80	10	158	40
110	30	153	30
115	15	90	10
105	15	153	40
95	20	107	10
35	2	96	10
45	1	155	50
		92	10
		146	40
		94	10
		103	12
		106	12
		90	10
		102	10
		90	10
		93	10
		101	10
		138	30
		95	10
		105	10
		101	10
		150	40

Smallmouth Bass			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
		150	40
		150	40
		150	40
		107	10
		118	20
		98	10
		111	20
		102	10
		105	12
		95	10
		107	15
		107	12
		103	10
		97	10
		90	10
		153	40
		107	10
		146	40
		155	50
		92	10
		146	40
		146	40
		92	10
		146	40
		130	30
		146	40
		146	40
		157	50
		110	10
		150	40
		155	50
		112	20
		92	10
		105	15
		107	20
		95	10
		93	10
		100	12
		97	10

Smallmouth Bass			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
		92	10
		106	12
		105	20
		97	10
		95	10
		107	20
		151	50
		67	4
		60	4
		74	6
		90	8
		65	6
		75	8
		77	8
		75	8
		60	5
		78	8
		85	6
		88	8
		87	8
		63	5
		110	12
		110	12
		110	12
		110	12
		110	12
		110	12
		110	12
		110	12
		110	12
		110	12
		110	12
		110	12
		110	12
		75	8
		78	8
		74	8
		83	8
		83	8

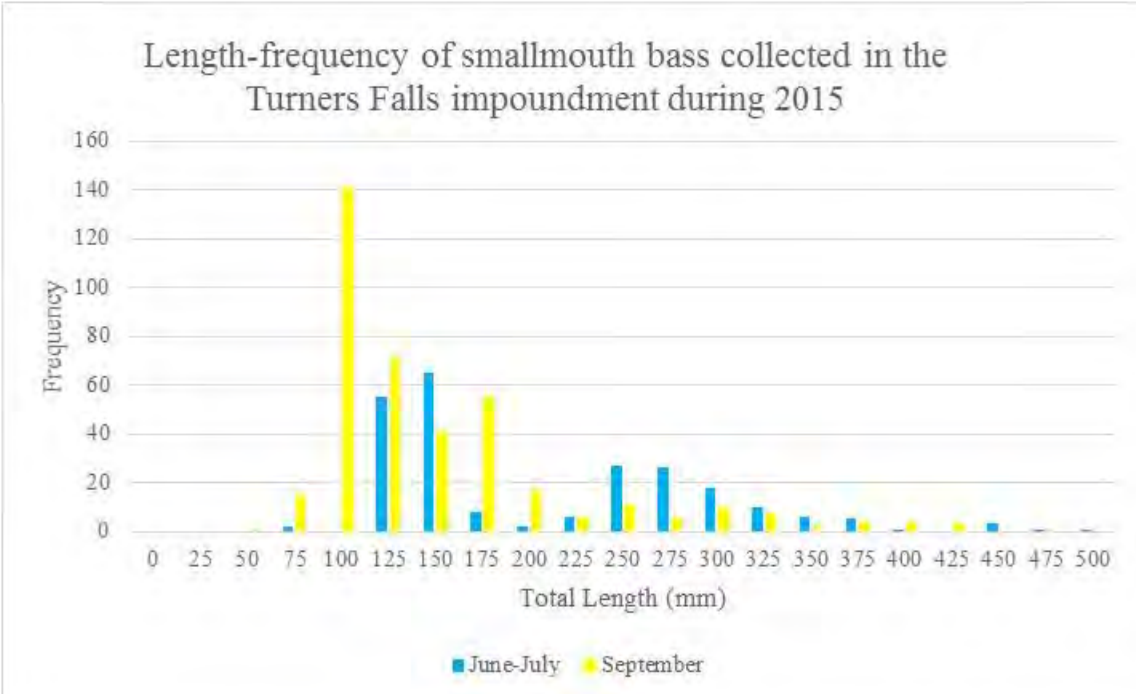
Smallmouth Bass			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
		58	5
		72	7
		67	4
		90	8
		80	8
		29	5
		89	8
		80	8
		91	8
		91	8
		91	8
		91	8
		91	8
		91	8
		91	8
		91	8
		91	8
		91	8
		91	8
		91	8
		91	8
		91	8
		91	8
		90	8
		90	8
		73	5
		80	8
		80	8
		80	8
		80	8
		80	8
		80	8
		80	8
		80	8
		80	8
		80	8
		80	8
		80	8
		80	8

Smallmouth Bass			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
		80	8
		80	8
		80	8
		80	8
		80	8
		80	8
		80	8
		80	8
		80	8
		80	8
		80	8
		80	8
		80	8
		80	8
		80	8
		80	8
		80	8
		80	8
		80	8
		80	8
		80	8
		80	8
		86	7
		80	7
		75	5
		87	8
		81	8



9.2 Length-frequency of smallmouth bass collected in the Turners Falls impoundment during 2015

Smallmouth Bass		
length class (mm)	**June-July**	**September**
25	0	0
50	0	1
75	2	15
100	0	141
125	55	71
150	65	41
175	8	55
200	2	17
225	6	6
250	27	11
275	26	6
300	18	10
325	10	7
350	6	2
375	5	4
400	1	4
425	0	3
450	3	0
475	1	1
500	1	0



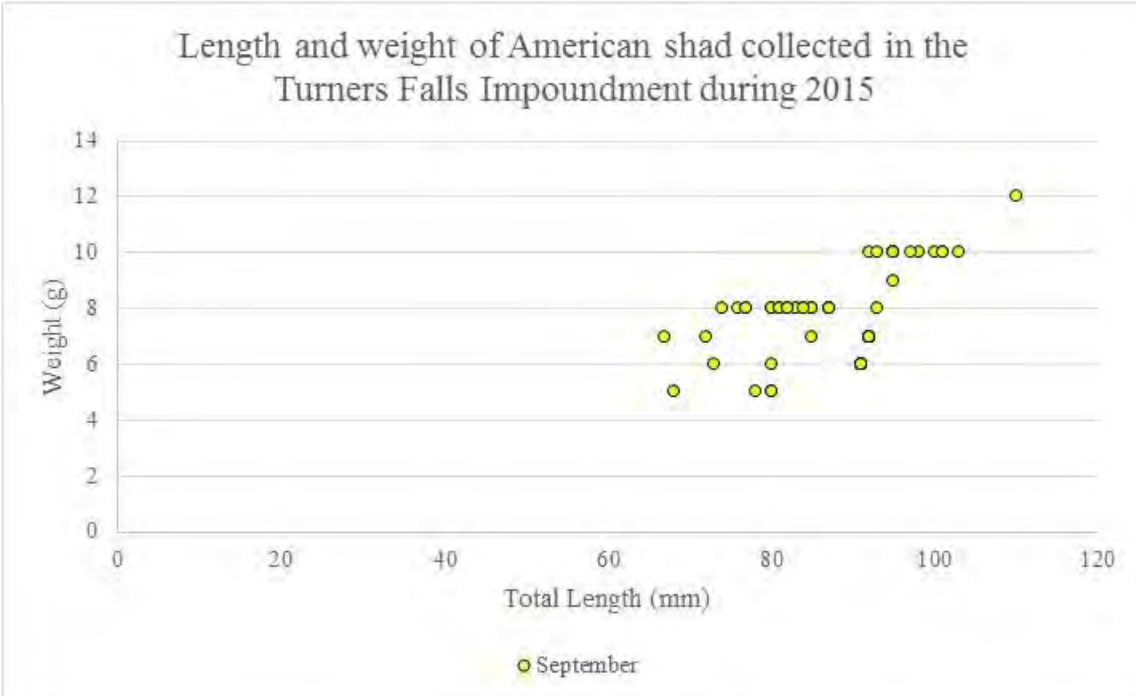
10.0 AMERICAN SHAD

10.1 Length and weight of American shad collected in the Turners Falls Impoundment during 2015

American Shad			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
		87	8
		95	9
		85	8
		95	10
		83	8
		85	8
		84	8
		73	6
		80	6
		87	8
		87	8
		80	8
		81	8
		87	8
		80	8
		81	8
		85	8

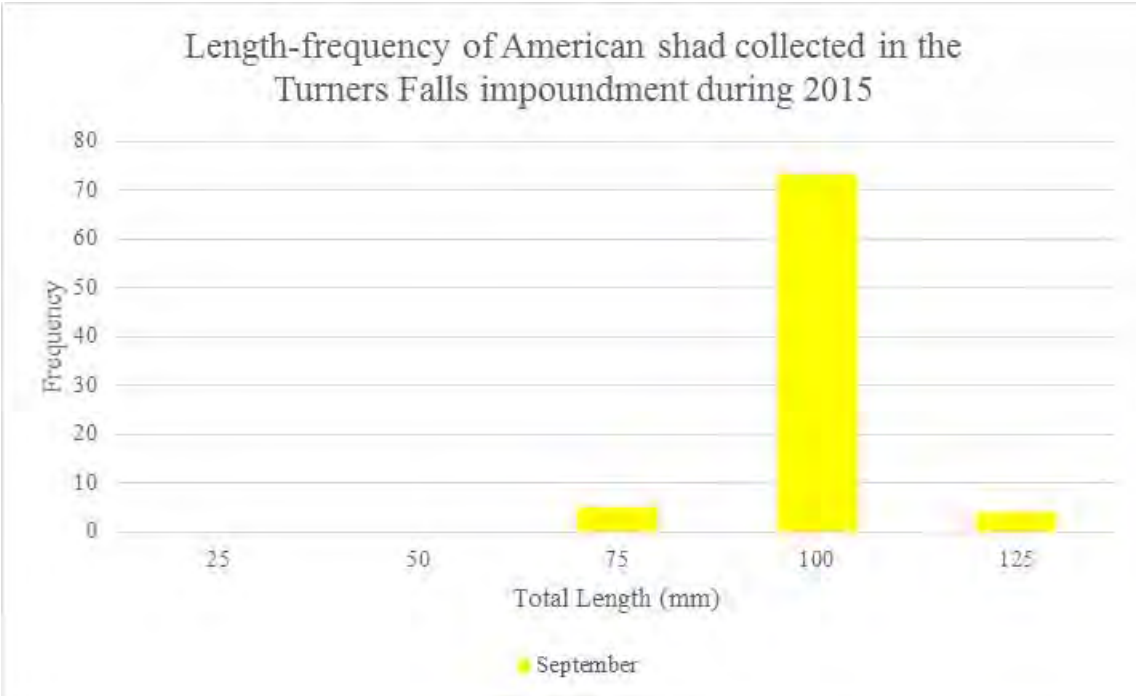
American Shad			
June-July		September	
Length (mm)	Weight (g)	Length (mm)	Weight (g)
		93	8
		83	8
		87	8
		84	8
		101	10
		76	8
		67	7
		81	8
		98	10
		77	8
		95	10
		95	10
		77	8
		95	10
		82	8
		72	7
		82	8
		103	10
		100	10
		95	10
		101	10
		92	10
		80	5
		68	5
		80	5
		85	7
		78	5
		74	8
		91	6
		91	6
		91	6
		91	6
		91	6
		91	6
		91	6
		91	6
		91	6
		91	6
		91	6

American Shad			
June-July		**September**	
Length (mm)	**Weight (g)**	**Length (mm)**	**Weight (g)**
		91	6
		91	6
		91	6
		91	6
		97	10
		110	12
		92	7
		92	7
		92	7
		92	7
		92	7
		92	7
		92	7
		92	7
		92	7
		92	7
		92	7
		92	7
		92	7
		92	7
		92	7
		92	7
		92	7
		92	7
		92	7
		93	10



10.2 Length-frequency of American shad collected in the Turners Falls impoundment during 2015

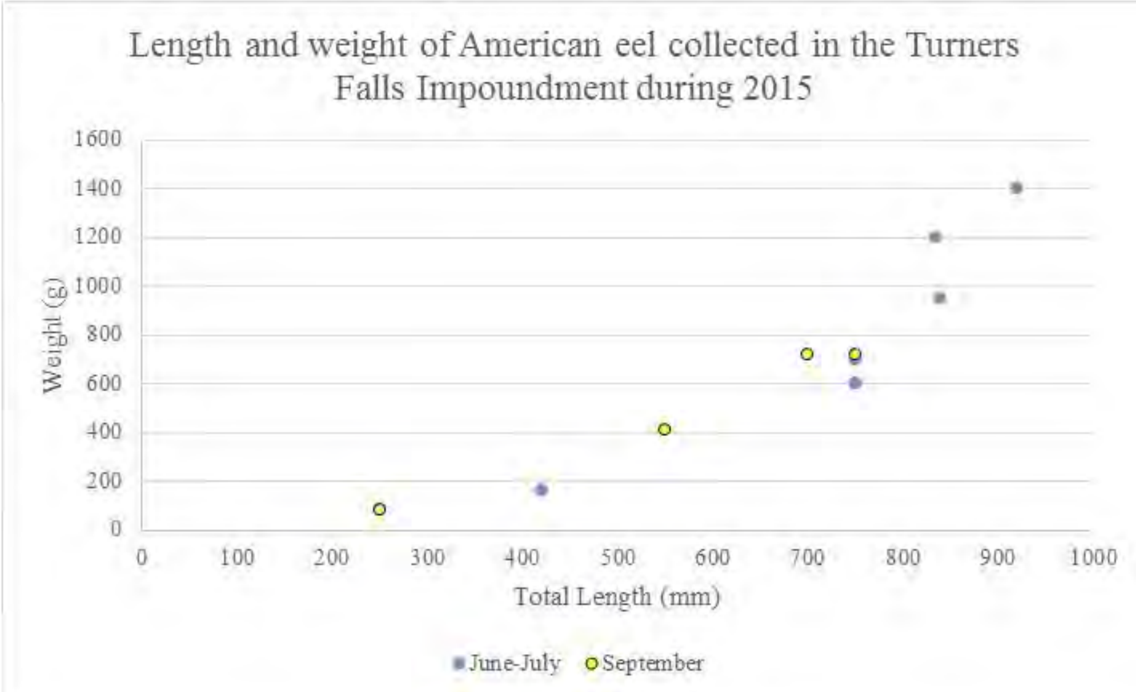
American Shad		
Length Class (mm)	**June-July**	**September**
25		0
50		0
75		5
100		73
125		4



11.0 AMERICAN EEL

11.1 Length and weight of American eel collected in the Turners Falls Impoundment during 2015

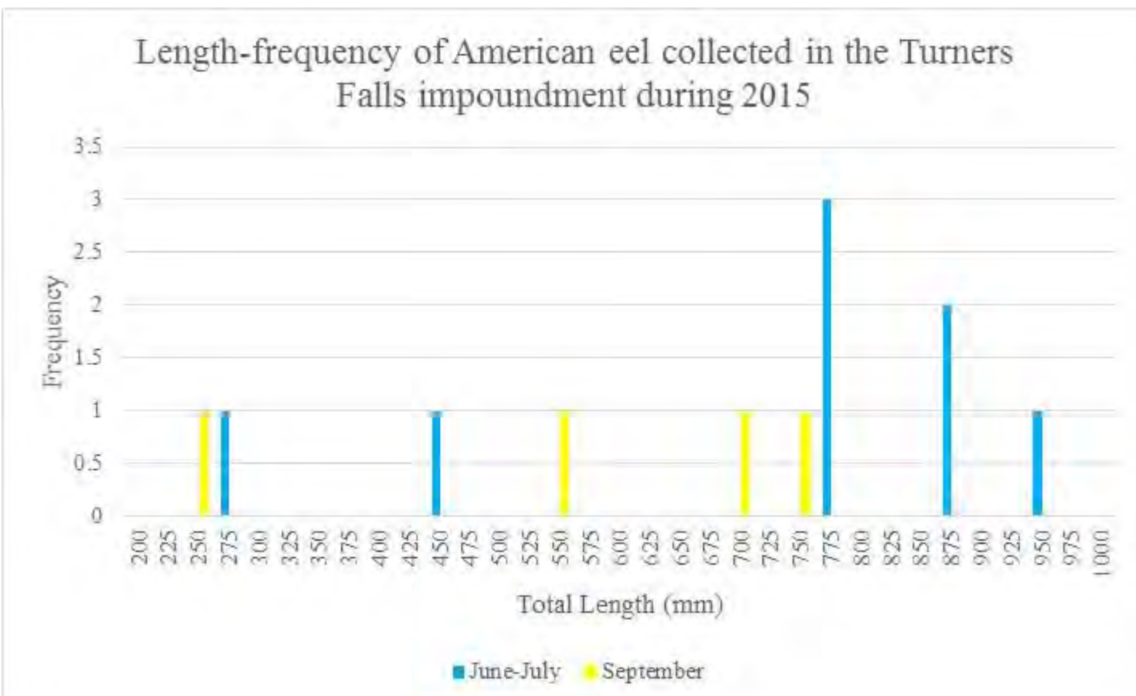
American Eel			
June-July		**September**	
Length (mm)	**Weight (g)**	**Length (mm)**	**Weight (g)**
835	1200	700	720
920	1400	750	720
420	160	550	410
750	700	250	80
750	600		
750	600		
840	950		
250	80		



11.2 Length-frequency of American eel collected in the Turners Falls impoundment during 2015

American Eel		
Length Class (mm)	**June-July**	**September**
200	0	0
225	0	0
250	0	1
275	1	0
300	0	0
325	0	0
350	0	0
375	0	0
400	0	0
425	0	0
450	1	0
475	0	0
500	0	0
525	0	0
550	0	1
575	0	0
600	0	0
625	0	0
650	0	0
675	0	0

American Eel		
Length Class (mm)	**June-July**	**September**
700	0	1
725	0	0
750	0	1
775	3	0
800	0	0
825	0	0
850	0	0
875	2	0
900	0	0
925	0	0
950	1	0
975	0	0
1000	0	0



STUDY 3.3.12 ATTACHMENTS

Attachment A to Study 3.3.12.
Vermont Stream Geomorphic Assessment. Particle Entrainment and Transport

Vermont Stream Geomorphic Assessment

Appendix O

Particle Entrainment and Transport

Vermont Agency of Natural Resources
May, 2009

Particle Entrainment and Transport

Introduction

What follows is an introduction to basic concepts associated with measurement and prediction of entrainment and transport of bed material in natural rivers. The purpose of this discussion is to familiarize the reader with methods for predicting particle entrainment and their limitations. This discussion does not represent the full breadth of study and research on this subject matter. Rather it introduces core principles and gives background on methods of entrainment prediction most commonly used by river management practitioners.

The Importance of Bedload Transport: Understanding characteristics of sediment transport benefits many applications including prediction of the effects of land use or flow regime change and channel restoration efforts (Wilcock, 2001). The relationship between discharge and bedload transport rate through a reach and the ability of the existing channel to transport the bedload (sediment transport capacity) is critical to the establishment of river equilibrium in river corridor protection and restoration efforts. Measuring the size and quantity of bedload particles moving through a reach at different discharges and developing a sediment rating curve is the ideal predictive tool for project design. Once the conditions required for bedload transport are known, they can be translated into an understanding of the channel dimension, pattern, and profile that will result in sufficient transport of the expected sediment supply.

Measuring Bedload Transport: Unfortunately, bedload transport is not simple to measure or predict. It is a sporadic process that occurs through a variety of mechanisms. Its variability both spatially and temporally add to the difficulty. Bedload measurement is particularly challenging for river managers to conduct due to its high cost and the length of time over which it takes to accurately complete. Additionally, sampling devices placed in the flow may perturb local hydraulics sufficiently to create anomalously high or low transport conditions (Wohl, 2000). Despite these difficulties, efforts to understand bed-load transport and its relation to flow discharge are worthwhile and can lead to better assessment and project design.

Sediment Entrainment Calculation

In lieu of creating sediment rating curves on a project by project basis, practitioners have had fairly good results using empirically derived equations for the prediction of the conditions necessary to entrain bed particles and designing channels to produce those conditions. While the first efforts in this area resulted in equations that were accurate only when applied to channels with homogeneous bed sediments, more recent efforts have resulted in equations that are applicable to natural rivers.

The parameter often used as a measure of the stream's ability to entrain bed material is the shear stress created by the flow acting on the bed material. Shear stress acts in the direction of the flow as it slides along the channel bed and banks. Critical shear stress is the shear stress required to mobilize sediments delivered to the channel. When the shear stress equals the critical shear stress, the channel will likely be in equilibrium. Where shear stress is excessively greater than critical shear stress, channel degradation will likely result. Where the shear stress is less than critical shear stress, channel aggradation will likely result. Thus the ability to calculate or measure both shear and critical shear stress is crucial in understanding channel adjustments.

Calculating Shear Stress: Unfortunately, attempts to calculate or measure shear stress values in mountain rivers are complicated by the channel bed roughness and the associated turbulence and velocity fluctuations (Wohl, 2000). Turbulence can lead to substantial variability in velocity and shear stress at a point during constant discharge. Heterogeneities caused by grains and bedforms may create substantial velocity and shear stress variations across the channel or downstream during a constant discharge. Despite these issues measurement of the general shear stress in a reach is feasible and useful.

Based upon the physical properties involved, the following theoretical equation for general shear stress has been developed.

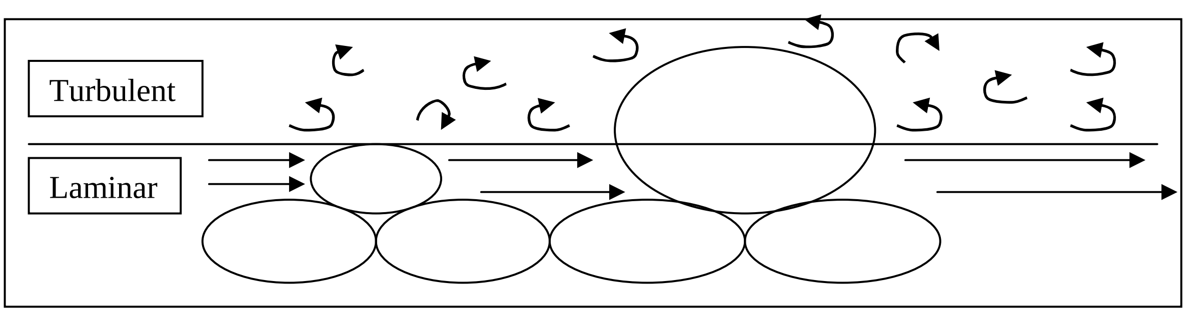
$$\tau = \gamma R s \text{ (lbs./sq.ft.),}$$

where τ is the fluid shear stress
γ is the specific gravity of water
(density x gravitational acceleration)
(1.94 slugs x 32.2 ft/sq.sec) = 62.4 lbs./sq.ft.
R is the hydraulic radius (approximately mean depth)
s is the slope of the channel

The Physical Properties Involved
Initiation of motion involves mass, force, friction and stress. Gravity and friction are the two primary forces in play as water flows through a channel. Gravity acts upon water to move it down slope. Friction exerted on the water by the bed and banks of the channel works to slow the movement of the water. When the force of gravity is equal and opposite to the force of friction the water flows through the channel at a constant velocity. When the force of gravity is greater than the force of friction the water accelerates (Leopold et.al., 1964).

