Relicensing Study 3.3.11

Fish Assemblage Assessment Study Report

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

Prepared for:

FirstLight™
GDF SUEZ

Prepared by:

Kleinschmidt
GOMEZ AND SULLIVAN ENGINEERS

MARCH 2016

EXECUTIVE SUMMARY

FirstLight Hydro Generating Company (FirstLight) is the current licensee of the Northfield Mountain Pumped Storage Development (Northfield Mountain Project, FERC No. 2485) and the Turners Falls Hydroelectric Project (Turners Falls Project, FERC No. 1889). FirstLight has initiated with the Federal Energy Regulatory Commission (FERC, the Commission) the process of relicensing the Northfield Mountain and Turners Falls Projects using the FERC's Integrated Licensing Process (ILP). The current licenses for the Northfield Mountain and Turners Falls Projects were issued on May 14, 1968 and May 5, 1980, respectively, with both set to expire on April 30, 2018.

As part of the ILP, FERC conducted a public scoping process during which various resource issues were identified. On October 31, 2012, FirstLight filed its Pre-Application Document (PAD) and Notice of Intent with the FERC (FirstLight, 2012). The PAD included FirstLight's preliminary list of proposed studies. On December 21, 2012, FERC issued Scoping Document 1 (SD1) and preliminarily identified resource issues and concerns. On January 30 and 31, 2013, FERC held scoping meetings for the two Projects. FERC issued Scoping Document 2 (SD2) on April 15, 2013. Study No. 3.3.11 *Fish Assemblage* was developed to evaluate the fish assemblage in the Turners Falls Impoundment (TFI) and from the Turners Falls Dam to Rock Dam[1].

FirstLight conducted a fish assemblage study to document species occurrence, distribution, and relative abundance of resident and diadromous fish within the study area along spatial and temporal gradients, describe the distribution of resident and diadromous fish species in relationship to habitat, and compare historical records of fish species occurrence in the study area to results of this study.

The study area extended approximately 23 miles from the Vernon Dam tailwater to Rock Dam immediately upstream from the Cabot Station tailwater, and included the TFI and Bypass[2] Reach. Sampling locations within the approximately 20 mile-long TFI included 24 boat electrofishing stations, supplemented by additional gill net and beach seine locations to fish areas potentially inaccessible to boat electrofishing gear. The TFI was stratified into upper, mid- and lower impoundment regions and stations were randomly selected within each stratum, with equal sampling effort within each stratum. Each mesohabitat in the bypass reach was sampled by boat electrofishing. Boat electrofishing methods followed those of Yoder, *et al.* (2010) so that the resulting data could be compared to historic information.

The TFI was sampled in two events: early summer (June-July) and late summer (September); the bypass reach was sampled in late summer only. A total of 5,908 fish representing 28 species (inclusive of hybrid sunfish) was collected. All of these species were collected by electrofishing; 14.2% of the species were collected in gillnets, and 18% were collected via conventional beach seining. In early summer, spottail shiner were the most dominant species, followed by smallmouth bass, and yellow perch; these three species accounted for 74% of the catch, and were ubiquitous (occurring in all samples across all three strata, with the exception of smallmouth bass, which was absent from one station). Smallmouth bass were consistently abundant in stations in the upper two strata, and relatively scarce in the lower stratum. Other species that tended to be more abundant in the upper stratum included fallfish, rock bass, mimic shiner and American eel. Conversely, species such as bluegill, pumpkinseed, and largemouth bass tended toward greater abundances in the lower stratum. Species such as white sucker and walleye exhibited no specific spatial pattern throughout the TFI.

A similar pattern was evident during the late summer survey. Adult, juvenile and Young-Of-Year (YOY) life stages were collected. Smallmouth bass abundance declined in stations from upstream to downstream,

[1] Rock Dam is located approximately 4,000 ft upstream of the Cabot tailrace and consists of natural bedrock ledge that acts similar to a dam.
[2] The bypass reach extends from the Turners Falls Dam to the Cabot Station tailwater, but for this study the fish assemblage field work was limited to the Turners Falls Dam to Rock Dam.

a trend consistent with early summer sampling. Other species that tended to be more abundant in the upper stratum included fallfish, rock bass, tessellated darter and American eel. Sea lamprey ammocetes were detected at stations in close proximity to where adults had been sampled in June-July and where evidence of spawning had been observed. YOY American shad were distributed throughout the TFI.