Shear Stress vs. a Particle Resistance to Movement: A given particle will move only when the shear stress acting on it is greater than the resistance of the particle to movement. The magnitude of shear stress required to move a given particle is known as the critical shear stress (τ_{cr}). The resistance of the particles to movement and thus its entrainment will vary depending on its size, its size relative to surrounding particles, how it is oriented and the degree to which it is embedded. The size of the particle will influence the weight of the particle. The size of the particles relative to surrounding particles will affect the amount of shear stress the particle is exposed to via the "hiding" factor. Orientation of the particle will affect the force required to roll the particle along the bed. Packing or embeddedness will affect the amount of shear stress that the particle is exposed to.

Because of turbulence the hiding affect may be the primary factor in determining critical shear stress. Turbulence can result in shear stress spikes that are four times greater than the average shear stress. Thus a particle exposed to turbulence will experience greater fluid force than a particle not exposed to the turbulence. There is a layer of water just above the stream bed that is not turbulent. The thickness of this layer is sufficient to cover the average particle size of the bed. A larger particle however, will extend above this zone of non-turbulent flow and be exposed to turbulent flow. Thus, a particle surrounded by smaller particles will experience turbulence while a particle that is the same size as the average bed size will experience only non-turbulent flow and thus be exposed to less fluid shear stress. Accurate estimations of critical shear stress requires accurate characterization of these parameters (Wohl, 2000).



Calculating Critical Shear Stress: With the above principles in mind, Shields in 1936 conducted flume experiments to develop an expression for the critical shear stress to move a particle of a given size (Knighton, 1998). His work resulted in the following equation:

$$\tau_{cr} = \tau_{ci} \times g(\rho_s - \rho_w)d$$

where;

τ_{cr} is critical shear stress,
τ_{ci} is dimensionless critical shear stress,
g is acceleration due to gravity,
ρ_s is the density of sediment,
ρ_{ws} is the density of water; and
d is the size of the particle of interest.

Shields' studies showed that in gravel bed channels of homogeneous sediment sizes and turbulent flow the value of dimensionless critical shear stress is 0.06. Shields' still serves as a basis for defining critical shear stress (Fischenich, 2001). However, since Sheilds' work other researchers have developed derivations of Shields' equation in an effort to improve the prediction of critical shear in natural channels with heterogeneous substrate sizes.

Fischenich, (2001) lists the following equations presented by Julien to approximate the critical shear stress for particles of various sizes.

$$\tau_{cr} = 0.5 \times g(\rho_s - \rho_w)d \times Tan\phi \quad \text{:For clays}$$
$$\tau_{cr} = 0.25 d_*^{-0.6} \times g(\rho_s - \rho_w)d \times Tan\phi \quad \text{:For silts and sands}$$
$$\tau_{cr} = 0.06 \times g(\rho_s - \rho_w)d \times Tan\phi \quad \text{:For gravels and cobbles}$$

Where;

$$d_* = d\left[\frac{(G-1)g}{v^2}\right]^{1/3}$$

ϕ is the angle of repose of the particle
G is the specific gravity of sediment
g is acceleration due to gravity,
ρ_s is the density of sediment,
ρ_{ws} is the density of water
v is the kinematic velocity; and
d is the size of the particle of interest.

Angles of repose are given in Table 1 (Julien, 1995). Critical shear stresses are also provided in Table 1. It is important to realize that mixtures of sediments behave differently than uniform sediments. Particles larger than the median will be entrained at shear stresses lower than those given in Table 1 and, conversely, larger shear stresses than those listed in the table are required to entrain particles smaller than the median size (Fischenich, 2001).

Table 1 Limiting Shear Stress and Velocity For Uniform Noncohesive Sediments

Class name	d_s (in)	ϕ (deg)	τ_c	τ_{cr} (lb/sf)	V_{*c} (ft/s)
Boulder					
Very large	>80	42	0.054	37.4	4.36
Large	>40	42	0.054	18.7	3.08
Medium	>20	42	0.054	9.3	2.20
Small	>10	42	0.054	4.7	1.54
Cobble					
Large	>5	42	0.054	2.3	1.08
Small	>2.5	41	0.052	1.1	0.75
Gravel					
Very coarse	>1.3	40	0.050	0.54	0.52
Coarse	>0.6	38	0.047	0.25	0.36
Medium	>0.3	36	0.044	0.12	0.24
Fine	>0.16	35	0.042	0.06	0.17
Very fine	>0.08	33	0.039	0.03	0.12
Sands					
Very coarse	>0.04	32	0.029	0.01	0.070
Coarse	>0.02	31	0.033	0.006	0.055
Medium	>0.01	30	0.048	0.004	0.045
Fine	>0.005	30	0.072	0.003	0.040
Very fine	>0.003	30	0.109	0.002	0.035
Silts					
Coarse	>0.002	30	0.165	0.001	0.030
Medium	>0.001	30	0.25	0.001	0.025

Since Shields conducted his work further research has shown that τ_{ci} can range from 0.25-0.02 depending upon the size distribution of the bed particles. Andrews (1984) showed that τ_{ci} can be calculated using the following equation:

$$\tau^*_{ci} = 0.0834\left(\frac{d_i}{d_{s_{50}}}\right)^{-0.872}$$

where;

d_i is the particle size of interest

$d_{S_{50}}$ is the median particle size of the sub-surface

Andrews equation can be used to calculate τ^*_{ci} which can then be used in the Shields equation to determine the critical shear stress required to move a particle of a given size in gravel-cobble bed streams. As discussed in Step 2.7 of the Phase 3 handbook, d_i and $d_{S_{50}}$ can be determined through field sampling.

Cautions and the use of Multiple Methodologies

It is important to remember that the equations presented above, while used widely, are not used exclusively. The predictive tools presented here are understood to be general in nature and may not be appropriate for all situations. As stated above there are many variables associated with measurement or calculation of shear stress, critical shear stress and bed-load transport. Despite the uncertainties, the weighing of river management alternatives will benefit from attempts to develop as accurate an understanding as possible. Otherwise, assessment, river corridor protection, and restoration efforts are less likely to meet established goals. Careful use of prediction and application methods and an understanding of the limitations of those methods, will greatly improve project outcomes and helps explain the variables and uncertainties that are inherent in river assessment and management work. Following these guidelines will increase the likelihood of success.

- **Increase your own expertise by reviewing the literature**. Below is a list references that pertain to the subject of sediment transport processes. A review of this literature will greatly increase your understanding of the methods for analyzing sediment transport processes and associated limitations.
- **Employ multiple methodologies and seek convergence.** Methods for calculation and measurement of shear stress and critical shear stress are described above. This is by no means a complete list: nor are the individual methods in the list preferred by the River management Program. Use as many various analyses as possible given particular circumstances and evaluate the results on how well they agree with other data pertaining to the project or assessment.

References

1. Andrews, E.D., Entrainment of Gravel From Naturally Sorted Riverbed Material. Geological Society of America Bulletin, v.94, p. 1225-1231, October 1983.

2. Knighton, D., Fluvial Forms and Processes A New Perspective. 1998. Oxford University Press Inc. New York.

3. Fischenich. 2001. Stability Thresholds for Stream Restoration Materials. EMRRP Technical Notes Collection (ERDC TN-EMRRP-SR-29), U.S. Army Engineer Research and Development Center, Vicksburg, M.S. www.wes.army.mil/e/emrrp

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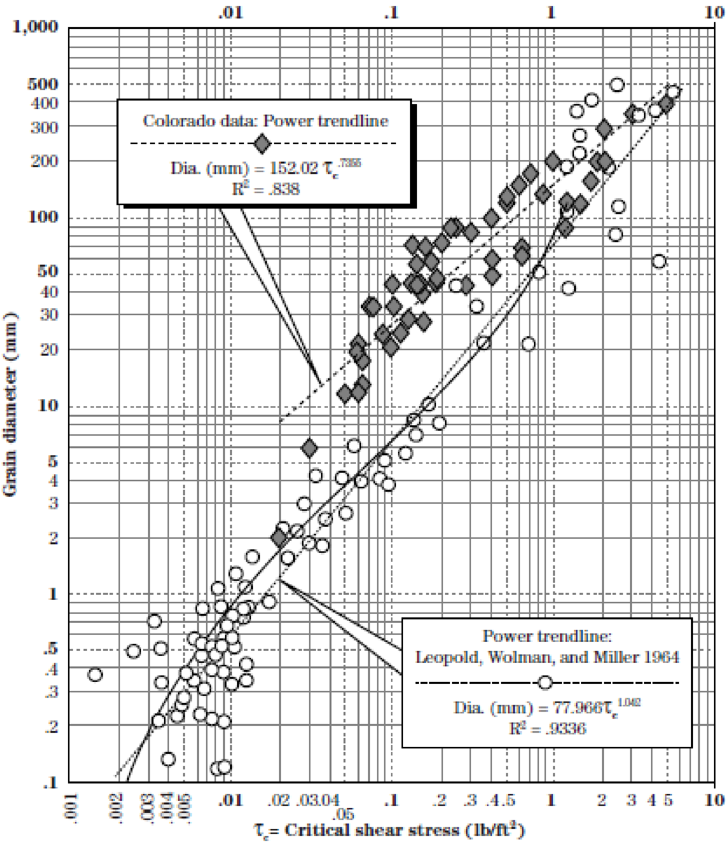
5. Wohl, E. 2000. Mountain Rivers. American Geophysical Union. Washington, D.C.

6. Wilcock, P.R. Toward a Practical Method For Estimating Sediment Transport Rates in Gravel Bed Rivers. Earth Surface Processes and Landforms, v.26, p. 1395-1408, September 2001.

Attachment B to Study 3.3.12.
Relation between Grain diameter for Entrainment and shear stress using Shields relations

Figure 11–11 Relation between grain diameter for entrainment and shear stress using Shields relations



Laboratory and field data on critical shear stress required to initiate movement of grains (Leopold, Wolman, and Miller 1964). The solid line is the Shields curve of *the threshold of motion;* transposed from the θ versus R_g form into the present form, in which critical shear is plotted as a function of grain diameter.

○ Leopold, Wolman, and Miller 1964
◆ Colorado data (Wildland Hydrology)

STUDY 3.3.20 ATTACHMENTS

Attachment A to Study 3.3.20.
Table 4.1-2. Northfield Mountain Project American Shad Ichthyoplankton Entrainment Densities.

Date	Rep	Life Stage	Sum	Volume (m^3)	Density (x $100m^3$)	Unit 1	Unit 2	Unit 3	Unit 4
5/28/2015	1	Egg	5	100.12	5	on	on	off	on
5/28/2015	2	Egg	1	100.68	1	on	on	off	on
6/5/2015	1	Egg	2	100.01	2	off	on	on	on
6/5/2015	2	Egg	3	100.45	3	off	on	on	on
6/9/2015	1	Egg	5	100.40	5	on	on	on	on
6/9/2015	2	Egg	3	102.90	3	on	on	on	on
6/10/2015	1	Egg	3	111.18	3	off	on	on	on
6/10/2015	2	Egg	4	100.76	4	off	on	on	on
6/11/2015	1	Egg	12	100.28	12	off	on	on	on
6/11/2015	2	Egg	31	100.00	31	off	on	on	on
6/16/2015	1	Egg	3	100.13	3	off	on	on	on
6/16/2015	2	Egg	8	100.09	8	on	on	on	on
6/18/2015	2	Egg	2	100.22	2	on	on	off	off
6/19/2015	1	Egg	1	101.31	1	off	on	off	off
6/19/2015	2	Egg	2	107.21	2	off	on	off	off
6/26/2015	2	Egg	1	100.89	1	off	on	on	on
7/1/2015	1	Egg	0	99.92	0	off	on	on	on
7/1/2015	2	Egg	0	100.04	0	off	on	on	on
7/8/2015	1	Egg	0	100.26	0	on	on	on	on
7/8/2015	2	Egg	0	100.03	0	on	on	on	on
7/17/2015	1	Egg	0	100.19	0	off	on	off	off

Attachment B to Study 3.3.20.
Table 4.2-1. Northfield Mountain Project American Shad Ichthyoplankton Densities in Offshore Samples

Sample Number	Week No.	Date	Time	Life Stage	Count	Volume (m^3)	Density (org/100 m^3)
1	24	6/9/2015	1:40	E	3	107	2.80
1	24	6/9/2015	1:40	L	0	107	0.00
2	24	6/9/2015	2:01	E	0	102	0.00
2	24	6/9/2015	2:01	L	0	102	0.00
3	24	6/9/2015	2:17	E	0	105	0.00
3	24	6/9/2015	2:17	L	0	105	0.00
4	24	6/10/2015	1:40	E	0	108	0.00
4	24	6/10/2015	1:40	L	1	108	0.93
5	24	6/10/2015	1:51	E	0	112	0.00
5	24	6/10/2015	1:51	L	0	112	0.00
6	24	6/10/2015	2:04	E	0	148	0.00
6	24	6/10/2015	2:04	L	0	148	0.00
7	25	6/18/2015	1:10	E	0	147	0.00
7	25	6/18/2015	1:10	L	0	147	0.00
8	25	6/18/2015	1:35	E	0	196	0.00
8	25	6/18/2015	1:35	L	0	196	0.00
9	25	6/18/2015	2:00	E	1	156	0.64
9	25	6/18/2015	2:00	L	0	156	0.00
10	25	6/19/2015	1:00	E	2	194	1.03
10	25	6/19/2015	1:00	L	0	194	0.00
11	25	6/19/2015	1:25	E	2	178	1.12
11	25	6/19/2015	1:25	L	0	178	0.00
12	25	6/19/2015	1:40	E	2	173	1.16
12	25	6/19/2015	1:40	L	0	173	0.00

Attachment C to Study 3.3.20.
The total time of pumping with 1, 2, 3 & 4 pumps, by week, from May 15 to July 15 for 2015.

Week of	No. of Pumps	No. of Minutes	No. of Hours
May 15, 2015*	1	210	3.50
May 15, 2015*	2	420	7.00
May 15, 2015*	3	105	1.75
May 17, 2015	1	900	15.00
May 17, 2015	2	1230	20.50
May 17, 2015	3	900	15.00
May 24, 2015	1	390	6.50
May 24, 2015	2	720	12.00
May 24, 2015	3	1110	18.50
May 24, 2015	4	330	5.50
May 31, 2015	1	1425	23.75
May 31, 2015	2	600	10.00
May 31, 2015	3	540	9.00
May 31, 2015	4	285	4.75
June 7, 2015	1	585	9.75
June 7, 2015	2	1110	18.50
June 7, 2015	3	600	10.00
June 7, 2015	4	285	4.75
June 14, 2015	1	840	14.00
June 14, 2015	2	885	14.75
June 14, 2015	3	645	10.75
June 14, 2015	4	525	8.75
June 21, 2015	1	705	11.75
June 21, 2015	2	825	13.75
June 21, 2015	3	1155	19.25
June 21, 2015	4	120	2.00
June 28, 2015	1	600	10.00
June 28, 2015	2	660	11.00
June 28, 2015	3	780	13.00
June 28, 2015	4	585	9.75
July 5, 2015	1	840	14.00
July 5, 2015	2	615	10.25
July 5, 2015	3	945	15.75
July 5, 2015	4	660	11.00
July 12, 2015	1	585	9.75
July 12, 2015	2	540	9.00
July 12, 2015	3	180	3.00

* This week starts Friday May 15, 2015

Attachment D to Study 3.3.20
The total time by pump for the nights in 2015 when samples were collected with more than one pump operating.

Sample No.	Unit 1 Duration	Unit 2 Duration	Unit 3 Duration	Unit 4 Duration
1	165	165		165
2	120	120		120
3	15	135	135	135
4	30	150	150	150
5	135	135	135	135
6	90	105	90	105
7		135	135	135
8		120	75	120
9		135	90	135
10		150	105	165
11	120	120	45	120
12	120	120	45	105
13	120	120		
14	135	135		
17		120	60	120
18		135	120	135
19		135	135	75
20		135	135	75
21	105	135	135	135
22	150	150	150	150
23		30	30	

STUDY 3.4.1 ATTACHMENTS

Attachment A to Study 3.4.1
Turners Falls Study Area Plant List

Common Name	Scientific Name
alternate-leaved dogwood	*Swida alternifolia*
American basswood	*Tilia americana*
American beech	*Fagus grandifolia*
American chestnut	*Castanea dentata*
American elm	*Ulmus americana*
American hazelnut	*Corylus americana*
American hornbeam	*Carpinus caroliniana*
American pokeweed	*Phytolacca americana*
American speedwell	*Veronica americana*
American witch-hazel	*Hamamelis virginiana*
anise-scented goldenrod	*Solidago odora*
arrow arum	*Peltandra virginica*
arrow-leaved tearthumb	*Persicaria sagittata*
arrowwood	*Viburnum dentatum*
Asian bush honeysuckle	*Lonicera sp.*
Asiatic dayflower	*Commelina communis*
asparagus	*Asparagus officinalis*
autumn olive	*Elaeagnus umbellata***
balsam fir	*Abies balsamea*
barberpole sedge	*Scirpus microcarpus*
bearberry	*Arctostaphylos uva-ursi*
bedstraw	*Gallium spp.*
bee balm	*Monarda didyma*
big bluestem	*Andropogon gerardii*
big-star sedge	*Carex rosea*
bigtooth aspen	*Populus grandidentata*
bird's-foot trefoil	*Lotus corniculatus*
bittersweet nightshade	*Solanum dulcamara*
black cherry	*Prunus serotina*
black chokeberry	*Aronia melanocarpa*
black elderberry	*Sambucus nigra*
black gum	*Nyssa sylvatica*
black locust	*Robinia pseudoacacia***
black oak	*Quercus velutina*
black swallow-wort	*Cynanchum louiseae***
black-eyed Susan	*Rudbeckia hirta*
bladder campion	*Silene sp.*
bladder sedge	*Carex intumescens*
bloodroot	*Sanguinaria canadensis*
blue flag iris	*Iris versicolor*
blue vervain	*Verbena hastata*
blue-eyed grass	*Sisyrinchium angustifolium*
bluejoint grass	*Calamagrostis canadensis*
blue-stemmed goldenrod	*Solidago caesia*
bluets	*Houstonia sp.*
blunt spikerush	*Elocharis obtusa*
blunt-lobed cliff-fern	*Woodsia obtusa*
boneset	*Eupatorium perfoliatum*

Common Name	Scientific Name
box elder	*Acer negundo*
bracken fern	*Pteridium aquilinum*
broad-leaved cattail	*Typha latifolia*
broad-leaved dock	*Rumex obtusifolius*
broom sedge	*Carex scoparia*
burning bush	*Euonymus alatus***
burred	*Sparganium americanum*
bush honeysuckle	*Diervilla lonicera*
butter-and-eggs	*Linaria vulgaris*
buttonbush	*Cephalanthus occidentalis*
calico aster	*Symphyotrichum lateriflorum*
Canada mayflower	*Maianthemum canadense*
Canada rush	*Juncus canadensis*
Canada St. John's wort	*Hypericum canadense*
Canada thistle	*Cirsium arvense*
Canada yew	*Taxus canadensis*
cardinal flower	*Lobelia cardinalis*
carrion flower	*Smilax herbacea*
chestnut oak	*Quercus montana*
chickweed	*Stellaria media*
chokecherry	*Prunus virginiana*
christmas fern	*Polystichum acrostichoides*
cinnamon fern	*Osmundastrum cinnamomeum*
clasping dogbane	*Apocynun cannabinum*
clearweed	*Pilea pumila*
club moss	*Huperzia sp.*
coltsfoot	*Tussilago farfara****
common blackberry	*Rubus allegheniensis*
common buckthorn	*Rhamnus cathartica***
common burdock	*Arctium minus*
common chicory	*Cichorium intybus*
common cinquefoil	*Potentilla simplex*
common cocklebur	*Xanthium strumarium* var. *glabratum*
common cow-wheat	*Melampyrum pratense*
common dewberry	*Rubus flagellaris*
common evening primrose	*Oenothera biennis*
common greenbrier	*Smilax rotundifolia*
common jewelweed	*Impatiens capensis*
common milkweed	*Asclepias syriaca*
common mugwort	*Artemisia vulgaris***
common mullein	*Verbascum thapsus*
common plantain	*Plantago major*
common ragweed	*Ambrosia artemisiifolia*
common reed	*Phragmites australis***
common shadbush	*Amelanchier arborea*
common spikerush	*Elocharis palustris*
common threesquare	*Schoenoplectus pungens*
common water plantain	*Alisma subcordatum*
common woodsorrell	*Oxalis montata*
cow vetch	*Vicia cracca*
creeping jenny	*Lysimachia nummularia***
creeping spearwort	*Ranunculus repens*

Common Name	Scientific Name
curled dock	*Rumex crispus*
dandelion	*Taraxacum officinale*
daylily	*Hemerocallis sp.*
deer berry	*Vaccinium stanimeum*
deer-tongue grass	*Dichanthelium clandestinum*
deptford pink	*Dianthus armeria*
devil's begger-ticks	*Bidens frondosa*
Dewey's sedge	*Carex deweyana*
downy rattlesnake plantain	*Goodyera pubescens*
early lowbush blueberry	*Vaccinium vacillans*
early saxifrage	*Micranthes virginiensis*
eastern cottonwood	*Populus deltoides*
eastern hemlock	*Tsuga canadensis*
eastern serviceberry	*Amelanchier canadensis*
eastern teaberry	*Gaultheria procumbens*
eastern white pine	*Pinus strobus*
ebony spleenwort	*Asplenium platyneuron*
enchanter's nightshade	*Cerastium fontanum*
European alder	*Alnus glutinosa*
false baby's breath	*Galium mollugo*
false dragonhead	*Physostegia virginiana*
false hellebore	*Veratrum viride*
false indigo	*Amorpha fruticosa*
false nettle	*Boehmeria cylindrica*
false Solomon's seal	*Maianthemum racemosum*
field penny-cress	*Thlaspi arvense*
field pepperweed	*Lepidium campestre*
flattened oatgrass	*Danthonia compressa*
flat-top goldentop	*Euthamia graminifolia*
flat-top white aster	*Doellingeria umbellata*
fleabane	*Erigeron spp.*
flowering dogwood	*Benthamidia florida*
foam flower	*Tiarella cordifolia*
forget-me-not	*Myosotis scorpioides*
fox grape	*Vitis labrusca*
fringe loosestrife	*Lysimachia ciliata*
fringed sedge	*Carex crinita*
garlic mustard	*Alliaria petiolata***
gaywings	*Polygala paucifolia*
giant goldenrod	*Solidago gigantica*
glossy buckthorn	*Frangula alnus***
golden alexanders	*Zizua ayrea*
golden ragwort	*Packera aurea*
goldenrod	*Solidago spp.*
goldthread	*Coptis trifolia*
grass-leaf flat-topped goldenrod	*Euthamia graminifolia*
grass of Parnassus	*Parnassia glauca*
gray birch	*Betula populifolia*
gray goldenrod	*Solidago nemoralis*
great blue lobelia	*Lobelia siphilitica**
great Solomon's seal	*Polygonatum biflorum*
green ash	*Fraxinus pennsylvanica*

Common Name	Scientific Name
green bulrush	*Scirpus atrovirens*
gill over the ground	*Glechoma hederacea*
groundnut	*Apios americana*
ground pine	*Lycopodium obscurum*
hair-cap moss	*Polytrichum juniperinum*
hairy bush clover	*Lespedeza hirta*
hairy Solomon's seal	*Polygonatum pubescens*
harebell	*Campanula rotundifolia*
hawkweed	*Hieracium caespitosum*
hawthorn	*Crataegus sp.*
hay-scented fern	*Dennstaedtia punctilobula*
heart-leaved aster	*Symphyotrichum cordifolium*
hepatica	*Hepatica nobilis*
highbush blueberry	*Vaccinium corymbosum*
hobblebush	*Viburnum lantanoides*
hog peanut	*Amphicarpaea bracteata*
hop hornbeam	*Ostrya virginiana*
hop trefoil	*Trifolium campestre*
Indian cucumber	*Medeola virginiana*
Indian grass	*Sorghastrum nutans*
Indian pipe	*Monotropa uniflora*
Indian tobacco	*Lobelia inflata*
intermediate spike-sedge	*Eleocharis intermedia**
interrupted fern	*Osmunda claytoniana*
Jack in the pulpit	*Arisaema triphyllum*
Japanese barberry	*Berberis thunbergii***
Japanese honeysuckle	*Lonicera japonica***
Japanese knotweed	*Fallopia japonica***
Japanese privet	*Ligustrum obtusifolium***
Japanese stiltgrass	*Microstegium vimineum****
Jerusalum artichoke	*Helianthus tuberosus*
joe-pye weed	*Eutrochium purpureum*
jump seed	*Persicaria virginiana*
leafy spurge	*Euphorbia esula***
lesser celandine	*Ranunculus ficaria***
lily-of-the-valley	*Convallaria majalis*
little bluestem grass	*Schizachyrium scoparium*
lowbush blueberry	*Vaccinium angustifolium*
mad dog skullcap	*Scutellaria lateriflora*
maiden-hair fern	*Adiantum pedatum*
maidenhair spleenwort	*Asplenium trichomanes*
mannagrass	*Glyceria sp.*
marginal wood-fern	*Dryopteris marginalis*
marsh fern	*Thelypteris palustris*
marsh horsetail	*Equisetum palustre*
marsh marigold	*Caltha palustris*
marsh speedwell	*Veronica scutellata*
marshpepper knotweed	*Persicaria hydropiper*
mayapple	*Podophyllum peltatum*
mint	*Mentha arvensis*
monkey flower	*Mimulis ringens*
morning glory	*Ipomoea purpurea*

Common Name	Scientific Name
Morrow's honeysuckle	*Lonicera morrowii***
mountain alder	*Alnus viridis* ssp. *crispa**
mountain laurel	*Kalmia latifolia*
mouse-ear-chickweed	*Cerastium fontanum*
multiflora rose	*Rosa multiflora***
naked-flowered tick trefoil	*Hylodesmum nudiflorum*
nannyberry	*Viburnum lentago*
narrowleaf cattail	*Typha angustifolia*
New England aster	*Symphyotrichum novae-angliae*
New England sedge	*Carex novae-angliae*
New York aster	*Symphyotrichum novi-belgii*
New York fern	*Parathelypteris noveboracensis*
nodding smartweed	*Persicaria lapathifolia*
northern bayberry	*Morella pensylvanica*
northern bugleweed	*Lycopus uniflorus*
northern catalpa	*Catalpa speciosa*
northern red oak	*Quercus rubra*
Norway maple	*Acer platanoides***
Norwegian cinquefoil	*Potentilla norvgica*
Olney's three-square bulrush	*Schoenoplectus americanus*
orangegrass	*Hypericum gentianoides*
Oriental bittersweet	*Celastrus orbiculatus***
ostrich fern	*Matteuccia struthiopteris*
ovate spikerush	*Eleocharis ovata*
oxeye daisy	*Leucanthemum vulgare*
pale corydalis	*Corydalis sempervirens*
panicled aster	*Symphyotrichum lanceolatum*
partridge berry	*Mitchella repens*
path rush	*Juncus tenuis*
pearly everlasting	*Anaphalis margaritacea*
pickerelweed	*Pontederia cordata*
pin cushion moss	*Leucobryum albidum*
pin oak	*Quercus palustris*
pinkweed	*Persicaria pensylvanica*
pippsissewa	*Chimaphila umbellata*
pale dogwood	*Swida amomum* var. *schueltzeana*
plantain-leaved pussytoes	*Antennaria plantaginifolia*
plantain-leaved sedge	*Carex plantaginea*
poison ivy	*Toxicodendron radicans*
prickly lettuce	*Lactuca serriola*
princess pine	*Dendrolycopodium obscurum*
purple chokeberry	*Aronia x floribunda*
purple cliff brake	*Pellaea atropurpurea*
purple leaved willow herb	*Epilobium ciliatum*
purple loosestrife	*Lythrum salicaria***
purple osier willow	*Salix purpurea*±
purple-flowering raspberry	*Rubus odoratus*
quaking aspen	*Populus tremuloides*
Queen Anne's lace	*Daucus carota*
quillwort	*Isotes spp.*
rabbit-foot clover	*Trifolium arvense*
red cedar	*Juniperus virginiana*

Common Name	Scientific Name
red chokeberry	*Aronia arbutifolia*
red clover	*Trifolium pratense*
red fescue	*Festuca rubra*
red maple	*Acer rubrum*
red mullberry	*Morus alba*
red pine	*Pinus resinosa*
red trillium	*Trillium erectum*
red-osier dogwood	*Swida sericea*
reed canary grass	*Phalaris arundinacea***
Rhododendron	*Rhododendron sp.*
rice cutgrass	*Leersia oryzoides*
river bank grape	*Vitis riparia*
rock polypody	*Polypodium virginianum*
rough bedstraw	*Galium asprellum*
rough-fruited cinquefoil	*Potentilla novegica*
rough-leaved goldenrod	*Solidago patula*
round-leaved dogwood	*Swida rugosa*
rough-stemmed goldenrod	*Solidago rugosa*
round-lobed hepatica	*Anemone americana*
royal fern	*Osmunda regalis*
Russian olive	*Elaeagnus angustifolia*
Rusty cliff-fern	*Woodsia ilvensis*
sandbar cherry	*Prunus pumila var. depressa**
sandbar willow	*Salix exigua**
sassafras	*Sassafras albidum*
saxifrage	*Micranthes sp.*
scouring rush	*Equisetum hyemale*
scrub oak	*Quercus ilicifolia*
seedbox	*Ludwigia alternifolia*
self-heal	*Prunella vulgaris*
sensitive fern	*Onoclea sensibilis*
shagbark hickory	*Carya ovata*
shallow sedge	*Carex lurida*
shaved sedge	*Carex tonsa*
sheep laurel	*Kalmia angustifolia*
silky dogwood	*Swida amomum*
silver maple	*Acer saccharinum*
silver rod	*Solidago bicolor*
silver vein	*Parthenocissus henryana*
skunk cabbage	*Symplocarpus foetidus*
slender gerardia	*Agalinis tenuifolia*
slender rattlesnake root	*Nabalus altissimus*
smartweed	*Persicaria sp.*
smooth alder	*Alnus serrulata*
smooth sumac	*Rhus glabra*
soft rush	*Juncus effusus*
soft-stem bulrush	*Schoenoplectus tabernaemontani*
speckled alder	*Alnus incana*
sphagnum	*Sphagnum sp.*
spinulose woodfern	*Dryopteris carthusiana*
spotted joe-pyeweed	*Eutrochium maculatum*
spotted knapweed	*Centaurea maculosa****

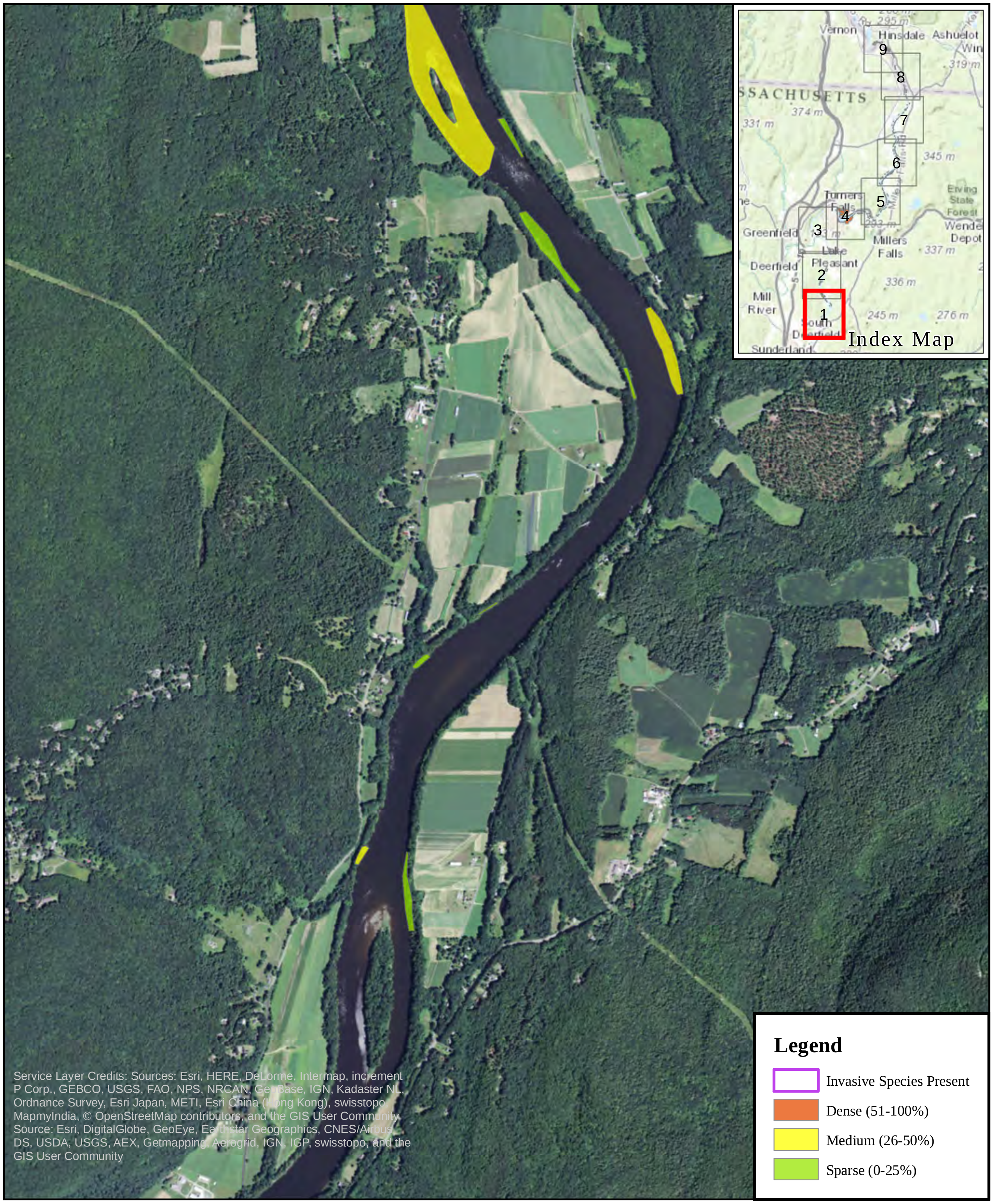
Common Name	Scientific Name
spreading dogbane	*Aposynum androsaemifolium*
squashberry	*Viburnum edule*
St. John's wort	*Hypericum perforatum*
staghorn sumac	*Rhus hirta*
starflower	*Lysimachia borealis*
steeplebush	*Spiraea tomentosa*
stiff aster	*Lonactis linariifolia*
stinging nettle	*Urtica dioica*
striped maple	*Acer pensylvanicum*
striped wintergreen	*Chimaphila maculata*
sugar maple	*Acer saccharum*
swamp azalea	*Rhodoendron viscosum*
swamp candles	*Lysimachia terrestris*
swamp dewberry	*Rubus hispidus*
swamp honeysuckle	*Lonicera oblongifolia*
swamp rose	*Rosa palustris*
swamp white oak	*Quercus bicolor*
sweet fern	*Comptonia peregrina*
sweet flag	*Acorus calamus*
sweetgale	*Myrica gale*
switchgrass	*Panicum vigatum*
sycamore	*Platanus occidentalis*
tall blue lettuce	*Lactuca biennis*
tall meadow rue	*Thalictrum puescens*
Tartarian honeysuckle	*Lonicera tatarica****
three-leaved blackberry	*Rubus parvifolius*
three seed mercury	*Acalypha rhomboidea*
three-way sedge	*Dulichium arundinaceum*
tick-trefoil	*Desmondium glutinosum*
tiger lily	*Lilium lancifolium*
tower mustard	*Arabis glabra*
Tradescant's aster	*Symphyotrichum tradescantii*
trident maple	*Acer rubrum* var. *trilobum*
trillium	*Trillium sp.*
turtle head	*Chelone glabra*
tussock sedge	*Carex stricta*
twig sedge	*Cladium mariscoides*
twisted stalk	*Streptopus amplexifolis*
thyme-leaved speedwell	*Veronica serpyllifolia*
upland white aster	*Oligoneuron album**
violet	*Viola sp.*
viper's bugloss	*Echium vulgare*
Virginia creeper	*Parthenocissus quinquefolia*
virgin's bower	*Clematis virginiana*
water hemlock	*Cicuta maculata*
water horehound	*Lycopus americanus*
water horsetail	*Equisetum fluviatile*
water parsnip	*Sium suave*
water pennywort	*Hydrocotyle sp.*
water purslane	*Ludwigia palustris*
water-chestnut	*Trapa natans*
watercress	*Nasturtium officinale*

Common Name	Scientific Name
white ash	*Fraxinus americana*
white avens	*Geum canadense*
white birch	*Betula papyrifera*
white clover	*Trifolium repens*
white meadowsweet	*Spiraea alba var. latifolia*
white oak	*Quercus alba*
white ricegrass	*Leersia virginica*
white snakeroot	*Ageratina altissima*
white sweet clover	*Melilotus albus*
white vervain	*Verbena urticifolia*
white wood aster	*Eurybia divaricata*
whorled loosestrife	*Lysimachia quadrifolia*
whorled wood aster	*Oclemena acuminata*
wild columbine	*Aquilegia canadinsis*
wild madder	*Rubia peregrina*
wild oats	*Avena fatua*
wild oats	*Uvularia sessilifolia*
wild raisin	*Viburnum nudum*
wild sarsaparilla	*Aralia nudicaulis*
wild strawberry	*Fragaria virginiana*
winterberry	*Ilex verticillata*
wood nettle	*Laportea canadensis*
woodfern	*Dryopteris sp.*
woolgrass	*Scirpus cyperinus*
yarrow	*Achillea millefolium*
yellow birch	*Betula alleghaniensis*
yellow iris	*Iris pseudacorus***
yellow nutsedge	*Cyperus esculentus*
yellow woodsorrell	*Oxalis stricta*

* Denotes RTE
**Denotes Invasive according to MIPAG
***Denotes Likely Invasive according to MIPAG
± Denotes Non-native species of interest

STUDY 3.5.1 ATTACHMENTS

Attachment A to Study No. 3.5.1.
Figure 4.2.2-1 Submerged Aquatic Vegetation Mapping



FirstLight
GDF SUEZ

Northfield Mountain Pumped Storage Project (No. 2485)
and Turners Falls Hydroelectric Project (No. 1889)
Study 3.5.1 Baseline Inventory of Wetland, Riparian and Littoral Habitat in the Turners Falls Impoundment and Assessment of Operational Impacts on Special Status Species

N

0 0.125 0.25 0.5 Miles

Figure 4.2.2-1
Submerged Aquatic Vegetation Mapping
Map 1

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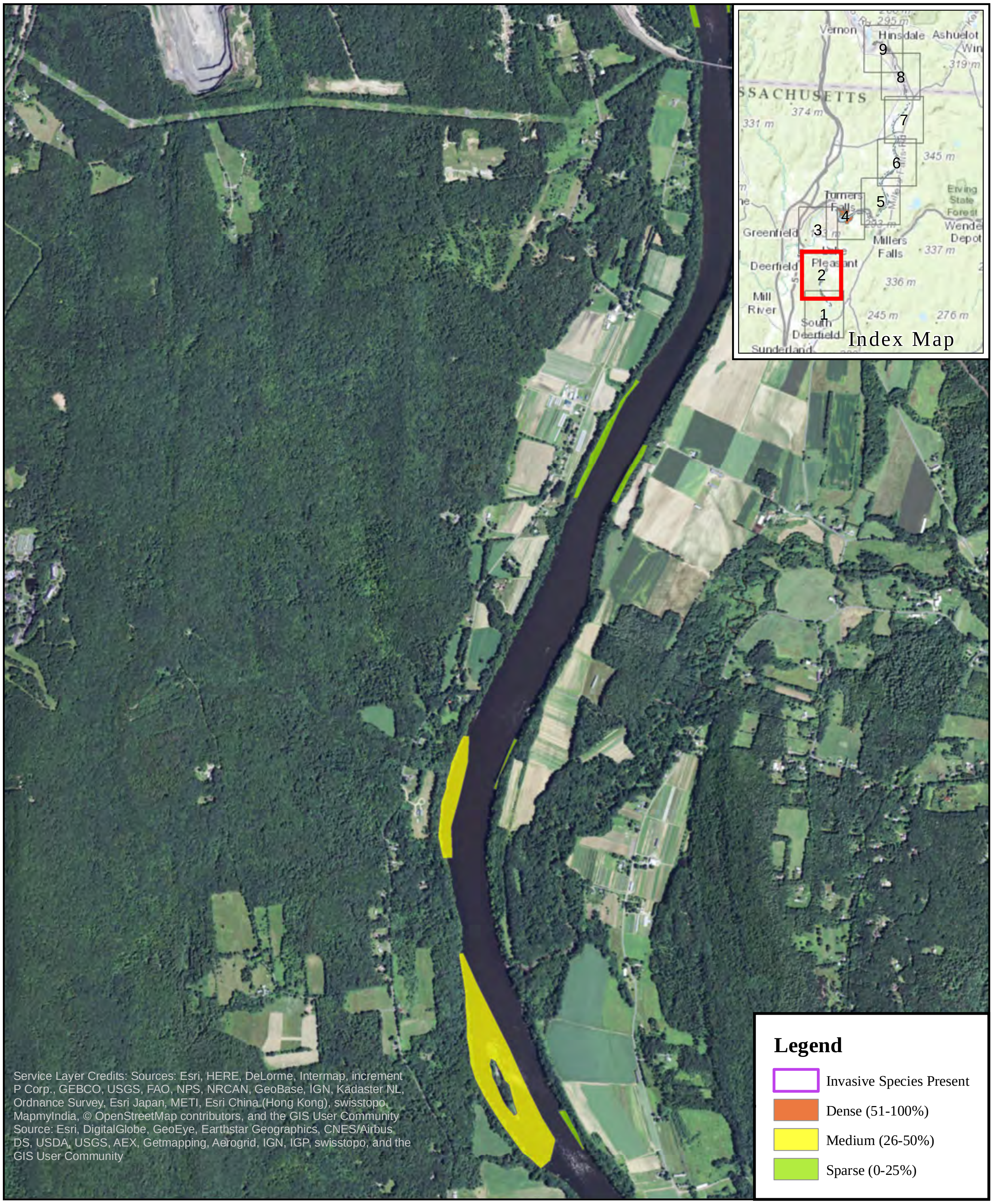

FirstLight GDF SUEZ

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

Study 3.5.1 Baseline Inventory of Wetland, Riparian and Littoral Habitat in the Turners Falls Impoundment and Assessment of Operational Impacts on Special Status Species