Fish assemblage metrics were influenced by relative position in the TFI, which is indirectly related to habitat characteristics. For example, the upstream stratum of the TFI, which was dominated by habitat with gravel and cobble substrate, free of fines, was dominated by smallmouth bass and fallfish, whereas the lowermost stratum, which features habitat that is primarily lentic with substrates dominated by fines, aquatic vegetation and dense debris cover, was dominated by bluegill, pumpkinseed and yellow perch. Habitat generalists, including spottail shiner and yellow perch were relatively evenly distributed throughout the TFI. This pattern of species distribution was consistent with that observed by other surveys conducted in the 1970's and in 2008.

Data from the present study were compared to survey records from 1971-75 and 2008-09. Four of the six most dominant species in the TFI (smallmouth bass, yellow perch, bluegill and spottail shiner) remained the same between the 1970's and 2015, suggesting that the resident fish assemblage is relatively stable. Variations between catch data from the 1970's and the present study may reflect a degree of ecological change, natural inter-annual variability, and also differences in sampling methodology. Some notable differences between the two surveys were that fallfish were dominant in both 2015 sampling efforts, but not dominant in the 1970's, and diadromous American eel and American shad (YOY) were dominant in 2015 but either absent or not dominant during the 1970's, which may reflect opening of fishways at the Project in 1979.

The TFI was previously surveyed in 2008 and the bypass reach in 2009 by Midwest Biodiversity Institute (MBI). Site-specific comparisons between 2008-09 and 2015 data were made; four of the six most dominant species in the TFI (smallmouth bass, yellow perch, fallfish and spottail shiner) remained consistent, and YOY of different diadromous species were among the six most dominant species in both surveys. Variations between catch data from 2008 and the present study may reflect natural inter-annual variability. Fallfish were dominant in both 2015 sampling efforts. Anadromous sea lamprey YOY were dominant in 2008, whereas American shad YOY and catadromous American eel were dominant in 2015. In the bypass reach, three of the six most dominant species (smallmouth bass, American eel, and white sucker) remained the same in both 2009 and 2015; however, tessellated darter and bluegill were relatively more common in 2015 than in 2009. Sea lamprey YOY were evident in both bypass reach surveys, but were not among the most common species. The metrics of species richness, abundance and Catch per Unit Effort (CPUE) generally follow the same spatial trends in both studies.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

cfs	cubic feet per second
CPUE	catch-per-unit-effort
FERC	Federal Energy Regulatory Commission
FirstLight	FirstLight Hydro Generating Company
ILP	Integrated Licensing Process
MBI	Midwest Biodiversity Institute
MDFG	Massachusetts Division of Fisheries and Game
Northfield Mountain Project	Northfield Mountain Pumped Storage Project
PAD	Pre-Application Document
PSP	Proposed Study Plan
QHEI	Qualitative Habitat Evaluation Index
RSA	Rank Score Analysis
RSP	Revised Study Plan
SD1	Scoping Document 1
SD2	Scoping Document 2
SPDL	Study Plan Determination Letter
Turners Falls Project	Turners Falls Hydroelectric Project
TFI	Turners Falls impoundment
USGS	United States Geological Survey
VY	Vermont Yankee Nuclear Power Plant
YOY	Young-of-the-year

1 INTRODUCTION

FirstLight Hydro Generating Company (FirstLight), is the current licensee of the Northfield Mountain Pumped Storage Project (Northfield Mountain Project, FERC No. 2485) and the Turners Falls Hydroelectric Project (Turners Falls Project, FERC No. 1889). FirstLight has initiated with the Federal Energy Regulatory Commission (FERC, the Commission) the process of relicensing the two Northfield Mountain and Turners Falls Projects using the FERC's Integrated Licensing Process (ILP). The current licenses for Northfield Mountain and Turners Falls Projects were issued on May 14, 1968 and May 5, 1980, respectively, with both set to expire on April 30, 2018.