N

0 0.125 0.25 0.5 Miles

Figure 4.2.2-1
Submerged Aquatic Vegetation Mapping
Map 2

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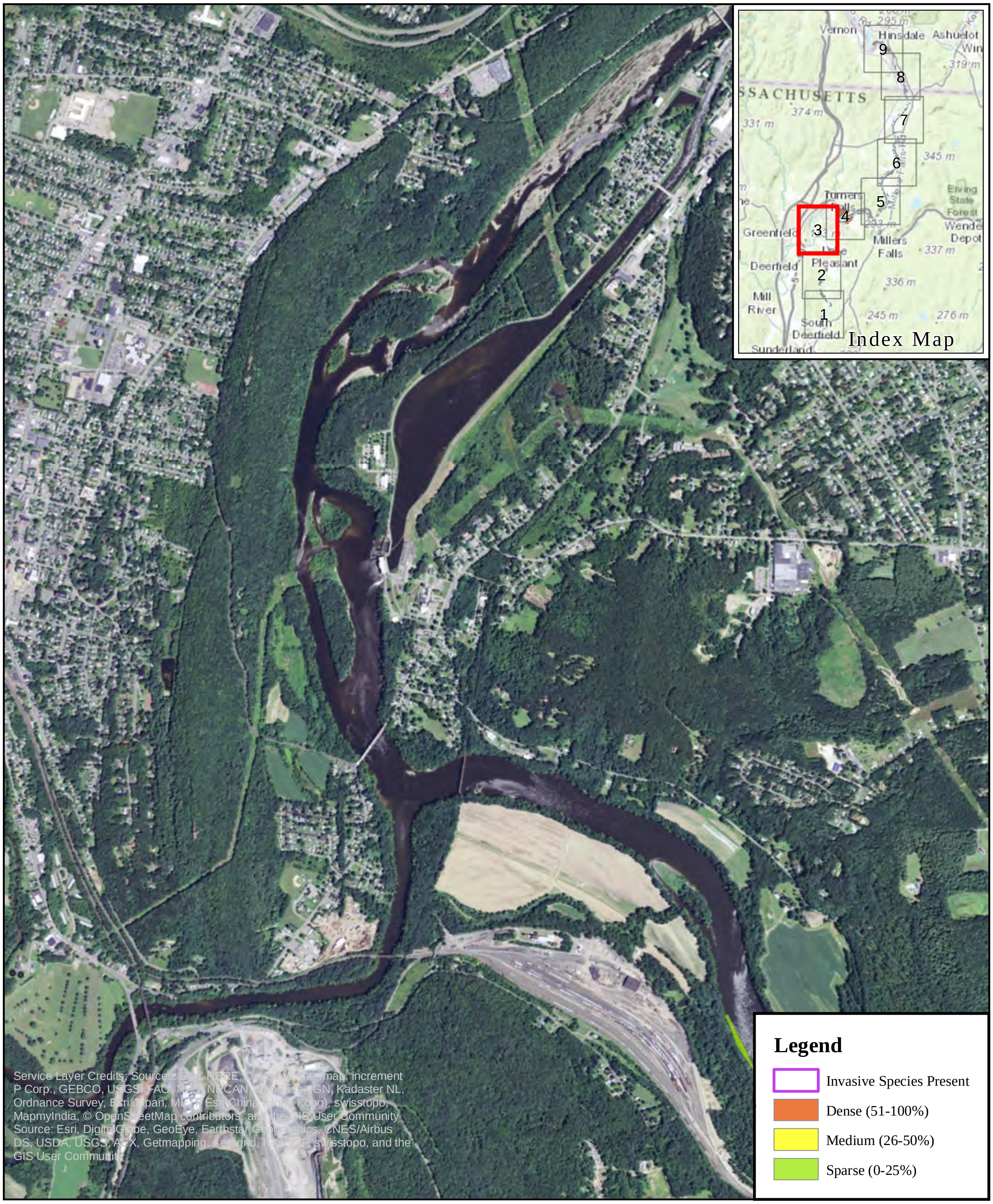

Northfield Mountain Pumped Storage Project (No. 2485)
and Turners Falls Hydroelectric Project (No. 1889)

Study 3.5.1 Baseline Inventory of Wetland, Riparian and Littoral Habitat in the Turners Falls Impoundment and Assessment of Operational Impacts on Special Status Species

N

0 0.125 0.25 0.5 Miles

Figure 4.2.2-1
Submerged Aquatic Vegetation Mapping
Map 3

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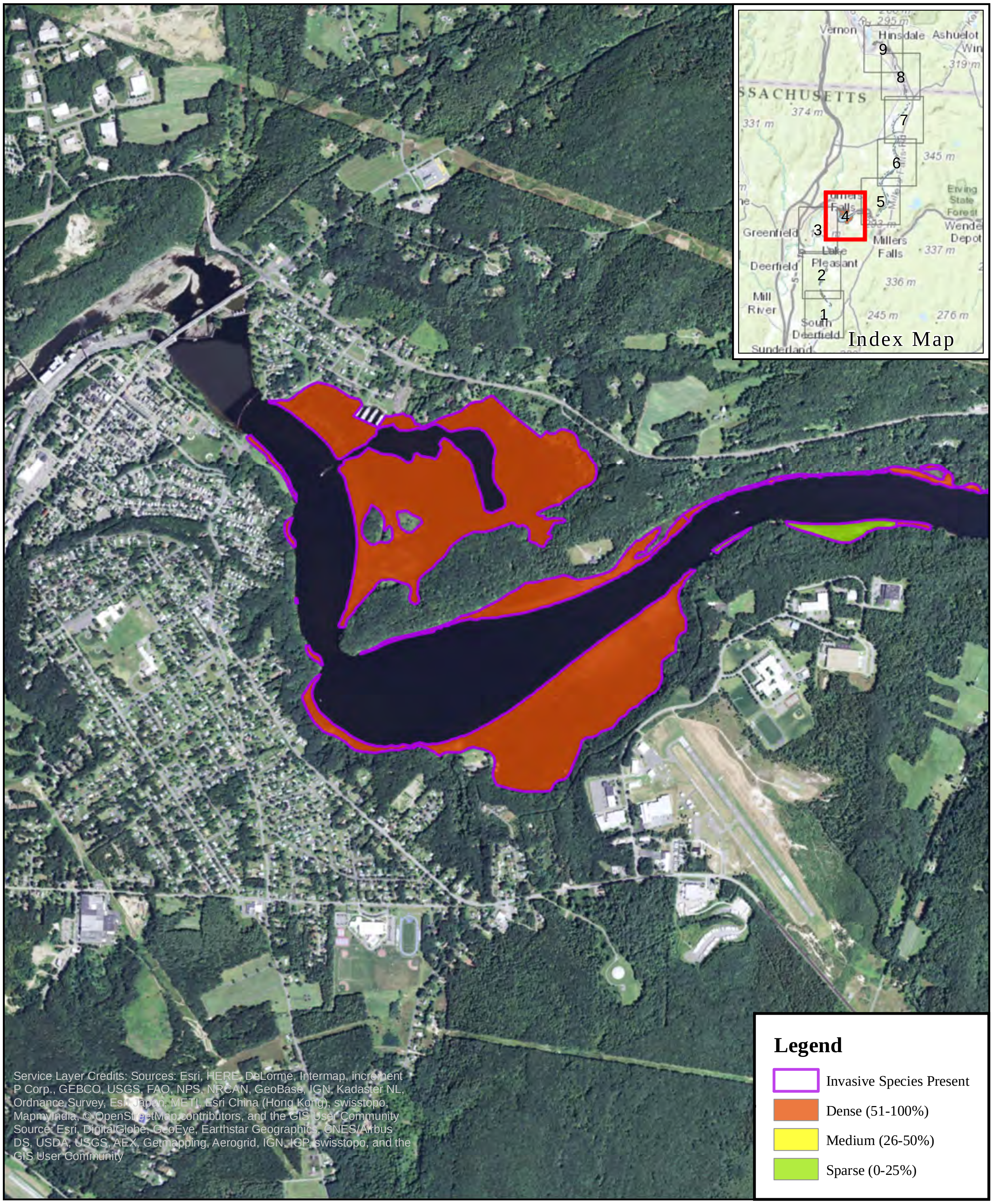
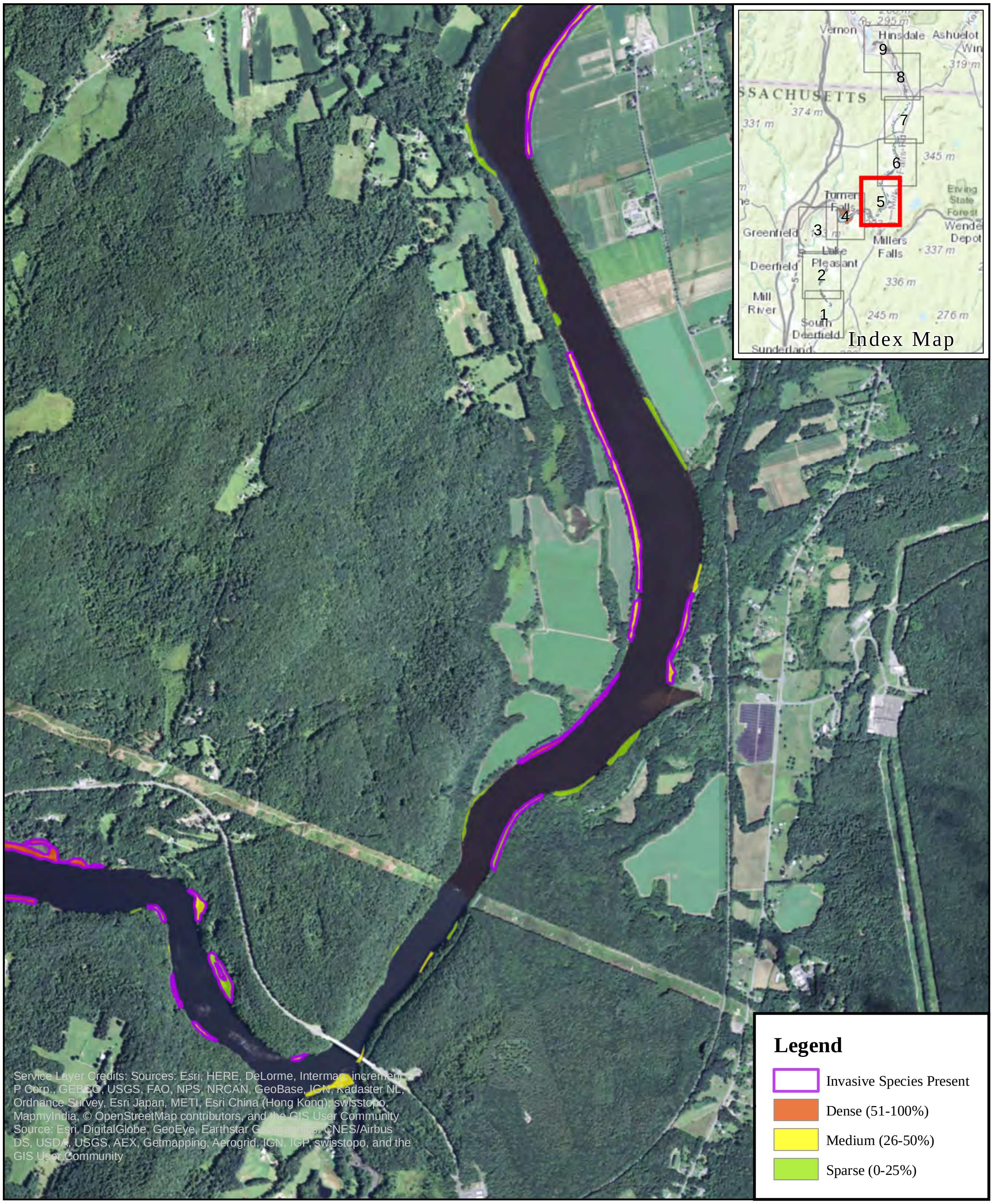


Northfield Mountain Pumped Storage Project (No. 2485)
and Turners Falls Hydroelectric Project (No. 1889)

Study 3.5.1 Baseline Inventory of Wetland, Riparian and Littoral Habitat in the Turners Falls Impoundment and Assessment of Operational Impacts on Special Status Species

Figure 4.2.2-1
Submerged Aquatic Vegetation Mapping
Map 4

Path: W:\gis\studies\3_5_1\maps\Study_3_5_1_SAV_Report_Figures.mxd



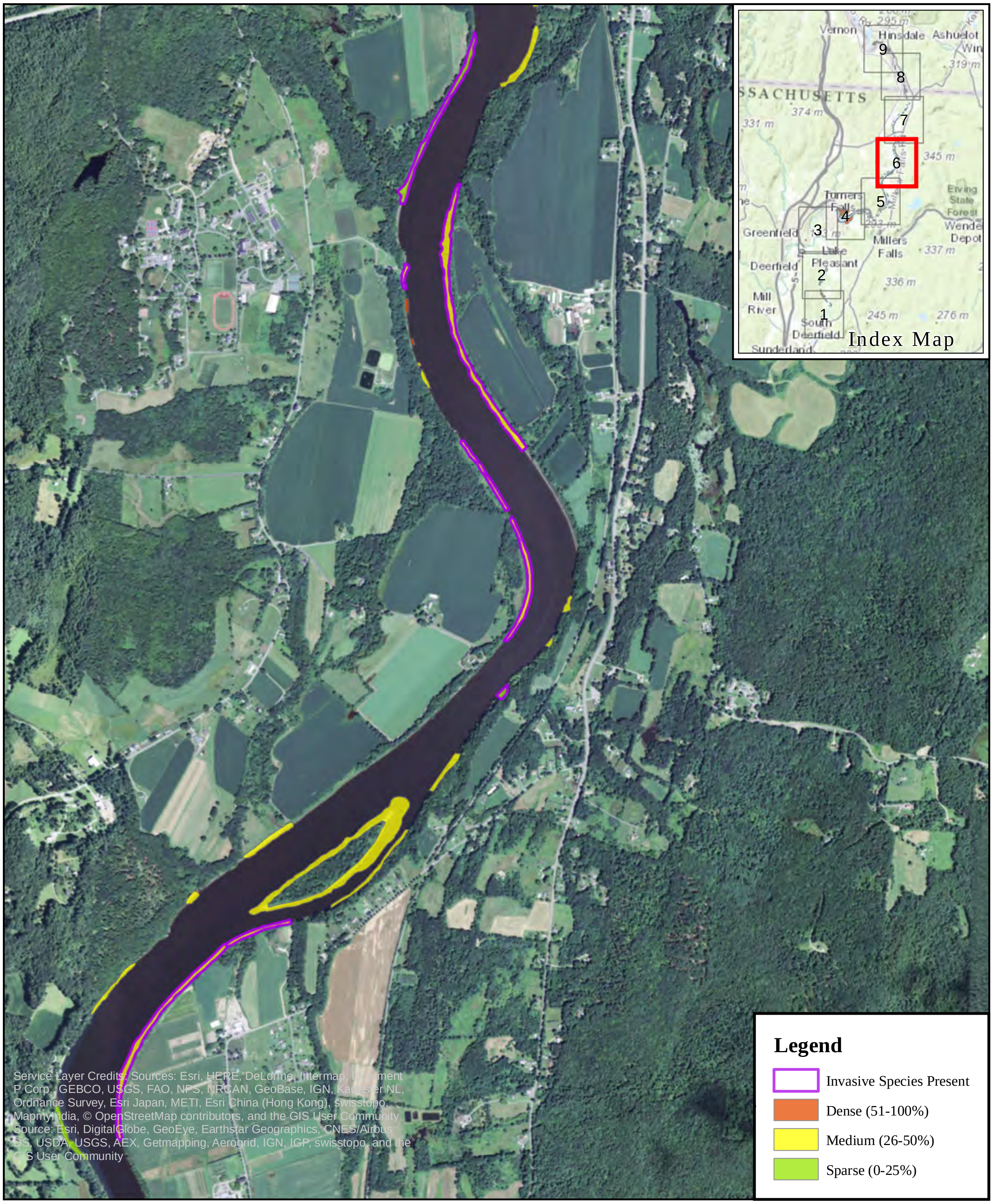
Northfield Mountain Pumped Storage Project (No. 2485) and Turners Falls Hydroelectric Project (No. 1889)

Study 3.5.1 Baseline Inventory of Wetland, Riparian and Littoral Habitat in the Turners Falls Impoundment and Assessment of Operational Impacts on Special Status Species

N

0 0.125 0.25 0.5 Miles

Figure 4.2.2-1 Submerged Aquatic Vegetation Mapping Map 5



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

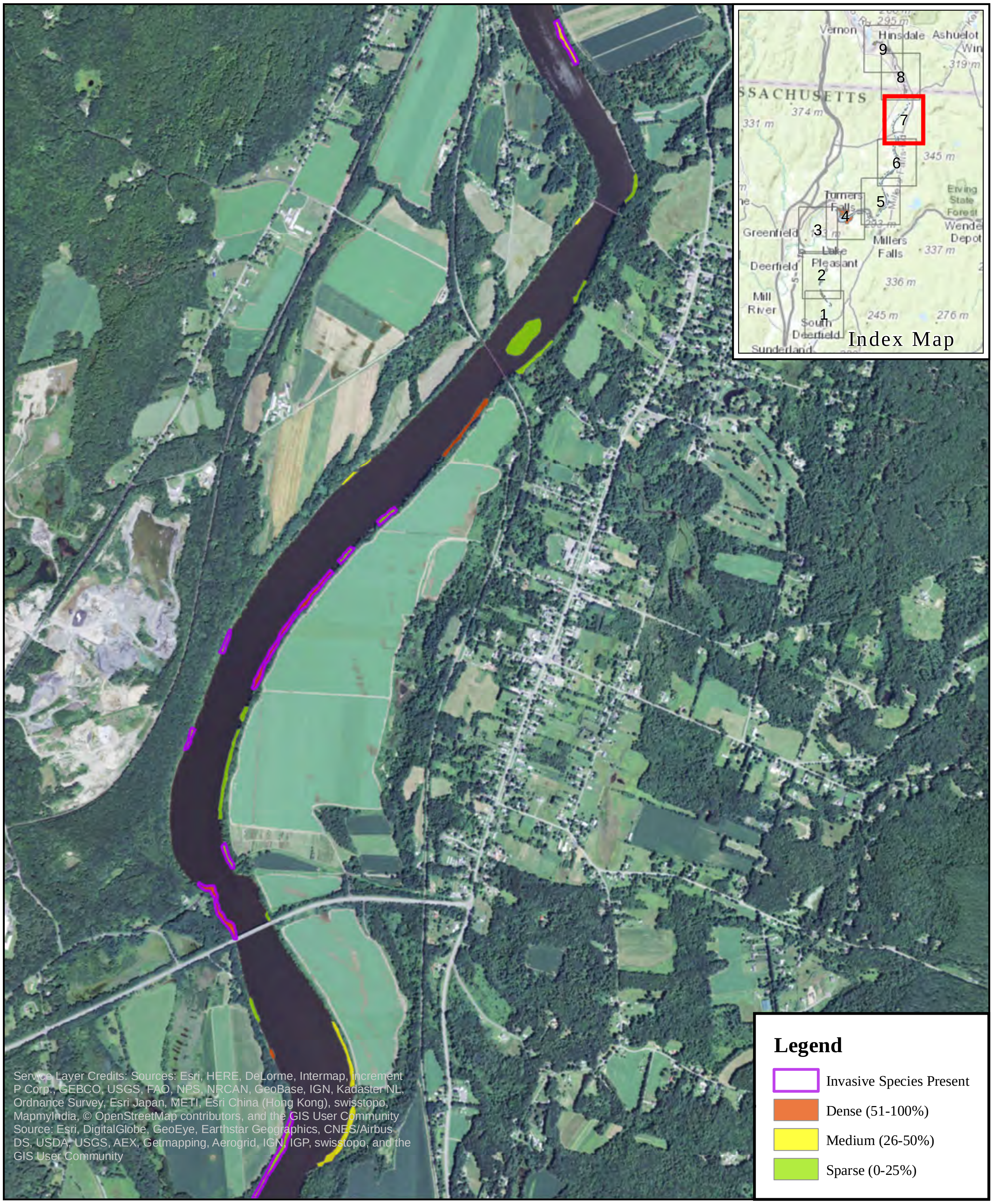
Study 3.5.1 Baseline Inventory of Wetland, Riparian and Littoral Habitat in the Turners Falls Impoundment and Assessment of Operational Impacts on Special Status Species

N

0 0.125 0.25 0.5 Miles

Figure 4.2.2-1
Submerged Aquatic Vegetation Mapping
Map 6

Path: W:\gis\studies\3_5_1\maps\Study_3_5_1_SAV_Report_Figures.mxd



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

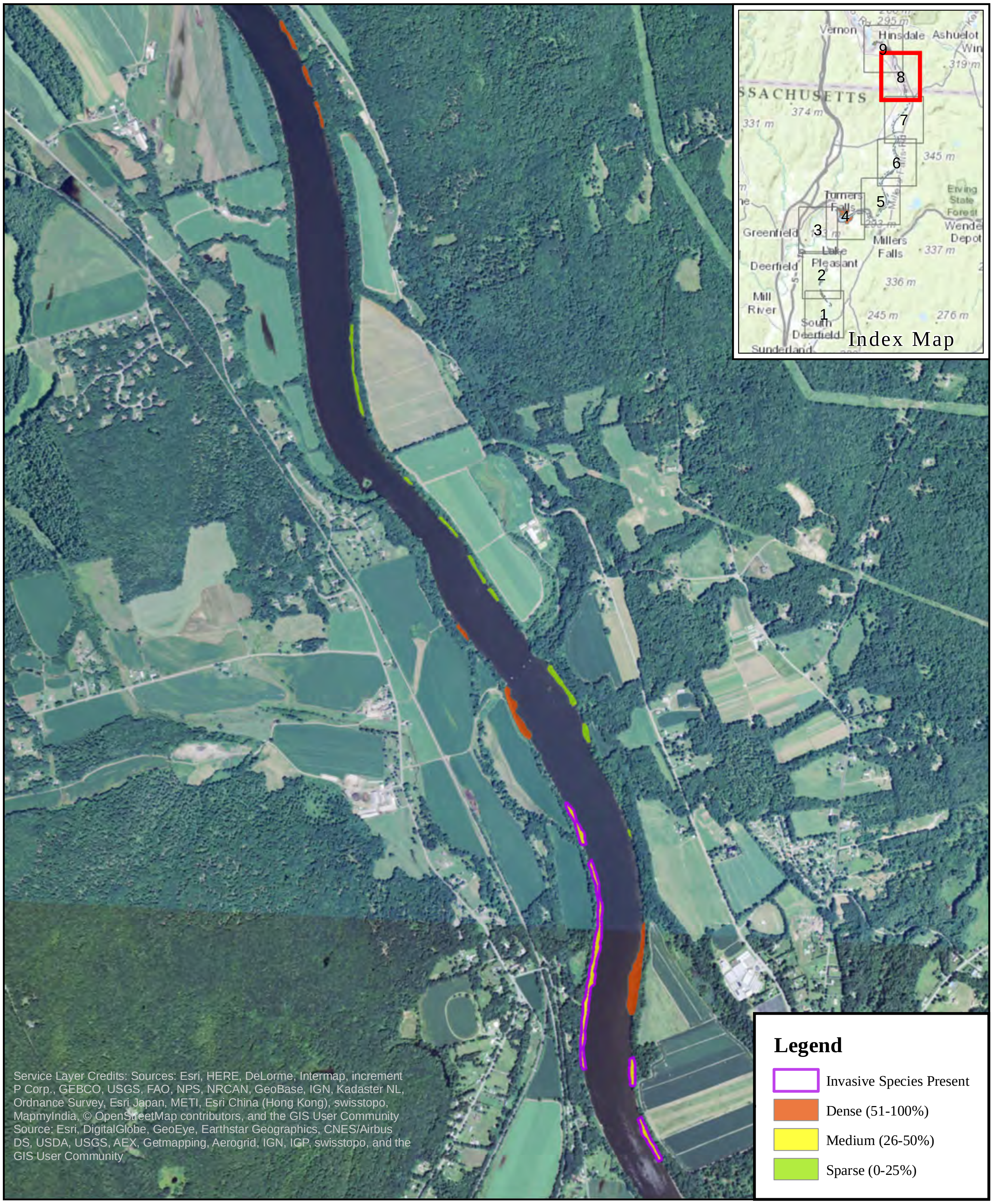
Study 3.5.1 Baseline Inventory of Wetland, Riparian and Littoral Habitat in the Turners Falls Impoundment and Assessment of Operational Impacts on Special Status Species

N

0 0.125 0.25 0.5 Miles

Figure 4.2.2-1
Submerged Aquatic Vegetation Mapping
Map 7

Path: W:\gis\studies\3_5_1\maps\Study_3_5_1_SAV_Report_Figures.mxd



FirstLight GDF SUEZ

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

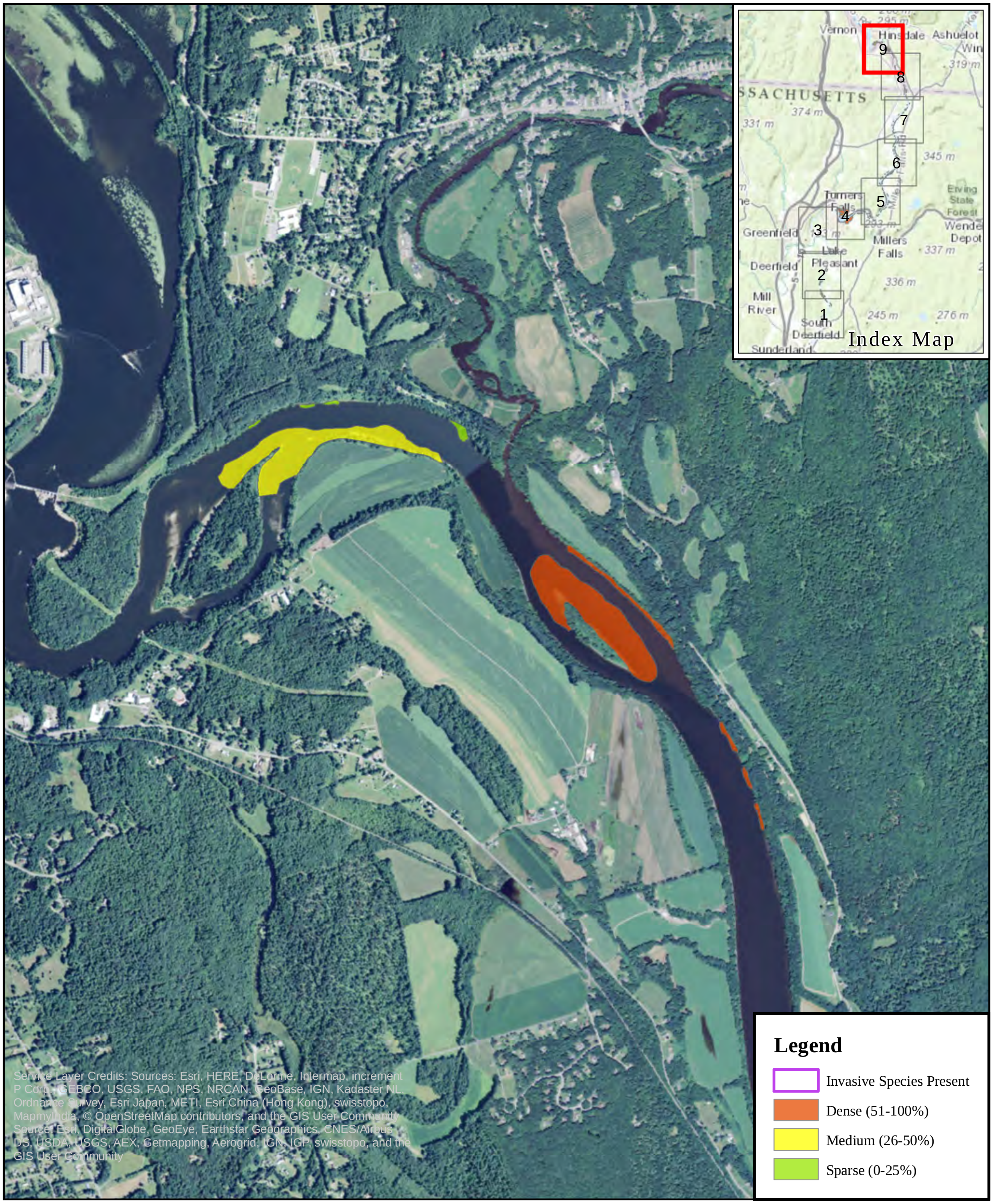
Study 3.5.1 Baseline Inventory of Wetland, Riparian and Littoral Habitat in the Turners Falls Impoundment and Assessment of Operational Impacts on Special Status Species

N

0 0.125 0.25 0.5 Miles

Figure 4.2.2-1
Submerged Aquatic Vegetation Mapping
Map 8

Path: W:\gis\studies\3_5_1\maps\Study_3_5_1_SAV_Report_Figures.mxd



FirstLight GDF SUEZ

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

Study 3.5.1 Baseline Inventory of Wetland, Riparian and Littoral Habitat in the Turners Falls Impoundment and Assessment of Operational Impacts on Special Status Species

Figure 4.2.2-1
Submerged Aquatic Vegetation Mapping
Map 9

Path: W:\gis\studies\3_5_1\maps\Study_3_5_1_SAV_Report_Figures.mxd

Attachment B to Study No. 3.5.1.
Rainbow Beach and North Bank Survey Transects

Attachment B to Study No. 3.5.1.
Rainbow Beach and North Bank Survey Transects

Point_Id	Northing	Easting	Elevation	Time_
bench.rb	2944832.45710000000	362603.96200000000	109.68700000000	11/26/2014
bench.rb.1	2944832.47770000000	362604.23860000000	109.93620000000	11/26/2014
bench.rb.2	2944832.47610000000	362604.20310000000	110.02880000000	11/26/2014
nb.bench.1	2945482.59430000000	360853.13460000000	113.89250000000	11/26/2014
nbt1.1	2945477.12550000000	360896.32360000000	113.27100000000	11/26/2014
nbt1.2	2945498.88490000000	360898.89020000000	100.91730000000	11/26/2014
nbt1.3	2945493.25000000000	360898.41550000000	102.30840000000	11/26/2014
nbt1.4	2945485.90710000000	360897.02410000000	104.97330000000	11/26/2014
nbt1.5	2945484.36800000000	360898.03950000000	108.63710000000	11/26/2014
nbt1.6	2945482.47560000000	360897.63270000000	108.93920000000	11/26/2014
nbt1.7	2945479.11030000000	360897.48110000000	111.92980000000	11/26/2014
nbt2.1	2945489.02810000000	360745.87720000000	114.90130000000	11/26/2014
nbt2.2	2945494.39210000000	360746.32520000000	111.24960000000	11/26/2014
nbt2.3	2945500.77790000000	360746.51880000000	107.13560000000	11/26/2014
nbt2.4	2945506.03270000000	360748.31030000000	103.54110000000	11/26/2014
nbt2.5	2945507.18830000000	360748.80570000000	102.55290000000	11/26/2014
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nbt2.7	2945514.76840000000	360750.87300000000	100.83580000000	11/26/2014
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nbt3.4	2945535.79870000000	360595.96290000000	109.43380000000	11/26/2014
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nbt3.7	2945546.27350000000	360601.07940000000	102.15080000000	11/26/2014
nbt3.8	2945551.19430000000	360603.47330000000	101.18760000000	11/26/2014
nbt4.1	2945602.02720000000	360382.03350000000	115.28560000000	11/26/2014
nbt4.2	2945603.13350000000	360382.32370000000	113.74440000000	11/26/2014
nbt4.3	2945606.49870000000	360384.07470000000	109.87460000000	11/26/2014
nbt4.4	2945608.36850000000	360383.72420000000	106.09240000000	11/26/2014
nbt4.5	2945611.48900000000	360386.37830000000	103.44550000000	11/26/2014
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nbt4.7	2945620.25940000000	360390.32320000000	101.10830000000	11/26/2014
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rb11.6	2944070.40660000000	362640.64480000000	105.77950000000	11/26/2014
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Point_Id	Northing	Easting	Elevation	Time_
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rb12.4	2943958.90970000000	362642.00310000000	103.45100000000	11/26/2014
rb12.5	2943962.52990000000	362626.17950000000	104.51100000000	11/26/2014
rb12.6	2943965.28420000000	362612.60670000000	105.36860000000	11/26/2014
rb12.7	2943968.14130000000	362603.63090000000	106.68890000000	11/26/2014
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rbt1.2	2945061.84580000000	362564.88230000000	102.52000000000	11/26/2014
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rbt1.6	2945050.01220000000	362550.29930000000	107.12660000000	11/26/2014
rbt1.7	2945044.83560000000	362548.81710000000	115.46080000000	11/26/2014
rbt2.2	2944974.56290000000	362626.86640000000	101.64530000000	11/26/2014
rbt2.3	2944969.94600000000	362617.25840000000	102.43580000000	11/26/2014
rbt2.4	2944965.79000000000	362609.87880000000	103.28460000000	11/26/2014
rbt2.5	2944961.69240000000	362601.80120000000	104.52570000000	11/26/2014
rbt2.6	2944958.72230000000	362593.83100000000	106.49020000000	11/26/2014
rbt2.7	2944957.98690000000	362590.55150000000	107.02630000000	11/26/2014
rbt2.8	2944978.03810000000	362632.66390000000	101.49140000000	11/26/2014
rbt2.9	2944947.52720000000	362587.30380000000	109.98770000000	11/26/2014
rbt2.10	2944944.47270000000	362579.81600000000	110.52580000000	11/26/2014
rbt2.11	2944952.10910000000	362594.57120000000	106.62900000000	11/26/2014
rbt3.1	2944882.70770000000	362671.46970000000	101.63730000000	11/26/2014
rbt3.2	2944876.82740000000	362658.69400000000	102.44880000000	11/26/2014
rbt3.3	2944871.85040000000	362647.32620000000	103.29500000000	11/26/2014
rbt3.4	2944868.12070000000	362637.06320000000	104.45290000000	11/26/2014
rbt3.5	2944864.59380000000	362627.87520000000	105.85510000000	11/26/2014
rbt3.6	2944861.83590000000	362620.47140000000	107.50760000000	11/26/2014
rbt3.7	2944857.46260000000	362613.85920000000	109.16510000000	11/26/2014
rbt3.8	2944853.39820000000	362604.56830000000	115.89510000000	11/26/2014
rbt4.1	2944787.96870000000	362717.87570000000	101.72770000000	11/26/2014
rbt4.2	2944784.32980000000	362705.50560000000	102.26470000000	11/26/2014
rbt4.3	2944779.48080000000	362686.39110000000	102.72570000000	11/26/2014
rbt4.4	2944776.43140000000	362673.23290000000	103.43840000000	11/26/2014
rbt4.5	2944774.01070000000	362659.43990000000	105.42830000000	11/26/2014
rbt4.6	2944773.22100000000	362654.13010000000	105.75730000000	11/26/2014
rbt4.7	2944772.55990000000	362651.29190000000	106.92820000000	11/26/2014
rbt4.8	2944769.66710000000	362644.28640000000	107.82660000000	11/26/2014
rbt4.9	2944767.70320000000	362636.42660000000	108.30550000000	11/26/2014
rbt5.1	2944685.50490000000	362732.41170000000	101.74240000000	11/26/2014
rbt5.2	2944684.31460000000	362716.79350000000	102.61810000000	11/26/2014
rbt5.3	2944680.78430000000	362702.13310000000	102.94500000000	11/26/2014
rbt5.4	2944676.93330000000	362686.34470000000	103.48050000000	11/26/2014

Point_Id	Northing	Easting	Elevation	Time_
rbt5.5	2944675.23020000000	362677.93180000000	104.17570000000	11/26/2014
rbt5.6	2944674.57450000000	362663.53090000000	105.80740000000	11/26/2014
rbt5.7	2944673.20810000000	362660.02340000000	105.59620000000	11/26/2014
rbt5.8	2944671.47280000000	362648.82020000000	106.67480000000	11/26/2014
rbt5.9	2944670.64230000000	362638.47230000000	107.62450000000	11/26/2014
rbt6.1	2944590.67400000000	362748.96780000000	101.71370000000	11/26/2014
rbt6.2	2944585.14940000000	362731.85420000000	102.51830000000	11/26/2014
rbt6.3	2944581.69180000000	362721.04580000000	102.80040000000	11/26/2014
rbt6.4	2944579.80440000000	362715.75670000000	102.84540000000	11/26/2014
rbt6.5	2944575.06860000000	362697.07390000000	103.51780000000	11/26/2014
rbt6.6	2944574.99970000000	362694.33890000000	103.20240000000	11/26/2014
rbt6.7	2944572.33920000000	362685.29360000000	103.67210000000	11/26/2014
rbt6.8	2944569.84700000000	362674.57760000000	104.76540000000	11/26/2014
rbt6.9	2944568.21310000000	362666.61350000000	105.77330000000	11/26/2014
rbt6.10	2944567.78240000000	362653.43730000000	108.00920000000	11/26/2014
rbt6.11	2944566.19840000000	362645.67910000000	108.34350000000	11/26/2014
rbt7.1	2944483.30450000000	362795.69910000000	101.69570000000	11/26/2014
rbt7.2	2944480.53490000000	362778.55840000000	101.80990000000	11/26/2014
rbt7.3	2944480.09280000000	362753.39890000000	102.31390000000	11/26/2014
rbt7.4	2944478.41730000000	362730.36630000000	102.70920000000	11/26/2014
rbt7.5	2944475.55490000000	362710.96530000000	103.19080000000	11/26/2014
rbt7.6	2944472.94920000000	362699.86650000000	103.62980000000	11/26/2014
rbt7.7	2944472.30880000000	362687.70320000000	104.86520000000	11/26/2014
rbt7.8	2944470.82140000000	362677.83330000000	105.87820000000	11/26/2014
rbt7.9	2944469.19490000000	362663.73870000000	107.10090000000	11/26/2014
rbt8.1	2944375.67990000000	362817.75820000000	101.73730000000	11/26/2014
rbt8.2	2944375.56370000000	362791.59490000000	102.23230000000	11/26/2014
rbt8.3	2944376.22180000000	362773.27480000000	102.74330000000	11/26/2014
rbt8.4	2944376.64670000000	362751.93050000000	102.71210000000	11/26/2014
rbt8.5	2944375.89230000000	362729.32900000000	102.85620000000	11/26/2014
rbt8.6	2944374.53270000000	362711.83110000000	103.02070000000	11/26/2014
rbt8.7	2944374.92180000000	362707.06230000000	102.71210000000	11/26/2014
rbt8.8	2944375.13610000000	362698.10130000000	103.41830000000	11/26/2014
rbt8.9	2944375.14610000000	362689.21380000000	104.19050000000	11/26/2014
rbt8.10	2944375.10000000000	362682.41230000000	105.59450000000	11/26/2014
rbt9.1	2944269.51450000000	362841.72040000000	101.76230000000	11/26/2014
rbt9.2	2944271.85970000000	362830.11330000000	101.55450000000	11/26/2014
rbt9.3	2944269.60750000000	362812.48230000000	102.37580000000	11/26/2014
rbt9.4	2944268.51600000000	362792.09250000000	102.50110000000	11/26/2014
rbt9.5	2944268.51600000000	362788.60280000000	102.28500000000	11/26/2014
rbt9.6	2944269.83210000000	362769.63630000000	102.59830000000	11/26/2014
rbt9.7	2944271.88370000000	362746.27280000000	102.56240000000	11/26/2014
rbt9.8	2944274.21190000000	362725.88100000000	102.69120000000	11/26/2014
rbt9.9	2944275.63790000000	362708.02110000000	102.87920000000	11/26/2014
rbt9.10	2944275.25830000000	362692.71850000000	103.42470000000	11/26/2014
rbt9.11	2944276.91100000000	362679.09870000000	104.43750000000	11/26/2014

Point_Id	Northing	Easting	Elevation	Time_
rbt9.12	2944280.48240000000	362670.55840000000	105.08480000000	11/26/2014
rbt9.13	2944275.04300000000	362656.58880000000	107.31530000000	11/26/2014
rbt10.1	2944158.70430000000	362741.84510000000	101.84880000000	11/26/2014
rbt10.2	2944160.99630000000	362727.98130000000	102.03140000000	11/26/2014
rbt10.3	2944162.83580000000	362713.34170000000	102.35470000000	11/26/2014
rbt10.4	2944165.50960000000	362700.35790000000	102.61020000000	11/26/2014
rbt10.5	2944167.81310000000	362692.57800000000	102.44830000000	11/26/2014
rbt10.6	2944169.46510000000	362682.15490000000	102.65170000000	11/26/2014
rbt10.7	2944169.41810000000	362678.29840000000	102.67670000000	11/26/2014
rbt10.8	2944170.44990000000	362667.89830000000	104.66370000000	11/26/2014
rbt10.9	2944169.71000000000	362660.20680000000	107.03740000000	11/26/2014
rbt10.10	2944167.65010000000	362656.66210000000	106.28050000000	11/26/2014
rbt10.11	2944167.51680000000	362650.28120000000	107.85900000000	11/26/2014
rbt10.12	2944167.21420000000	362648.11610000000	108.04150000000	11/26/2014
rbt10.13	2944167.60360000000	362644.08580000000	109.29660000000	11/26/2014
rbt10.14	2944169.68710000000	362639.25300000000	109.64280000000	11/26/2014
rbt10.15	2944171.44100000000	362634.97300000000	108.94710000000	11/26/2014
rbt10.16	2944175.22280000000	362626.93540000000	110.82510000000	11/26/2014
rbt10.17	2944173.41220000000	362621.28760000000	111.39820000000	11/26/2014
rbt11.1	2944057.76980000000	362694.61100000000	101.80180000000	11/26/2014
rbt11.2	2944061.27590000000	362679.67160000000	102.45390000000	11/26/2014
rbt13.1	2943867.87990000000	362626.87970000000	102.07620000000	11/26/2014
rbt13.2	2943873.75750000000	362613.73440000000	102.96240000000	11/26/2014
rbt13.3	2943880.48950000000	362599.27590000000	103.71330000000	11/26/2014
rbt13.4	2943884.59500000000	362591.27680000000	103.74250000000	11/26/2014
rbt13.5	2943889.40670000000	362582.72210000000	104.26950000000	11/26/2014
rbt13.6	2943893.75510000000	362572.86240000000	106.71310000000	11/26/2014
rbt14.1	2943771.31390000000	362584.05960000000	101.75640000000	11/26/2014
rbt14.2	2943779.34570000000	362572.37370000000	102.58960000000	11/26/2014
rbt14.3	2943785.90430000000	362560.54080000000	103.51070000000	11/26/2014
rbt14.4	2943793.34210000000	362543.77320000000	103.90550000000	11/26/2014
rbt14.5	2943795.00230000000	362538.73620000000	105.12650000000	11/26/2014
rbt14.6	2943796.02690000000	362537.33700000000	104.62500000000	11/26/2014
rbt14.7	2943799.57260000000	362529.07730000000	104.89240000000	11/26/2014
rbt14.8	2943802.08530000000	362522.97430000000	106.61510000000	11/26/2014
rbt14.9	2943803.86930000000	362517.76560000000	106.40290000000	11/26/2014
rbt14.10	2943806.76870000000	362506.87730000000	106.49880000000	11/26/2014
rbt14.11	2943805.75790000000	362502.95190000000	108.35200000000	11/26/2014
rbt15.1	2943675.94900000000	362535.36060000000	101.93990000000	11/26/2014
rbt15.2	2943682.86170000000	362522.86020000000	102.81730000000	11/26/2014
rbt15.3	2943691.06410000000	362507.92840000000	103.63050000000	11/26/2014
rbt15.4	2943702.77260000000	362487.48030000000	105.03090000000	11/26/2014
rbt15.5	2943710.84650000000	362477.32690000000	105.34680000000	11/26/2014
rbt15.6	2943717.03730000000	362467.78930000000	105.93300000000	11/26/2014
rbt15.7	2943722.13150000000	362462.83380000000	106.16970000000	11/26/2014
rbt15.8	2943726.50050000000	362458.67190000000	107.54630000000	11/26/2014