As part of the ILP, FERC conducted a public scoping process during which various resource issues were identified. On October 31, 2012, FirstLight filed its Pre-Application Document (PAD) and Notice of Intent with the FERC. The PAD included FirstLight's preliminary list of proposed studies. On December 21, 2012, FERC issued Scoping Document 1 (SD1) and preliminarily identified resource issues and concerns. On January 30 and 31, 2013, FERC held scoping meetings for the two Projects. FERC issued Scoping Document 2 (SD2) on April 15, 2013.

FirstLight filed its Proposed Study Plan (PSP) on April 15, 2013 and, per the Commission regulations, held a PSP meeting at the Northfield Visitors Center on May 14, 2013. Thereafter, FirstLight held ten resource-specific study plan meetings to allow for more detailed discussions on each PSP and on studies not being proposed. On June 28, 2013, FirstLight filed with the Commission an Updated PSP to reflect further changes to the PSP based on comments received at the meetings. On or before July 15, 2013, stakeholders filed written comments on the Updated PSP. FirstLight filed a Revised Study Plan (RSP) on August 14, 2013 with FERC addressing stakeholder comments.

On August 27, 2013 Entergy Corp. announced that the Vermont Yankee Nuclear Power Plant (VY), located on the downstream end of the Vernon Impoundment on the Connecticut River and upstream of the two Projects, will be closing no later than December 29, 2014. With the closure of VY, certain environmental baseline conditions will change during the relicensing study period. On September 13, 2013, FERC issued its first Study Plan Determination Letter (SPDL) in which many of the studies were approved or approved with FERC modification. However, due to the impending closure of VY, FERC did not act on 19 proposed or requested studies pertaining to aquatic resources. The SPDL for these 19 studies was deferred until after FERC held a technical meeting with stakeholders on November 25, 2013 regarding any necessary adjustments to the proposed and requested study designs and/or schedules due to the impending VY closure. FERC issued its second SPDL on the remaining 19 studies on February 21, 2014, approving the Study No. 3.3.11 *Fish Assemblage Assessment* with one modification--: requiring consultation with the agencies to seek to avoid all effects to shortnose sturgeon. On June 5, 2013 FirstLight and stakeholders, met to discuss the RSP. In comments dated July 15, NMFS recommended that: (1) no electrofishing occur in the reach of the Connecticut River below the Deerfield River; and (2) a seasonal restriction be placed on sampling in the Turners Falls bypassed reach to ensure that no electrofishing is carried out when shortnose sturgeon may be present (April 15 – June 30 to avoid potential for adverse effects on shortnose sturgeon. The FERC by letter dated February 21, 2014, recommend that FirstLight consult with the NMFS, USFWS, MADFW, and Commission staff on an amendment to the revised study plan that would seek to avoid all effects to shortnose sturgeon and provide sufficient information needed by the jurisdictional agencies and the Commission for their needs. Following consultation, it was determined that no fish sampling was to be conducted below the Turners Falls Dam during the early summer survey, but would be performed during the late summer survey, and that no sampling would occur below Rock Dam.

1.1 Study Goals and Objectives

The PAD for the Turners Falls Project and Northfield Mountain Projects identified 22 species of fish that occur in the Connecticut River within the Project boundary (the Project Boundary extends from the base of

Vernon Dam to just below the Cabot tailrace). This study documents fish species occurrence, distribution and relative abundance within the Turners Falls Project and Northfield Mountain Project areas.

The study goal is to provide baseline information pertaining to the fish assemblage structure within the study area. Specific study objectives include:

- Document species occurrence, distribution, and relative abundance of resident and diadromous fish within the study area along spatial and temporal gradients.

- Describe the distribution of resident and diadromous fish species within reaches of the river and in relationship to habitat.

- Compare historical records of fish species occurrence in the project area to results of this study.

2 STUDY AREA AND SURVEY SITE SELECTION

The study area was originally the Connecticut River from the base of Vernon Dam to the Route 116 Bridge in Sunderland, MA. However, after consultation with the stakeholders, to avoid potential impacts to shortnose sturgeon, the study area was refined to the Connecticut River from Vernon Dam to Rock Dam[3] (Figure 2.0-1). The total length of the study area was approximately 23 miles.