Point_Id	Northing	Easting	Elevation	Time_
rbt15.9	2943729.08270000000	362456.32970000000	107.63340000000	11/26/2014
rbt15.10	2943730.74130000000	362452.51310000000	108.24480000000	11/26/2014
rbt16.1	2943585.38600000000	362479.38850000000	102.02380000000	11/26/2014
rbt16.2	2943588.83380000000	362474.81510000000	102.59830000000	11/26/2014
rbt16.3	2943599.31710000000	362461.98330000000	103.28440000000	11/26/2014
rbt16.4	2943605.08340000000	362455.95620000000	103.96450000000	11/26/2014
rbt16.5	2943616.29570000000	362442.98180000000	104.52340000000	11/26/2014
rbt16.6	2943626.57340000000	362431.10660000000	104.87800000000	11/26/2014
rbt16.7	2943641.61900000000	362420.94310000000	105.37160000000	11/26/2014
rbt16.8	2943649.40570000000	362415.82230000000	106.34540000000	11/26/2014
rbt16.9	2943655.85460000000	362409.08260000000	106.89240000000	11/26/2014
rbt16.10	2943657.98240000000	362407.44350000000	106.90590000000	11/26/2014
rbt16.11	2943659.55930000000	362404.44770000000	107.32870000000	11/26/2014
rbt16.12	2943665.10680000000	362395.45820000000	107.89500000000	11/26/2014
rbt17.1	2943511.12550000000	362410.57740000000	101.89130000000	11/26/2014
rbt17.2	2943521.59440000000	362400.87200000000	102.92800000000	11/26/2014
rbt17.3	2943528.47770000000	362393.66350000000	103.17060000000	11/26/2014
rbt17.4	2943531.67550000000	362389.21680000000	103.80260000000	11/26/2014
rbt17.5	2943535.82510000000	362384.85080000000	103.95720000000	11/26/2014
rbt17.6	2943543.34320000000	362376.41880000000	104.33970000000	11/26/2014
rbt17.7	2943553.53890000000	362364.51510000000	104.62630000000	11/26/2014
rbt17.8	2943560.58850000000	362357.92190000000	104.83260000000	11/26/2014
rbt17.9	2943567.99660000000	362350.87840000000	105.63050000000	11/26/2014
rbt17.10	2943570.75010000000	362348.50950000000	105.40760000000	11/26/2014
rbt17.11	2943573.97670000000	362346.52600000000	105.63630000000	11/26/2014
rbt17.12	2943576.91000000000	362343.39690000000	106.25320000000	11/26/2014
rbt17.13	2943579.49240000000	362339.91450000000	106.02650000000	11/26/2014
rbt17.14	2943584.20460000000	362335.54550000000	106.87690000000	11/26/2014
rbt17.15	2943593.19580000000	362330.04510000000	107.32480000000	11/26/2014
rbt18.1	2943454.89880000000	362314.29670000000	101.88890000000	11/26/2014
rbt18.2	2943458.72950000000	362311.03210000000	102.61300000000	11/26/2014
rbt18.3	2943466.97080000000	362303.14710000000	102.82110000000	11/26/2014
rbt18.4	2943471.84450000000	362298.75940000000	103.20510000000	11/26/2014
rbt18.5	2943476.67000000000	362294.92920000000	103.83780000000	11/26/2014
rbt18.6	2943485.45060000000	362287.38430000000	104.51820000000	11/26/2014
rbt18.7	2943492.15640000000	362281.82590000000	104.71340000000	11/26/2014
rbt18.8	2943501.43620000000	362275.42210000000	105.50720000000	11/26/2014
rbt18.9	2943508.07230000000	362269.67110000000	106.26780000000	11/26/2014
rbt18.10	2943514.40810000000	362264.99500000000	106.52030000000	11/26/2014
rbt19.1	2943392.21420000000	362235.47240000000	101.93740000000	11/26/2014
rbt19.2	2943398.20430000000	362232.10550000000	102.24310000000	11/26/2014
rbt19.3	2943399.91050000000	362231.01550000000	102.50220000000	11/26/2014
rbt19.4	2943410.77120000000	362223.26750000000	102.74810000000	11/26/2014
rbt19.5	2943410.98130000000	362223.17220000000	102.78370000000	11/26/2014
rbt19.6	2943421.26980000000	362217.50670000000	103.49650000000	11/26/2014
rbt19.7	2943425.64480000000	362215.78800000000	103.89090000000	11/26/2014

Point_Id	Northing	Easting	Elevation	Time_
rbt19.8	2943428.63440000000	362215.11080000000	103.85030000000	11/26/2014
rbt19.9	2943436.98140000000	362210.21110000000	105.43550000000	11/26/2014
rbt19.10	2943442.16470000000	362205.73120000000	106.50960000000	11/26/2014
rbt19.11	2943448.58030000000	362201.53190000000	106.56190000000	11/26/2014
rbt19.12	2943453.15020000000	362197.79460000000	106.19320000000	11/26/2014
rbt19.13	2943459.16700000000	362193.98560000000	105.85340000000	11/26/2014
rbt19.14	2943465.69280000000	362186.73800000000	106.27050000000	11/26/2014
rbt20.1	2943348.10060000000	362151.24390000000	101.99590000000	11/26/2014
rbt20.2	2943348.18280000000	362151.27650000000	101.96540000000	11/26/2014
rbt20.3	2943348.02790000000	362151.12970000000	101.84000000000	11/26/2014
rbt20.4	2943352.83010000000	362148.14990000000	102.53470000000	11/26/2014
rbt20.5	2943359.46660000000	362141.29810000000	102.87170000000	11/26/2014
rbt20.6	2943366.04460000000	362134.78460000000	102.91240000000	11/26/2014
rbt20.7	2943371.08980000000	362130.12930000000	103.19410000000	11/26/2014
rbt20.8	2943375.22550000000	362126.70210000000	103.71770000000	11/26/2014
rbt20.9	2943383.26970000000	362123.67380000000	104.33640000000	11/26/2014
rbt20.10	2943393.48350000000	362116.57360000000	104.61060000000	11/26/2014
rbt21.1	2943306.39130000000	362067.58430000000	101.97980000000	11/26/2014
rbt21.2	2943311.55970000000	362064.21070000000	102.50430000000	11/26/2014
rbt21.3	2943319.59050000000	362060.65100000000	102.98180000000	11/26/2014
rbt21.4	2943324.83960000000	362056.48110000000	103.10250000000	11/26/2014
rbt21.5	2943331.57030000000	362054.76390000000	103.89040000000	11/26/2014
rbt21.6	2943339.85470000000	362051.36270000000	104.69490000000	11/26/2014
rbt21.7	2943348.26700000000	362045.69130000000	104.02890000000	11/26/2014
rbt22.1	2943262.18620000000	361981.60720000000	101.90900000000	11/26/2014
rbt22.2	2943267.90900000000	361977.40830000000	102.70060000000	11/26/2014
rbt22.3	2943276.43560000000	361973.04830000000	103.25390000000	11/26/2014
rbt22.4	2943279.61230000000	361970.99010000000	103.82400000000	11/26/2014
rbt22.5	2943287.49000000000	361966.30290000000	104.07350000000	11/26/2014
rbt22.6	2943291.83970000000	361962.44330000000	103.70680000000	11/26/2014
rbt23.1	2943221.31180000000	361882.48770000000	102.03320000000	11/26/2014
rbt23.2	2943226.18760000000	361880.76020000000	102.55130000000	11/26/2014
rbt23.3	2943230.55300000000	361877.96120000000	103.07230000000	11/26/2014
rbt23.4	2943241.34180000000	361870.33660000000	103.30030000000	11/26/2014
rbt23.5	2943248.17970000000	361867.90120000000	103.20800000000	11/26/2014
rbt24.1	2943186.09330000000	361773.61870000000	101.95720000000	11/26/2014
rbt24.2	2943195.56040000000	361767.15970000000	103.12560000000	11/26/2014
testtopo.1	2945434.73990000000	361294.39430000000	112.54900000000	11/26/2014
topo.1	2943909.48060000000	362649.20480000000	102.01250000000	11/26/2014
topo.2	2943936.48870000000	362672.46320000000	101.93300000000	11/26/2014
topo.3	2943960.08400000000	362699.35890000000	101.89190000000	11/26/2014
topo.4	2944000.44910000000	362685.70460000000	101.94270000000	11/26/2014
topo.5	2944027.74690000000	362674.09610000000	102.00970000000	11/26/2014
topo.6	2944051.00740000000	362677.14470000000	101.99750000000	11/26/2014
topo.7	2944061.42410000000	362697.14700000000	102.05950000000	11/26/2014
topo.8	2944092.36550000000	362714.44710000000	102.12300000000	11/26/2014

Point_Id	Northing	Easting	Elevation	Time_
topo.9	2944118.23720000000	362737.18670000000	101.94090000000	11/26/2014
topo.10	2944174.12270000000	362730.32000000000	101.68880000000	11/26/2014
topo.11	2944192.76040000000	362711.94250000000	101.82470000000	11/26/2014
topo.12	2944229.30860000000	362745.82910000000	101.78230000000	11/26/2014

Attachment C to Study No. 3.5.1.
RTE Plant RTK Survey Data collected in 2015

This is sensitive information and has been filed as Privileged

STUDY 3.6.1 ATTACHMENTS

Attachment A to Study 3.6.1.
Table 4.1.3-1: Estimated Use of Surveyed Recreation Sites by Season[1]
Revision (May 2016)

Recreation Site	Estimated Annual Use (2014)	Estimated Winter Use	Estimated Spring Use	Estimated Summer Use	Estimated Fall Use
Governor Hunt Boat Launch/Picnic Area	1,812	13%	11%	67%	9%
Pauchaug WMA	1,005	15%	0%	23%	62%
Pauchaug Boat Launch	9,630	1%	7%	68%	23%
Bennett Meadow WMA	3,729	2%	14%	40%	44%
Munn's Ferry Boat Camping Recreation Area	1,716	0%	0%	84%	16%
Boat Tour and Riverview Picnic Area	13,651	17%	23%	39%	21%
Northfield Mountain Tour and Trail Center	20,024	24%	12%	33%	31%
Cabot Camp Access Area	5,326	4%	10%	62%	24%
Barton Cove Nature Area	7,842	15%	19%	45%	21%
Barton Cove Campground	2,963	0%	5%	92%	3%
Barton Cove Canoe and Kayak Rental Area	4,455	2%	0%	98%	0%
State Boat Launch	15,126	1%	2%	74%	23%
Canalside Trail Bike Path	6,362	1%	13%	54%	31%
Gatehouse Fishway Viewing Area[2]	27,345	7%	28%	46%	20%
Turners Falls Branch Canal Area/Turners Falls Station No. 1 Fishing Access	1,264	27%	29%	20%	24%
Cabot Woods Fishing Access	18,053	17%	19%	43%	21%
Poplar Street Access Site	1,877	14%	5%	56%	25%
Rose Ledge Climbing Area Parking	1,790	2%	27%	54%	17%
Farley Ledge Climbing Area—Wells Street Parking	2,390	7%	51%	29%	13%
Farley Ledge Climbing Area—Route 2 Parking	6,232	4%	22%	48%	25%
Total Use of the above Recreation Sites	**152,592**	**10%**	**16%**	**51%**	**23%**

[1] *Percentages of estimated use by season at each recreation site may not sum to 100% due to rounding.*
[2] *Estimated Annual Use includes visitors to the Gatehouse Fishway Viewing Area, the associated picnic area, and the adjacent bike path.*

Attachment A to Study No. 3.6.1
Table 4.1.3-2: Percent of Recreation Use by Activity at Each Site
Revision (May 2016)

Recreation Site	Walk/ Hike/ Jogging	Motor Boating	Fishing	Ride Bikes	Picnicking	Climbing	Non-motor boating	Fishway Viewing	Cross-country Ski	Camping	Riverboat	Sight see	Hunt	Birding	Ice Fish	Ride Horses	Snow Shoe	Whitewater boat (Bypass only)	Ice Skate/ Boat	Unidentified Recreation Activity
Governor Hunt Boat Launch/Picnic Area	0%	53%	12%	0%	0%	0%	15%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	19%
Pauchaug WMA	32%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	44%	0%	0%	0%	0%	0%	0%	23%
Pauchaug Boat Launch	4%	49%	12%	0%	1%	0%	10%	0%	0%	0%	0%	2%	2%	0%	0%	0%	0%	0%	0%	20%
Bennett Meadow WMA	41%	0%	1%	0%	1%	0%	1%	0%	0%	0%	0%	4%	25%	0%	0%	0%	0%	0%	0%	27%
Munn's Ferry Boat Camping Recreation Area	0%	39%	0%	0%	5%	0%	9%	0%	0%	30%	0%	0%	0%	0%	0%	0%	0%	0%	0%	18%
Boat Tour and Riverview Picnic Area	29%	3%	2%	2%	18%	0%	1%	0%	0%	0%	20%	1%	0%	0%	0%	0%	0%	0%	0%	24%
Northfield Mountain Tour and Trail Center	49%	0%	0%	0%	0%	0%	0%	0%	17%	0%	0%	1%	0%	0%	0%	3%	1%	0%	0%	29%
Cabot Camp Access Area	19%	1%	26%	2%	1%	0%	1%	0%	0%	0%	0%	8%	0%	0%	0%	0%	0%	3%	0%	39%
Barton Cove Nature Area	31%	0%	23%	6%	5%	0%	4%	0%	0%	0%	0%	1%	0%	1%	9%	0%	0%	0%	1%	19%
Barton Cove Campground	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Barton Cove Canoe and Kayak Rental Area	0%	8%	4%	0%	12%	0%	60%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	14%
State Boat Launch	1%	74%	2%	0%	1%	0%	11%	0%	0%	0%	0%	1%	0%	2%	0%	0%	0%	0%	0%	8%
Canalside Trail Bike Path	41%	0%	0%	55%	3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%
Gatehouse Fishway Viewing Area[2]	36%	0%	6%	8%	14%	0%	0%	19%	0%	0%	0%	1%	0%	1%	0%	0%	0%	0%	0%	15%
Turners Falls Branch Canal/Station No. 1 Fishing Access	26%	0%	21%	21%	0%	0%	0%	0%	14%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	19%
Cabot Woods Fishing Access	58%	0%	11%	10%	3%	0%	0%	0%	0%	0%	0%	1%	0%	1%	0%	0%	0%	0%	0%	17%
Poplar Street Access Site	23%	0%	41%	3%	0%	0%	21%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	11%
Rose Ledge Climbing Area Parking	19%	0%	0%	0%	0%	75%	0%	0%	1%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	4%
Farley Ledge Climbing Area—Wells Street Parking	71%	0%	0%	0%	0%	25%	0%	0%	4%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Farley Ledge Climbing Area—Route 2 Parking	20%	0%	0%	0%	0%	75%	0%	0%	2%	0%	0%	1%	0%	0%	0%	1%	1%	0%	0%	1%
Total Project-Wide Use of the above Sites.	30%	12%	7%	6%	5%	4%	4%	3%	3%	2%	2%	1%	1%	1%	>1%	>1%	>1%	>1%	>1%	17%

[2] *Use includes visitors utilizing the Visitor Center and the associated picnic area, which includes a portion of the Canalside Trail Bike Path.*

Attachment A to Study No. 3.6.1
Table 4.1.3-3: Recreation Site Capacity Utilization by Site
Revision (May 2016)

Recreation Site	Recreation Days	Percent Capacity Utilized
Governor Hunt Boat Launch/Picnic Area	1,812	50%
Pauchaug WMA	1,005	1%
Pauchaug Boat Launch	9,630	20%
Bennett Meadow WMA	3,729	10%
Munn's Ferry Boat Camping Recreation Area	1,716	40%
Boat Tour and Riverview Picnic Area	13,651	10%
Northfield Mountain Tour and Trail Center	20,024	10%
Cabot Camp Access Area	5,326	15%
Barton Cove Nature Area	7,842	20%
Barton Cove Campground	2,963	40%
Barton Cove Canoe and Kayak Rental Area	4,455	25%
State Boat Launch	15,126	65%
Canalside Trail Bike Path	6,362	N/A
Gatehouse Fishway Viewing Area	27,345	25%
Turners Falls Branch Canal/Station No. 1 Fishing Access	1,264	1%
Cabot Woods Fishing Access	18,053	25%
Poplar Street Access Site	1,877	10%
Rose Ledge Climbing Area Parking	1,790	60%
Farley Ledge Climbing Area—Wells Street Parking	2,390	30%
Farley Ledge Climbing Area—Route 2 Parking	6,232	60%
Annual Total	**152,592**	

Attachment A to Study No. 3.6.1
Table 4.1.2-1: Recreation Use by Activity Type based on Spot Counts and Calibration Counts in 2014
Revision May 2016

Recreation Activity	Estimated Use (Recreation Days)	Percent (%) of Recreation Use
Walking/Hiking/Jogging	46,476	30%
Motor boating	18,470	12%
Fishing	9,960	7%
Bike Riding	8,643	6%
Picnicking	8,374	5%
Rock Climbing	6,703	4%
Non-motor boating	6,625	4%
Fishway Viewing	5,061	3%
Cross-country Skiing	3,960	3%
Camping	3,478	2%
Riverboat touring	2,733	2%
Sightseeing	1,746	1%
Hunting	1,569	1%
Birding	836	1%
Ice Fishing	761	1%
Horseback Riding	736	<1%
Snowshoeing	188	<1%
Whitewater boating	171	<1%
Ice skating/ Ice boat	97	<1%
Unidentified Activity	26,005	17%
Total	**152,592**	**100%**

Attachment A to Study No. 3.6.1
Table 4.7.2-4: Projected Recreation Use by Activity Type, 2060
Revision (May 2016)

Recreation Activity	2014 Use (Recreation Days)	2060 Projected Use (Recreation Days)	Percent (%) of Recreation Use
Walking/Hiking/Jogging	46,476	53,218	30%
Motor Boating	18,470	22,158	13%
Fishing	9,960	10,184	6%
Bike Riding	8,643	9,897	6%
Picnicking	8,374	9,017	5%
Rock Climbing	6,703	8,182	5%
Non-motor Boating	6,625	7,165	4%
Interpretive—Fishway Viewing	5,061	5,756	3%
Cross-country Skiing	3,960	5,335	3%
Camping	3,478	3,745	2%
Riverboat Touring	2,733	2,966	2%
Sightseeing	1,746	1,895	1%
Hunting	1,569	1,314	1%
Birding	836	908	1%
Ice Fishing	761	778	0%
Horseback Riding	736	908	1%
Snowshoeing	188	253	0%
Whitewater boating	171	185	0%
Ice skating/ Ice boat	97	132	0%
Unidentified Recreation Activity	26,005	30,119	17%
Projects Total	**152,592**	**175,503**	

Attachment A to Study 3.6.1 (Redline Version).
Table 4.1.3-1: Estimated Use of Surveyed Recreation Sites by Season[1]

Attachment A to Study No. 3.6.1

Table 4.1.3-1: Estimated Use of Surveyed Recreation Sites by Season[1]

Revision May 2016

Recreation Site	Estimated Annual Use (2014)	Estimated Winter Use	Estimated Spring Use	Estimated Summer Use	Estimated Fall Use
Governor Hunt Boat Launch/Picnic Area	1,812	13%	11%	67%	9%
Pauchaug WMA	1,005	15%	0%	23%	62%
Pauchaug Boat Launch	9,630	1%	7%	68%	23%
Bennett Meadow WMA	3,729	2%	14%	40%	44%
Munn's Ferry Boat Camping Recreation Area	1,716	0%	0%	84%	16%
Boat Tour and Riverview Picnic Area	13,651	17%	23%	39%	21%
Northfield Mountain Tour and Trail Center	20,024	24%	12%	33%	31%
Cabot Camp Access Area	5,326	4%	10%	62%	24%
Barton Cove Nature Area	7,842	15%	19%	45%	21%
Barton Cove Campground	2,963	0%	5%	92%	3%
Barton Cove Canoe and Kayak Rental Area	4,455	2%	0%	98%	0%
State Boat Launch	15,126	1%	2%	74%	23%
Canalside Trail Bike Path	6,362	1%	13%	54%	31%
Gatehouse Fishway Viewing Area[2]	27,345	7%	28%	46%	20%
Turners Falls Branch Canal Area/Turners Falls Station No. 1 Fishing Access	1,264	27%	29%	20%	24%
Cabot Woods Fishing Access	~~18,230~~18,053	17%	19%	~~38%~~43%	~~27%~~21%
Poplar Street Access Site	1,877	14%	5%	56%	25%
Rose Ledge Climbing Area Parking	1,790	2%	27%	54%	17%
Farley Ledge Climbing Area—Wells Street Parking	2,390	7%	51%	29%	13%
Farley Ledge Climbing Area—Route 2 Parking	6,232	4%	22%	48%	25%
Total Use of the above Recreation Sites	**~~152,769~~152,592**	**10%**	**16%**	**~~50%~~51%**	**23%**

[1] *Percentages of estimated use by season at each recreation site may not sum to 100% due to rounding.*

[2] *Estimated Annual Use includes visitors to the Gatehouse Fishway Viewing Area, the associated picnic area, and the adjacent bike path.*

Attachment A to Study No. 3.6.1

Table 4.1.3-2: Percent of Recreation Use by Activity at Each Site

Revision May 2016

Recreation Site	Walk/ Hike/ Jogging	Motor Boating	Fishing	Ride Bikes	Picnicking	Climbing	Non-motor boating	Fishway Viewing	Cross-country Ski	Camping	Riverboat	Sight see	Hunt	Birding	Ice Fish	Ride Horses	Snow Shoe	Whitewater boat (Bypass only)	Ice Skate/ Boat	Unidentified Recreation Activity
Governor Hunt Boat Launch/Picnic Area	0%	53%	12%	0%	0%	0%	15%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	19%
Pauchaug WMA	32%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	44%	0%	0%	0%	0%	0%	0%	23%
Pauchaug Boat Launch	4%	49%	12%	0%	1%	0%	10%	0%	0%	0%	0%	2%	2%	0%	0%	0%	0%	0%	0%	20%
Bennett Meadow WMA	41%	0%	1%	0%	1%	0%	1%	0%	0%	0%	0%	4%	25%	0%	0%	0%	0%	0%	0%	27%
Munn's Ferry Boat Camping Recreation Area	0%	39%	0%	0%	5%	0%	9%	0%	0%	30%	0%	0%	0%	0%	0%	0%	0%	0%	0%	18%
Boat Tour and Riverview Picnic Area	29%	3%	2%	2%	18%	0%	1%	0%	0%	0%	20%	1%	0%	0%	0%	0%	0%	0%	0%	24%
Northfield Mountain Tour and Trail Center	49%	0%	0%	0%	0%	0%	0%	0%	17%	0%	0%	1%	0%	0%	0%	3%	1%	0%	0%	29%
Cabot Camp Access Area	19%	1%	26%	2%	1%	0%	1%	0%	0%	0%	0%	8%	0%	0%	0%	0%	0%	3%	0%	39%
Barton Cove Nature Area	31%	0%	23%	6%	5%	0%	4%	0%	0%	0%	0%	1%	0%	1%	9%	0%	0%	0%	1%	19%
Barton Cove Campground	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Barton Cove Canoe and Kayak Rental Area	0%	8%	4%	0%	12%	0%	60%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	14%
State Boat Launch	1%	74%	2%	0%	1%	0%	11%	0%	0%	0%	0%	1%	0%	2%	0%	0%	0%	0%	0%	8%
Canalside Trail Bike Path	41%	0%	0%	55%	3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%
Gatehouse Fishway Viewing Area[2]	36%	0%	6%	8%	14%	0%	0%	19%	0%	0%	0%	1%	0%	1%	0%	0%	0%	0%	0%	15%
Turners Falls Branch Canal/Station No. 1 Fishing Access	26%	0%	21%	21%	0%	0%	0%	0%	14%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	19%
Cabot Woods Fishing Access	~~53~~58%	0%	11%	10%	3%	0%	0%	0%	0%	0%	0%	1%	0%	1%	0%	0%	0%	0%	0%	~~20~~17%
Poplar Street Access Site	23%	0%	41%	3%	0%	0%	21%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	11%
Rose Ledge Climbing Area Parking	19%	0%	0%	0%	0%	75%	0%	0%	1%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	4%
Farley Ledge Climbing Area—Wells Street Parking	71%	0%	0%	0%	0%	25%	0%	0%	4%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Farley Ledge Climbing Area—Route 2 Parking	20%	0%	0%	0%	0%	75%	0%	0%	2%	0%	0%	1%	0%	0%	0%	1%	1%	0%	0%	1%
Total Project-Wide Use of the above Sites.	~~29~~30%	12%	7%	6%	5%	4%	4%	3%	3%	2%	2%	1%	1%	1%	~~1~~>1%	~~1~~>1%	~~0~~>1%	~~0~~>1%	~~0~~>1%	~~18~~17%

[2] *Use includes visitors utilizing the Visitor Center and the associated picnic area, which includes a portion of the Canalside Trail Bike Path.*

Attachment A to Study No. 3.6.1

Table 4.1.3-3: Recreation Site Capacity Utilization by Site

Revision May 2016

Recreation Site	Recreation Days	Percent Capacity Utilized
Governor Hunt Boat Launch/Picnic Area	1,812	50%
Pauchaug WMA	1,005	1%
Pauchaug Boat Launch	9,630	20%
Bennett Meadow WMA	3,729	10%
Munn's Ferry Boat Camping Recreation Area	1,716	40%
Boat Tour and Riverview Picnic Area	13,651	10%
Northfield Mountain Tour and Trail Center	20,024	10%
Cabot Camp Access Area	5,326	15%
Barton Cove Nature Area	7,842	20%
Barton Cove Campground	2,963	40%
Barton Cove Canoe and Kayak Rental Area	4,455	25%
State Boat Launch	15,126	65%
Canalside Trail Bike Path	6,362	N/A
Gatehouse Fishway Viewing Area	27,345	25%
Turners Falls Branch Canal/Station No. 1 Fishing Access	1,264	1%
Cabot Woods Fishing Access	~~18,230~~18,053	25%
Poplar Street Access Site	1,877	10%
Rose Ledge Climbing Area Parking	1,790	60%
Farley Ledge Climbing Area—Wells Street Parking	2,390	30%
Farley Ledge Climbing Area—Route 2 Parking	6,232	60%
Annual Total	**~~152,769~~152,592**	

Attachment A to Study No. 3.6.1

Table 4.1.2-1: Recreation Use by Activity Type based on Spot Counts and Calibration Counts in 2014

Revision May 2016

Recreation Activity	Estimated Use (Recreation Days)	Percent (%) of Recreation Use
Walking/Hiking/Jogging	~~45,691~~46,476	30%
Motor boating	18,470	12%
Fishing	~~9,966~~9,960	7%
Bike Riding	~~8,744~~8,643	6%
Picnicking	~~8,362~~8,374	5%
Rock Climbing	6,703	4%
Non-motor boating	~~6,656~~6,625	4%
Fishway Viewing	5,061	3%
Cross-country Skiing	3,960	3%
Camping	3,478	2%
Riverboat touring	2,733	2%
Sightseeing	1,746~~1,802~~	1%
Hunting	1,569	1%
Birding	836~~847~~	1%
Ice Fishing	761	1%
Horseback Riding	~~746~~736	<1%
Snowshoeing	188	<1%
Whitewater boating	171	<1%
Ice skating/ Ice boat	~~112~~97	<1%
Unidentified Activity	~~26,750~~26,005	~~18~~17%
Total	**~~152,769~~152,592**	**100%**

Attachment A to Study No. 3.6.1

Table 4.7.2-4: Projected Recreation Use by Activity Type, 2060

Revision May 2016

Recreation Activity	2014 Use (Recreation Days)	2060 Projected Use (Recreation Days)	Percent (%) of Recreation Use
Walking/Hiking/Jogging	~~45,691~~46,476	~~52,320~~53,218	30%
Motor Boating	18,470	22,158	13%
Fishing	~~9,966~~9,960	~~10,190~~10,184	6%
Bike Riding	~~8,744~~8,643	~~10,013~~9,897	6%
Picnicking	~~8,362~~8,374	9,017~~9,004~~	5%
Rock Climbing	6,703	8,182	5%
Non-motor Boating	~~6,656~~6,625	~~7,199~~7,165	4%
Interpretive—Fishway Viewing	5,061	5,756	3%
Cross-country Skiing	3,960	5,335	3%
Camping	3,478	3,745	2%
Riverboat Touring	2,733	2,966	2%
Sightseeing	~~1,802~~1,746	~~1,956~~1,895	1%
Hunting	1,569	1,314	1%
Birding	~~847~~836	~~919~~908	1%
Ice Fishing	761	778	0%
Horseback Riding	~~746~~736	~~918~~908	1%
Snowshoeing	188	253	0%
Whitewater boating	171	185	0%
Ice skating/ Ice boat	~~112~~97	~~150~~132	0%
Unidentified Recreation Activity	~~26,750~~26,005	~~30,283~~30,119	17%
Projects Total	**~~152,769~~152,592**	**~~175,684~~175,503**	

Attachment B to Study 3.6.1.
Table 4.2-3: Total Number of Times a Recreational Survey Respondent indicated they had Participated in Certain Recreational Activities at the Northfield Mountain and Turners Falls Projects.

Revision (May 2016)

Activity	Primary Activity This Trip	Spring (3/1 – 5/31)	Summer (6/1 – 8/31)	Fall (9/1 – 11/30)	Winter (12/1 – 2/28)	Total
Backpacking	3	7	8	6	5	26
Birding	66	90	84	82	51	307
Camping	7	5	17	6	0	28
Canoeing	15	28	40	29	0	97
Dog Walking	181	182	190	182	94	648
Driving for Pleasure	5	9	9	9	3	30
Educational Programs	6	8	7	8	2	25
Fishing from a Boat	27	64	88	65	4	221
Fishing from Shore	139	160	179	146	13	498
Fishway Viewing	6	11	11	2	0	24
Hiking	29	73	76	73	26	248
Horseback Riding	0	0	0	0	0	0
Hunting	6	3	3	10	5	21
Ice Fishing	34	1	0	0	45	46
Kayaking	40	59	71	53	6	189
Mountain Biking	0	11	14	11	1	37
Multi-day Float Trip	5	1	5	2	1	9
Nature Observation	97	132	133	124	50	439
Orienteering	0	0	2	1	0	3
Other	57	42	50	40	4	136
Paddle Boarding	2	1	5	1	0	7
Photography	28	41	39	43	18	141
Picnicking	58	97	114	86	4	301
Power Boating	43	42	68	41	1	152
Riding Jet Ski	0	1	6	1	0	8
Road Bicycling	33	97	107	98	6	308
Rock Climbing	21	22	23	20	4	69
Rowing	1	3	4	3	0	10
Running	6	18	20	20	4	62
Sailing	2	0	1	0	1	2
Sightseeing	46	32	37	35	12	116
Skiing	2	1	0	0	14	15
Snowshoeing	2	0	0	0	11	11
Swimming	19	16	42	19	0	77
Tubing	4	6	11	3	0	20
Walking	308	336	337	328	144	1,145
Waterskiing	1	1	5	1	1	8
Whitewater Boating	3	4	3	2	1	10

Attachment B to Study 3.6.1 (Redline Version).
Table 4.2-3: Total Number of Times a Recreational Survey Respondent indicated they had Participated in Certain Recreational Activities at the Northfield Mountain and Turners Falls Projects.

Attachment B to Study No. 3.6.1

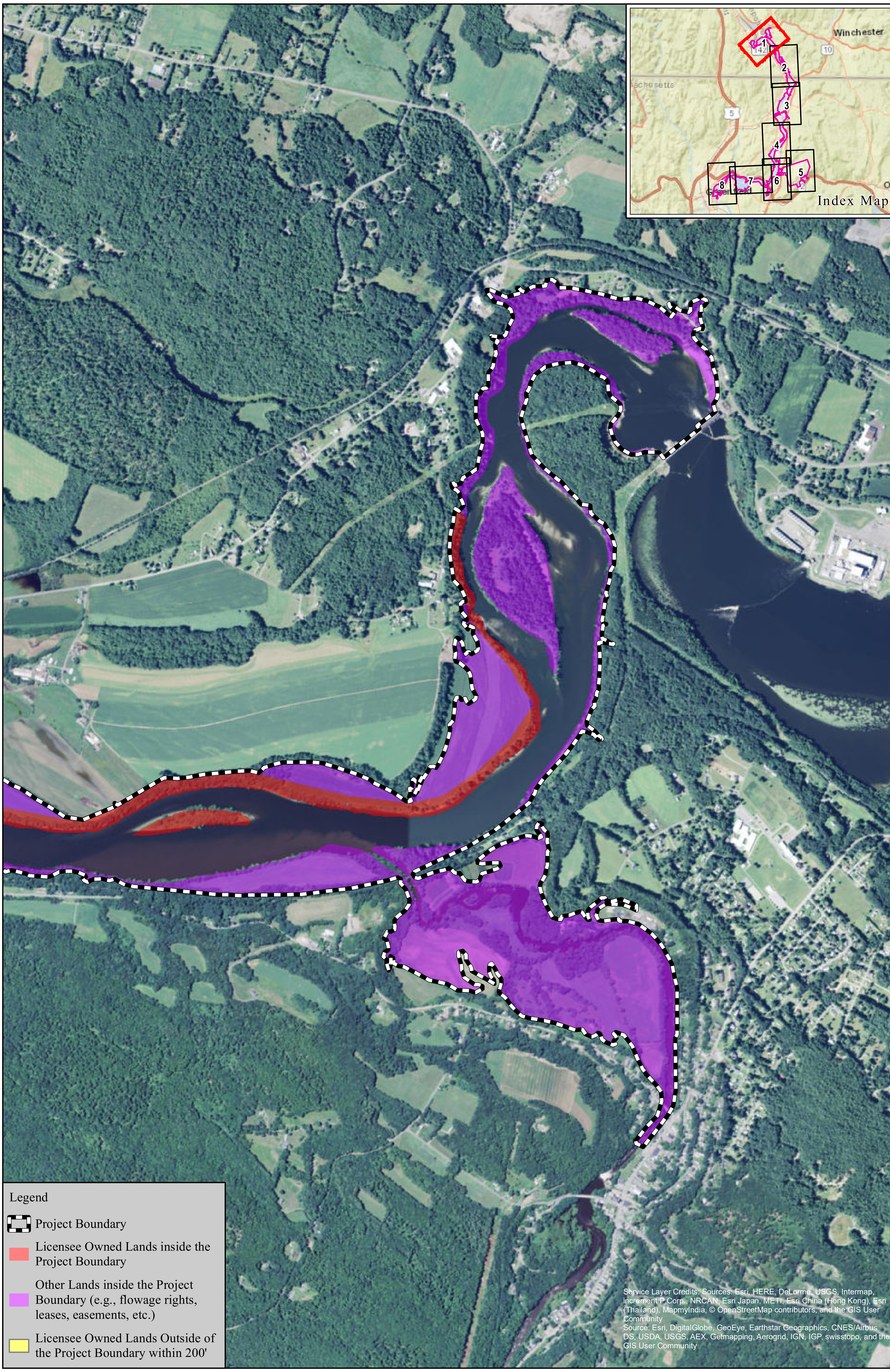
Table 4.2-3: Total Number of Times a Recreational Survey Respondent indicated they had Participated in Certain Recreational Activities at the Northfield Mountain and Turners Falls Projects.

Revision (May 2016)

Activity	Primary Activity This Trip	Spring (3/1 – 5/31)	Summer (6/1 – 8/31)	Fall (9/1 – 11/30)	Winter (12/1 – 2/28)	Total
Backpacking	3~~2~~	7	8	6~~7~~	5	26 ~~27~~
Birding	66	90	84	82	51~~54~~	307~~310~~
Camping	7	5	17	6	0	28
Canoeing	15~~18~~	28	40	29~~27~~	0~~6~~	97~~101~~
Dog Walking	181~~185~~	182	190~~189~~	182~~178~~	94~~114~~	648~~663~~
Driving for Pleasure	5	9	9~~10~~	9~~6~~	3~~10~~	30~~35~~
Educational Programs	6~~5~~	8	7	8	2	25
Fishing from a Boat	27~~29~~	64~~66~~	88~~86~~	65~~63~~	4~~12~~	221~~227~~
Fishing from Shore	139~~142~~	160~~162~~	179~~174~~	146~~131~~	13~~69~~	498~~536~~
Fishway Viewing	6	11	11	2	0	24
Hiking	29~~31~~	73	76	73~~69~~	26~~38~~	248~~256~~
Horseback Riding	0	0	0	0	0	0
Hunting	6~~7~~	3	3	10	5~~8~~	21~~24~~
Ice Fishing	34	1	0	0	45	46
Kayaking	40~~41~~	59	71	53~~49~~	6~~24~~	189~~203~~
Mountain Biking	0~~1~~	11	14	11~~10~~	1~~4~~	37~~39~~
Multi-day Float Trip	5	1	5	2	1	9
Nature Observation	97~~98~~	132~~133~~	133	124~~118~~	50~~73~~	439~~457~~
Orienteering	0	0	2	1	0	3
Other	57~~55~~	42	50	40~~39~~	4~~7~~	136~~138~~
Paddle Boarding	2	1	5	1	0	7
Photography	28~~29~~	41	39~~40~~	43~~33~~	18~~55~~	141~~169~~
Picnicking	58~~61~~	97	114~~113~~	86~~81~~	4~~21~~	301~~312~~
Power Boating	43~~44~~	42	68~~67~~	41	1~~3~~	152~~153~~
Riding Jet Ski	0	1	6	1	0	8
Road Bicycling	33~~34~~	97~~98~~	107~~105~~	98~~97~~	6~~12~~	308~~312~~
Rock Climbing	21~~22~~	22	23	20~~19~~	4~~7~~	69~~71~~
Rowing	1	3	4	3	0	10
Running	6~~7~~	18	20	20~~18~~	4~~10~~	62~~66~~
Sailing	2	0	1	0	1	2
Sightseeing	46~~41~~	32~~33~~	37	35~~28~~	12~~38~~	116~~136~~
Skiing	2	1	0	0	14	15
Snowshoeing	2	0	0	0	11	11
Swimming	19	16~~22~~	42~~34~~	19~~15~~	0~~22~~	77~~93~~
Tubing	4~~6~~	6	11~~10~~	3~~2~~	0~~5~~	20~~23~~
Walking	308~~304~~	336~~337~~	337~~335~~	328~~322~~	144~~183~~	1,145~~1,177~~
Waterskiing	1~~2~~	1	5~~4~~	1	1~~3~~	8~~9~~
Whitewater Boating	3	4~~3~~	3	2~~1~~	1~~8~~	10~~15~~

STUDY 3.6.5 ATTACHMENTS

Attachment A to Study 3.6.5
Revised Figure 4.4-1. Licensee Owned Lands



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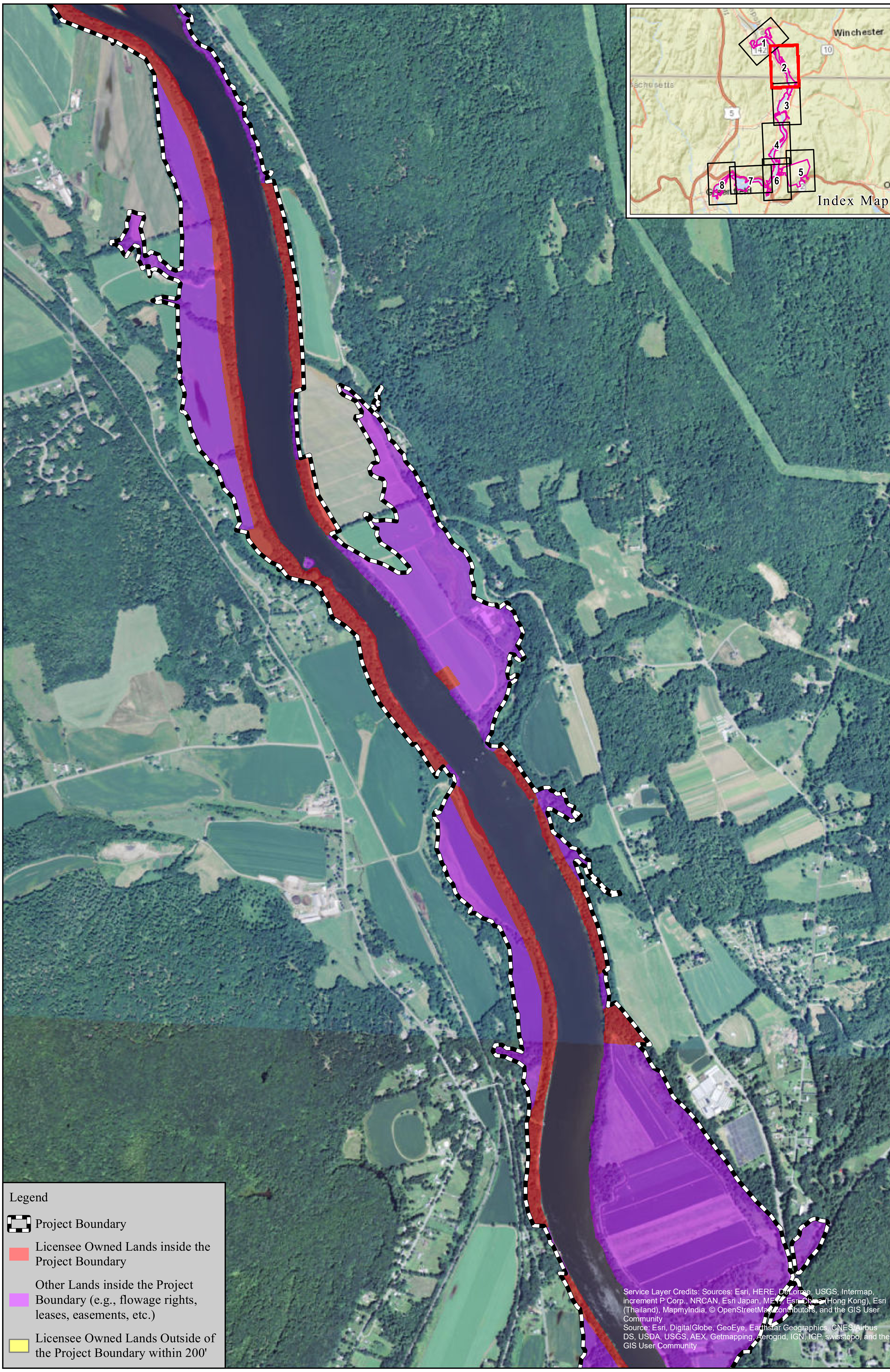
Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

Study 3.6.5
Land Use Inventory

0 625 1,250 2,500 Feet

Revised Figure 4.4-1
Licensee Owned Lands
Map 1 of 8

Path: W:\gis\studies\3_6_5\maps\ownership.mxd



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Study 3.6.5
Land Use Inventory