2.1 Site Selection

Sampling locations within the approximately 20 mile-long TFI were determined via a stratified-random sampling design. The TFI was divided into three strata based on mesohabitat type and variations in geomorphology. The upstream end of the TFI (approximately 13 miles) from Vernon to the Northfield Mountain Project intake/tailrace was dominated by lengthy, shallow and relatively riverine features, with only a few pronounced bends. Much of the shoreline in the upper TFI was relatively barren of optimal cover and substrates. However, there were several river bends with stretches of rich, suitable substrate (i.e. gravel/cobble/ boulder), object cover or vegetation that provided good fish habitat.

The TFI was ultimately divided into three strata based on lotic vs. lentic conditions. The approximately 15-mile "upper reach" (between Vernon Dam and the Northfield Mountain Project intake/tailrace) river geomorphology was defined by a broad alluvial flood plain. The shorter "lower reach" (between the intake/tailrace and Turners Falls Dam) river geomorphology was defined by bedrock. The upstream segment of the TFI was highly lotic but gradually becomes lentic, thus the upstream TFI segment was further stratified into "*upper*" and "*middle*" sub-strata, to provide better survey resolution and to potentially distinguish "transition zone" habitat/assemblage differences between the free-flowing river reach immediately downstream of Vernon Dam and the upper extent of the TFI (Appendix A).

Downstream from the intake/tailrace, the TFI enters an approximately 5.4 mile reach of much richer habitat, including bedrock-controlled, diverse shoreline areas with meanders, pronounced bends, well developed weed beds, varied substrates, a deep channel, partially embayed shorelines and abundant cover.

Electrofishing station selection

The stratified random sampling design randomly assigned sampling stations[4] within each stratum. 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. 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 (total of 6; Appendix A). Two additional electrofishing stations were randomly selected within each stratum from the remainder of the relatively uniform and barren shoreline areas. Each seasonal sampling event was therefore represented by a total of 12 independently selected electrofishing sites.

The bypass reach comprised four major mesohabitats (Figure 2.1-1):

[3] Rock Dam is located approximately 4,000 ft upstream of the Cabot tailrace and consists of natural bedrock ledge that acts similar to a dam.
[4] Sampling methods include boat electrofishing, gill nets, and seine nets. Sampling was performed during the early summer (June-July) and again in the early summer (September).

- a large plunge pool at the toe of the Turners Falls Dam,
- a low-gradient riffle/run/pool complex extending from the plunge pool downstream to the Station No. 1 discharge,
- a higher-gradient riffle-run extending downstream to a pool formed by Rock Dam, and
- Rock Dam pool.

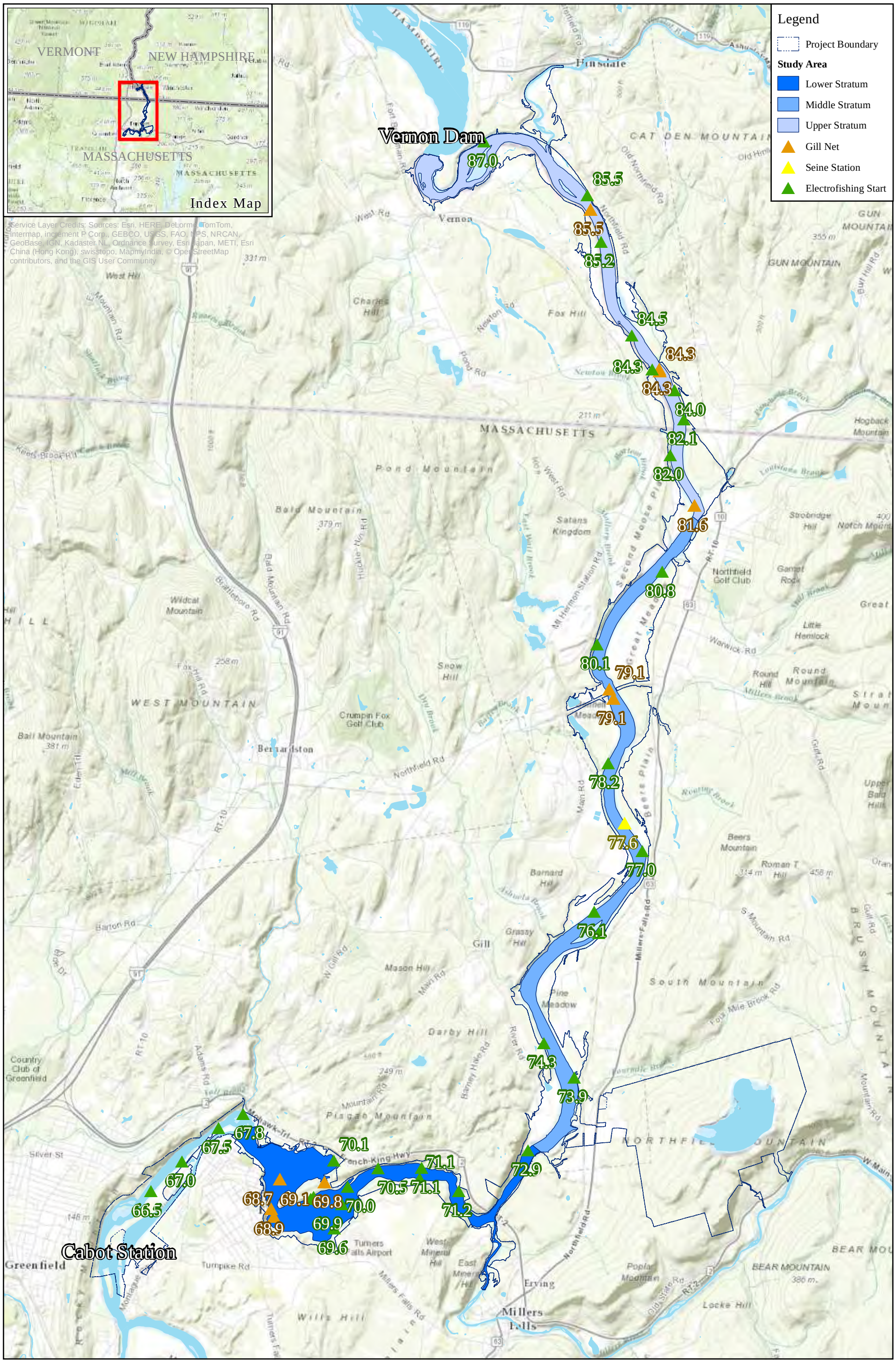
Each of these mesohabitats was sampled for its entire length.

Gill net station selection

Gill net candidate sampling stations were pre-determined by reviewing bathymetric maps of the TFI. Sites with extensive areas of adequate depth (*i.e.* ~ >12 ft) were relatively limited in the upper and middle TFI strata, but were more common in the lower TFI stratum. Gillnetting stations were selected by visiting these deeper areas looking for sites free of snags or other net deployment hazards. To the extent possible, two gill net stations were sampled in each of the three TFI strata during each survey.

Beach Seine station selection

Beach seine sampling stations were determined in the field, but were directed at *"shallow shoreline locations where boat access may not be feasible sampling will be performed via seining with a 100-ft long, 6-ft deep, 1/4-inch mesh bag seine net…"* (RSP, p. 3-249). The RSP also directed that: *"Seine samples will be collected by extending the net parallel to shore and then pulling the upstream end of the net into the water and in a downstream direction for a 180 degree sweep while the opposite end of the net is held in place Seining must inherently be performed in areas free of debris and snags in shallow shoreline locations where safe wading is possible."* Relatively few such areas with sufficiently large footprints (approximately 200 feet of linear shoreline) were available due to debris clutter and unwadable mucky substrates. Additionally, some sites were found that met general beach seining criteria, but were unwadable or too cluttered to facilitate efficient seining. As a compromise, these were boat electrofished for 500 seconds.