N

0 625 1,250 2,500
Feet

Revised Figure 4.4-1
Licensee Owned Lands
Map 2 of 8

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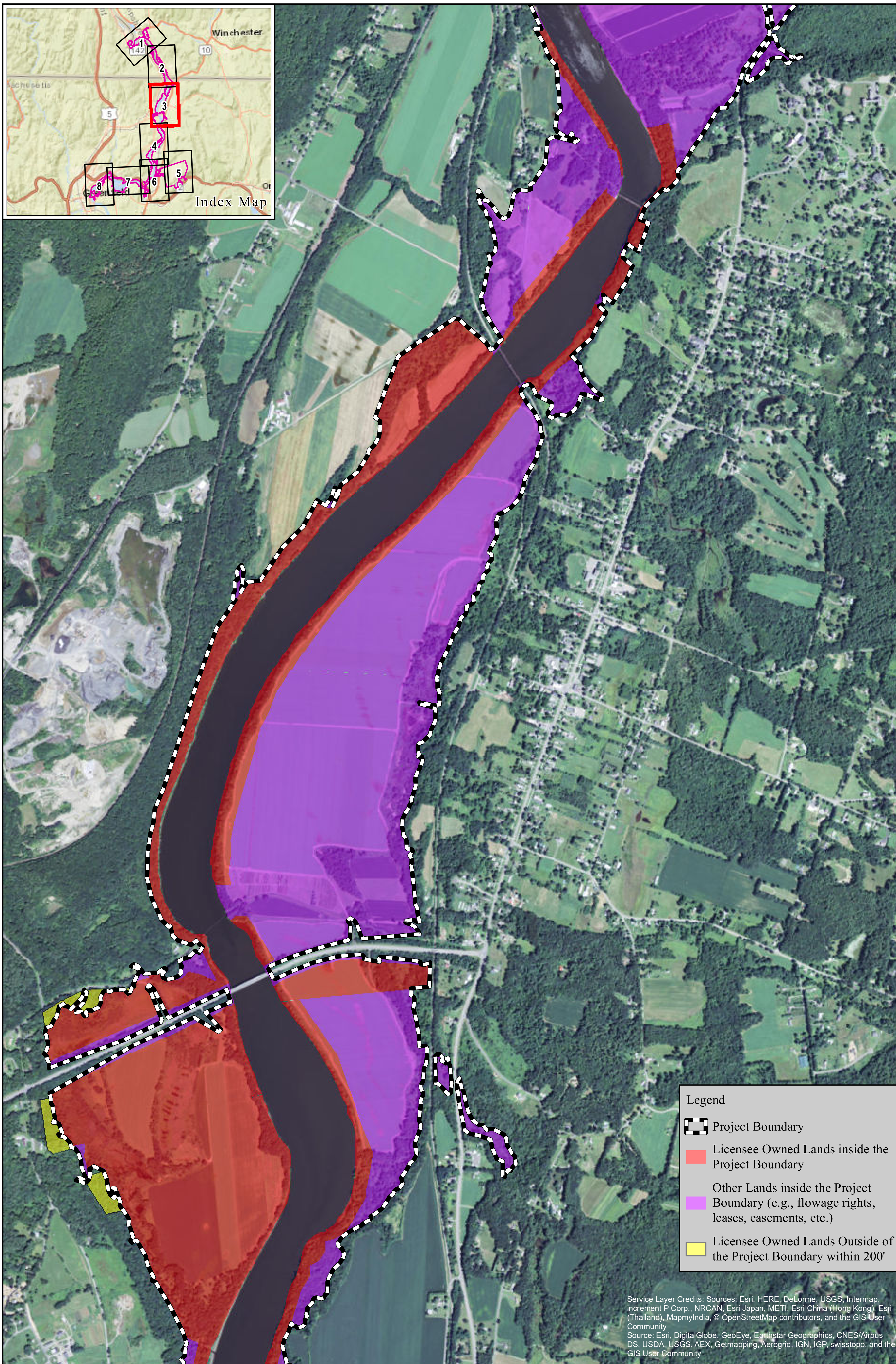

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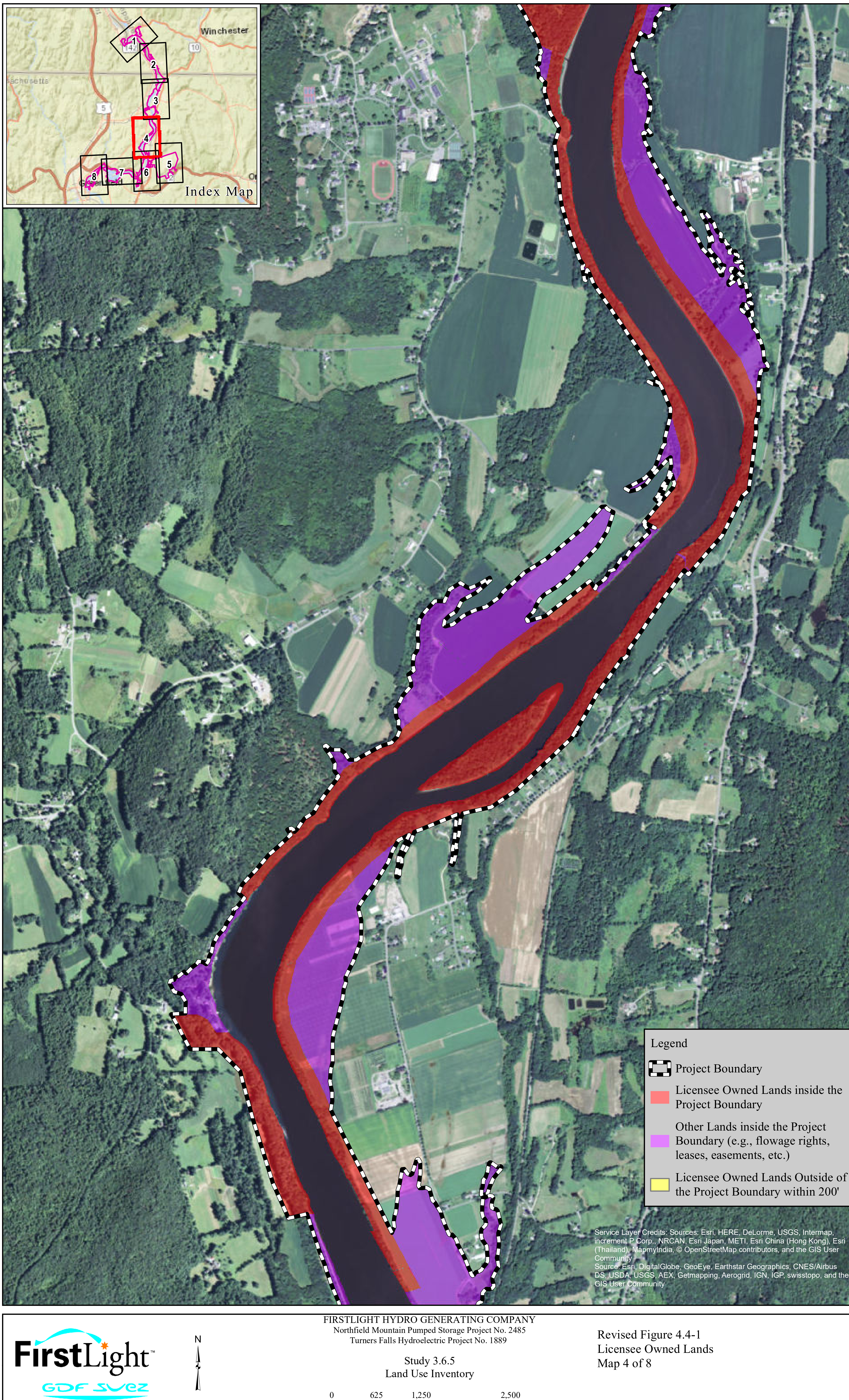
Study 3.6.5
Land Use Inventory

N

0 625 1,250 2,500 Feet

Revised Figure 4.4-1
Licensee Owned Lands
Map 3 of 8

Path: W:\gis\studies\3_6_5\maps\ownership.mxd



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Study 3.6.5
Land Use Inventory

Revised Figure 4.4-1
Licensee Owned Lands
Map 4 of 8

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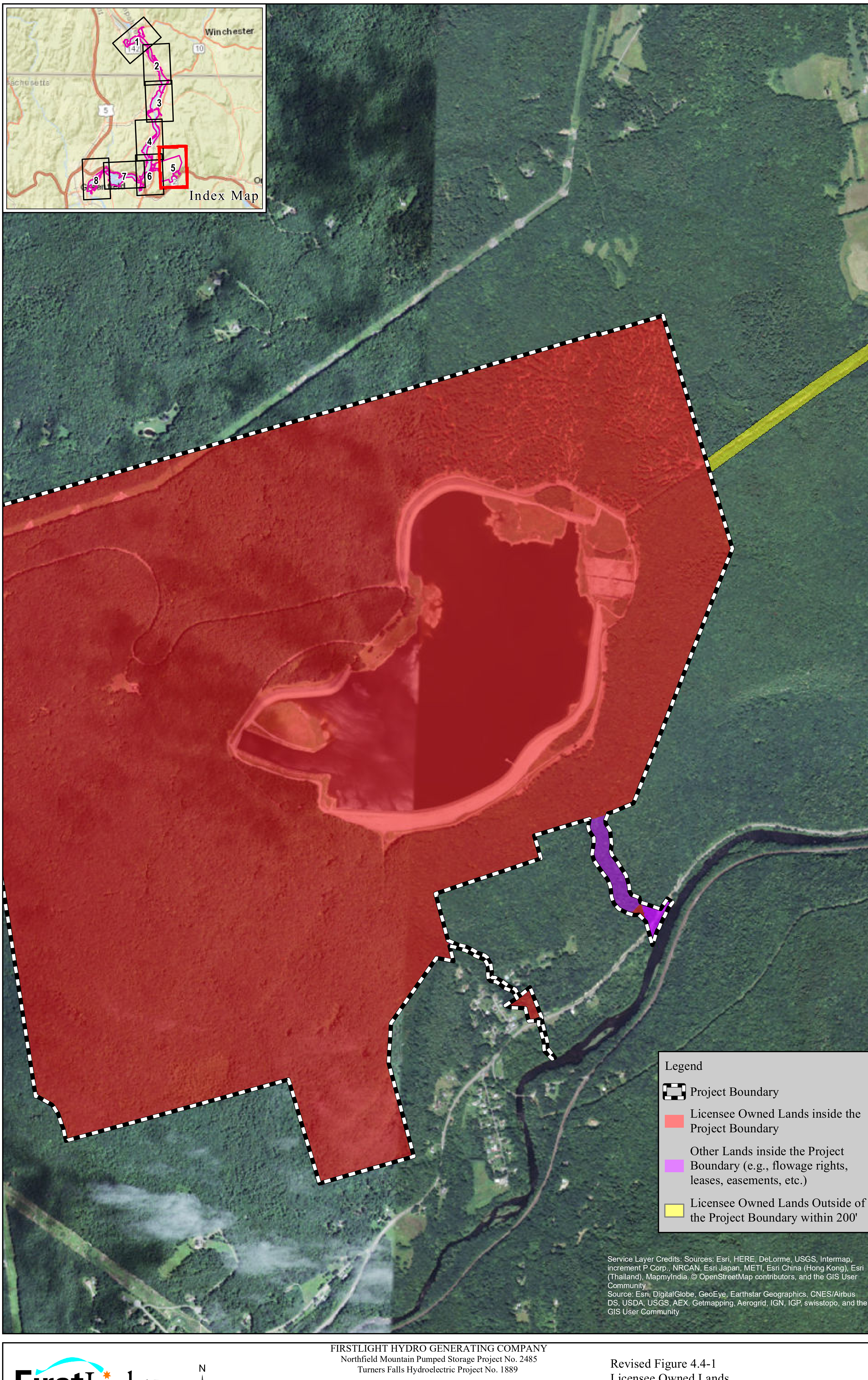

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Study 3.6.5
Land Use Inventory

0 625 1,250 2,500 Feet

Revised Figure 4.4-1
Licensee Owned Lands
Map 5 of 8

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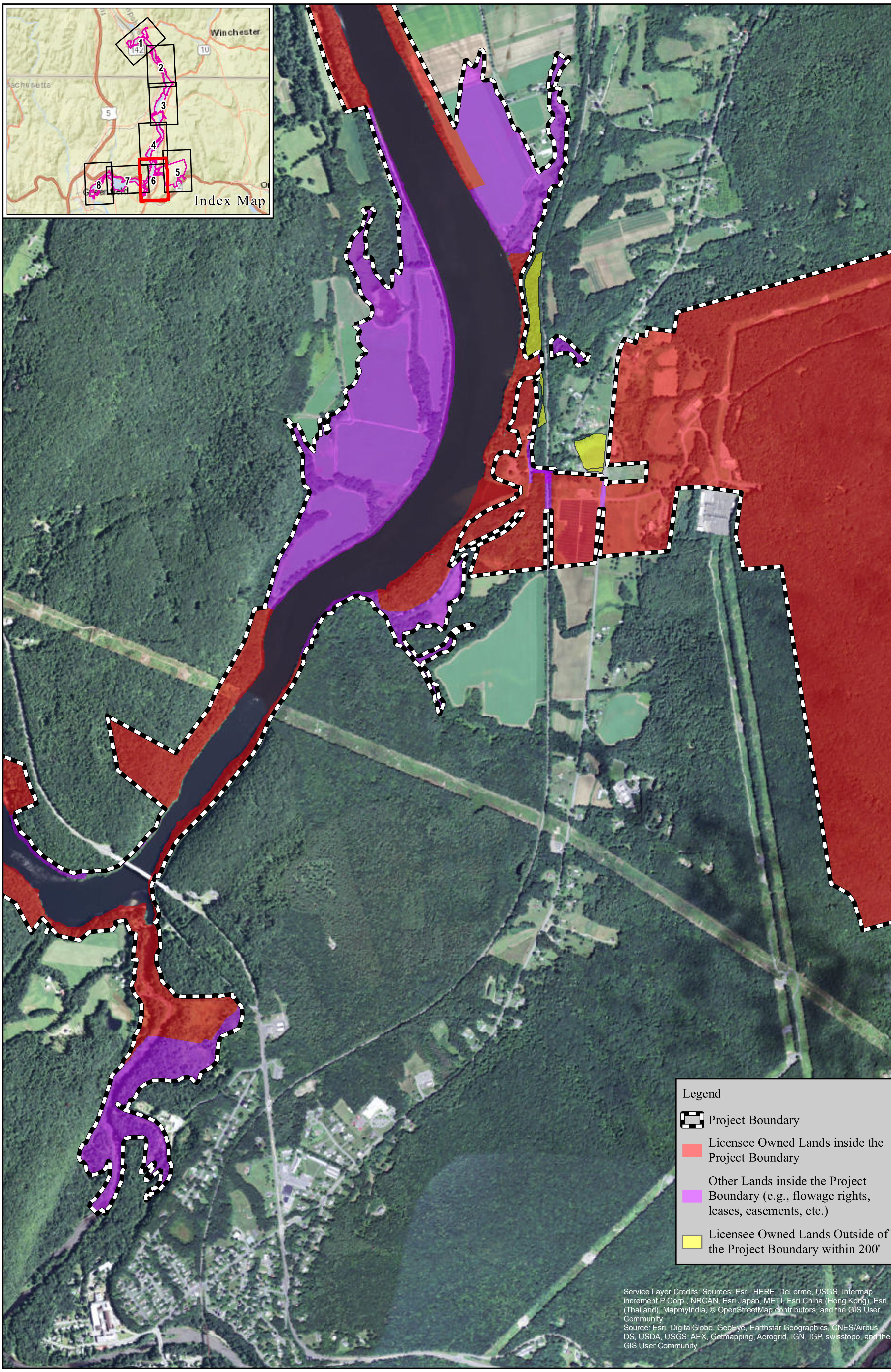

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Study 3.6.5
Land Use Inventory

Revised Figure 4.4-1
Licensee Owned Lands
Map 6 of 8

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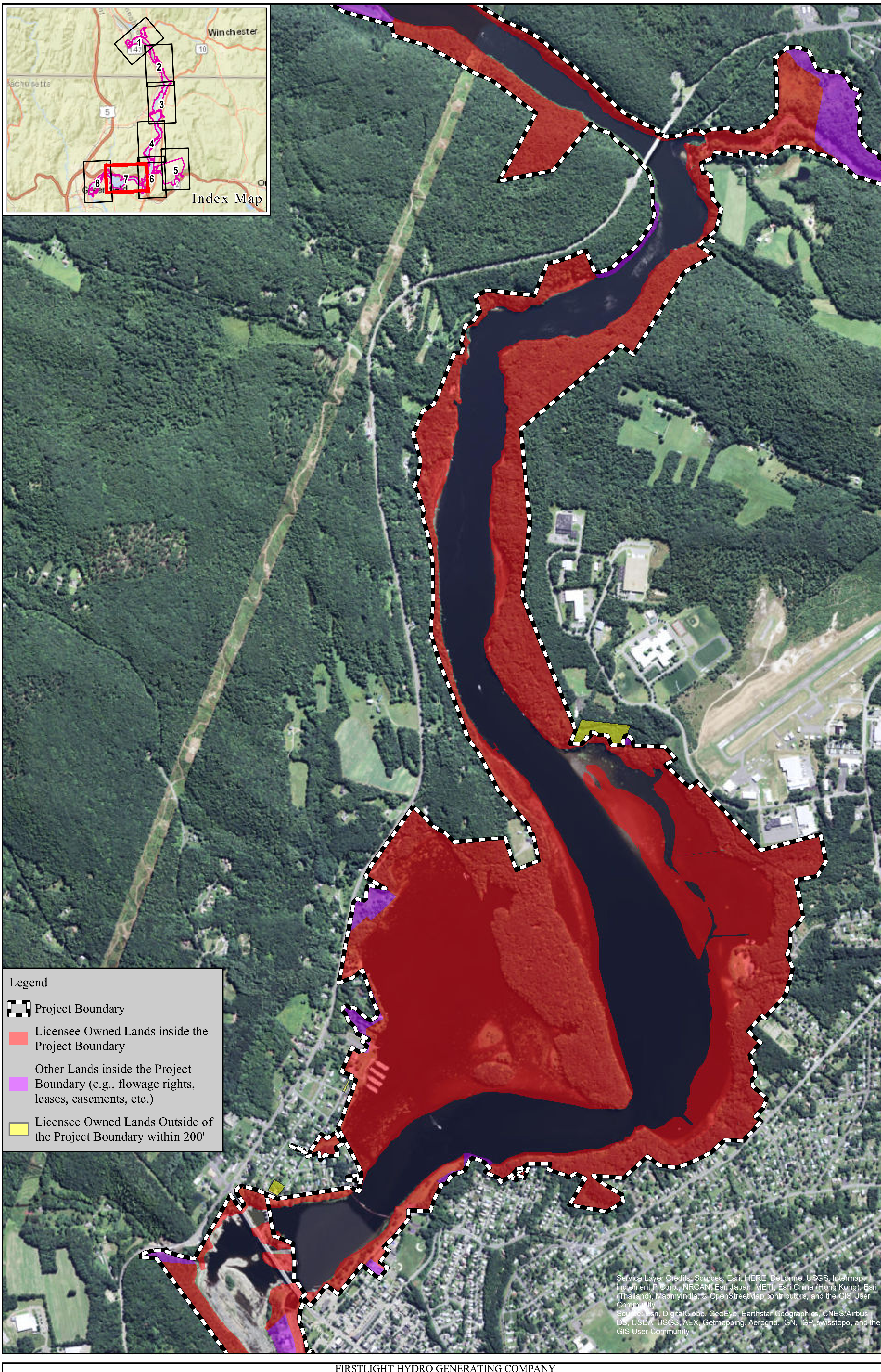

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Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

Study 3.6.5
Land Use Inventory

0 625 1,250 2,500 Feet

Revised Figure 4.4-1
Licensee Owned Lands
Map 7 of 8

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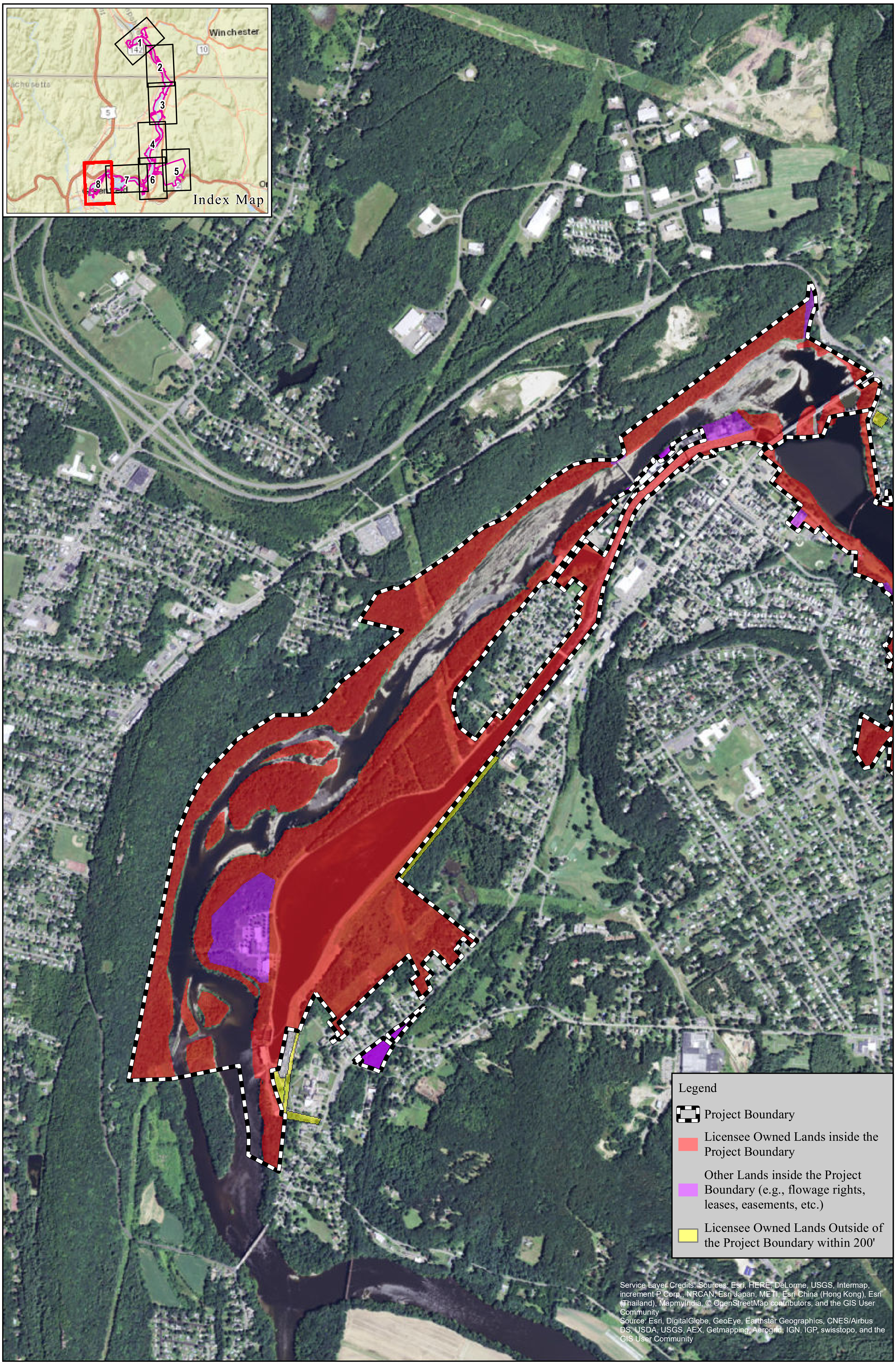

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Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

Study 3.6.5
Land Use Inventory

N

0 625 1,250 2,500 Feet

Revised Figure 4.4-1
Licensee Owned Lands
Map 8 of 8

Path: W:\gis\studies\3_6_5\maps\ownership.mxd