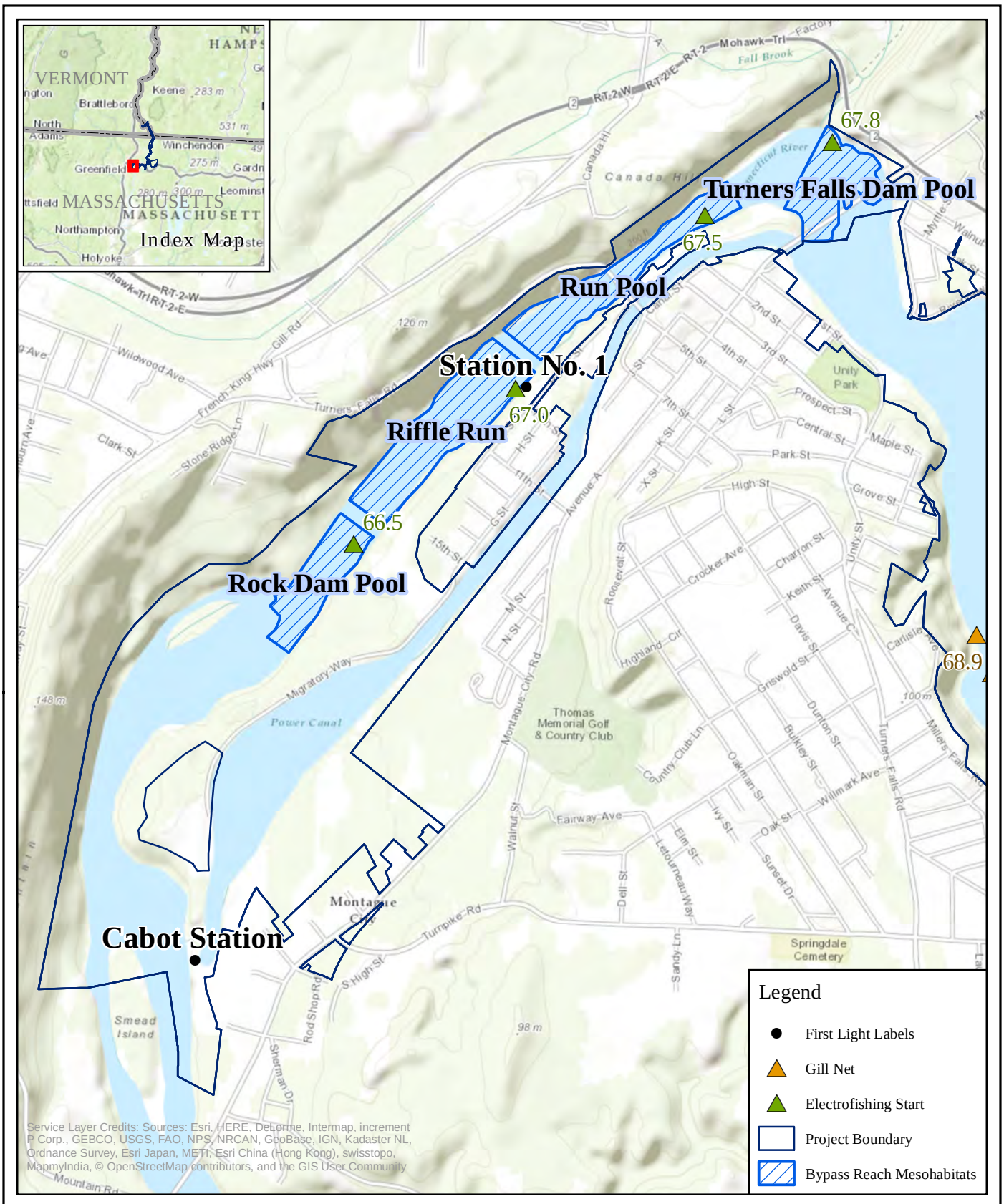


Northfield Mountain Pumped Storage Project (No. 2485) and Turners Falls Hydroelectric Project (No. 1889)

Relicensing Study 3.3.11

Figure 2.0-1:
Turners Falls Project Fish Assemblage Study Area

Path: W:\gis\studies\3_3_11\maps\Figure_2_0_1.mxd



Northfield Mountain Pumped Storage Project (No. 2485)
and Turners Falls Hydroelectric Project (No. 1889)
Relicensing Study 3.1.11

Figure 2.1-1:
Bypass Reach Fish
Assemblage Study Area

N

0 0.125 0.25 0.5 Miles

Path: W:\gis\studies\3_3_11\maps\Figure_2_1_1.mxd

3 METHODS

3.1 Sampling

Sampling was conducted during early (June/July) and late summer (September). FirstLight employed a variety of techniques to sample the various habitat types within the study area, including day and nighttime boat electrofishing, gill netting, and seining. In addition to biological data, supporting data collected for each sample site included: location (GPS), sampling gear type, sampling effort, mesohabitat type, average depth, average velocity, river flow, water temperature, turbidity, predominant substrate, time of day, day of year, presence of cover, and proportion of vegetation cover. Upon return from the field, data sheets were reviewed for quality assurance and archived. Sampling stations were identified by river mile value (based on Yoder *et al.*, 2010) to the nearest 0.1 mile and assigned a code based on gear type (e = electrofishing station, g = gill net station, s = seining station). Water quality parameters (temperature (°C), dissolved oxygen (ppm), conductivity (µS/cm), and pH) were measured in situ at the beginning of each sampling run using an YSI 556 multi meter outfitted with probes including: temperature, conductivity and pH. The meter was calibrated each day before use. Depending on the gear type, the probe was lowered to approximately the sampling depth to obtain readings. The start point, end point, and boat track for each electrofishing sampling station was geo-referenced using a handheld Garmin GPS (or similar device) and transposed to corresponding GIS mapping, and the locus of each gill net and beach seine station was similar recorded.

3.1.1 Boat Electrofishing

Boat electrofishing was performed in near-shore littoral habitats (typically 10 feet deep or less) during the daytime and night, though daytime sampling was restricted to twilight. All electrofishing transects were sampled for a minimum of 500 seconds, and a standardized distance of 500 m. In the TFI, fishing was conducted from a 16-ft jonboat and a pulsed-DC Smith-Root GPP 5.0 electrofisher with the capacity to adjust the pulse rates between 30 - 120 pulses/second and vary voltage to accommodate ambient conductivity. The pulse rate for all electroshocking was 120 pps pulsed DC current. The electrode array included cathodes suspended from the bow to a depth of approximately six feet to project the electric field into the shoreline epibenthic zone, as well as the upper water column. The anode array was suspended from the bow on an adjustable boom. Anodes and cathodes were configured to optimize the electric field under ambient conductivity conditions. An inflatable 14-foot raft capable of negotiating riffles and shoals, equipped with a Smith-Root GPP 2.5 unit was deployed for sampling in the shallower riverine habitats of the bypass reach. This raft was equipped with retractable anodes and side-mounted cathodes (Figure 3.1.1-1,).

Electrofishing was conducted from upstream down, following standardized methods developed specifically for large river quantitative electrofishing surveys (Yoder, 2002, Yoder & Kulik, 2003).

All stunned fish were collected with ¼-inch mesh dip nets and deposited into a live-well filled with aerated ambient river water. At the conclusion of each sample, all captured fish were sorted, identified to species, classified as adult, juvenile or Young-of-Year (YOY), enumerated, weighed, measured for total length, and then released.

Large numbers of small fish (YOY fish or cyprinids less than 100 mm) were grouped by size class, enumerated, and batch-weighed with length measurements only taken from one large and one small representative specimen within each group. Fish not able to be identified in the field, such as small cyprinids, were preserved and brought back to the lab for identification.

Habitat complexity of each littoral sampling station was scored using the Qualitative Habitat Evaluation Index (QHEI) after Rankin, (1989). The QHEI is a standard component of large-river fish assemblage surveys (e.g. Yoder *et al.*, 2010). It provides an index of lotic habitat quality based on characteristics important to fish assemblages (Rankin, 1989 and 1995). The QHEI indexes the types and quality of substrate, instream cover, several characteristics of channel morphology, riparian zone extent and quality,

bank stability and condition, and pool-run-riffle quality and characteristics. Gradient is also factored into the score.

3.1.2 Gill Netting

For deeper habitat where electrofishing would not be effective (i.e. depth greater than 10 ft), sampling was conducted with experimental gill nets consistent with standardized methods for fish capture from rivers (Bonar *et al.*, 2009). Each net was 12 feet high by 125 feet long and constructed of 5 panels of increasing mesh size (e.g., 1.5, 2, 2.5, 3, 3.5-inch stretched mesh) to accommodate collection of the various sized fish. Each net was deployed in selected locations and allowed to fish for at least four hours prior to retrieval. To the extent possible, two net sets were used to sample within each strata during both early and late-summer sampling events. The exact location of each net set was recorded using a handheld GPS and the time of deployment and retrieval was recorded. Catch processing was as described above for electrofishing.

3.1.3 Seining

The original RSP stated that "*In shallow shoreline locations sampling will be performed via seining with a 100-ft long, 6-ft deep, 1/4-inch mesh bag seine net.*" For reasons stated above, shoreline characteristics precluded this in most places; thus, supplemental boat electrofishing in comparable habitat was substituted[5]. However, at one location, it was feasible to fish a seine as described in the RSP. The sample was collected by extending the net parallel to shore and then arcing the upstream end of the net in a downstream direction to execute a 180 degree sweep while the opposite end of the net remained stationary. The catch was processed in the same manner as described above for electrofishing and gill netting.

3.1.4 Analysis

Several minnow specimens were preserved and lab-identified prior to data entry. Data sheets were reviewed for completeness, accuracy and legibility; data were transcribed from original data sheets to MS Excel®. Statistical calculation functions were performed using Statistix® (Analytical Software) or R® (R Foundation, 2015).

Species dominance was calculated using a Rank Score Analysis (RSA) in each of the strata. The RSA is a non-parametric scoring statistic that combines both abundance and persistence, and is not sensitive to highly volatile variations in numeric abundance as exhibited by species such as spottail shiner. This reduces the impact of a single large catch of an irruptive species from biasing results and facilitated comparison to sampling data in Massachusetts Division of Fisheries and Game (MDFG) (1978). Dominance was measured by ranking the five most abundant species from highest to lowest abundance within each sample (awarding a score from 5 to 1), then the rank score for each species was summed across all samples within a stratum.

Catch-per-unit-effort (CPUE) was calculated based on the number of fish caught per distance sampled (meters) so that results could be compared to historic data provided by Yoder *et al.*, (2010), and Midwest Biodiversity Institute (MBI) (2014).

[5] Sites were boat electrofished for 500 seconds that met general beach seining criteria (i.e. shallow, sandy or muddy, relatively free of object cover) but were unwadable and/or too cluttered to facilitate efficient seining.

Figure 3.1.1-1. Electrofishing in Bypass Reach

4 RESULTS

Early summer sampling was initiated on June 22-23, 2015 but was interrupted by high river flows; sampling resumed on July 7 and completed on July 9, 2015. Late summer sampling was conducted the week of September 21, 2015.

4.1 Environmental Conditions

The primary inflow to the TFI is controlled by TransCanada's Vernon Hydroelectric Project, which operates as a peaking hydroelectric facility with a maximum hydraulic capacity of 17,130 cfs. The drainage areas at the Vernon Dam and Turners Falls Dam are 6,266 and 7,163 square miles (mi^2), respectively, a difference of 897 mi^2. Thus, 87% of the drainage area is controlled by the Vernon Hydroelectric Project. The bulk of the increase in drainage area is attributable to two main tributaries equipped with United States Geological Survey (USGS) gages- the Ashuelot River (420 mi^2) and Millers River (372 mi^2) drain into the TFI (combined drainage area of 792 mi^2). The combination of the Vernon Hydroelectric Project discharge (powerhouse generation flow plus spill flows) plus discharges from the two USGS gages is termed by FirstLight as the "naturally routed flow".

The naturally routed flow through the TFI ranged from 8,007 to 26,210 cfs during the June-July 2015 sample period, and 2,001 to 3,031 cfs during the September 2015 sampling period (Table 4.1-1).

Flow in the bypass reach is controlled by Turners Falls Dam spill (bascule gate), Spillway Fishway releases (operated only during the early summer sampling), Fall River and Station No. 1 discharges. FirstLight records spill via gate rating curves. Station No. 1 discharges were estimated based on a MW versus cfs relationship.

The flow in the upper bypass reach (above Station No. 1) was approximately 120 cfs during the late summer sampling period, which is the FERC-required minimum flow release during September for the protection of shortnose sturgeon. This flow does not account for the minor contribution from the Fall River which drains into the upper reach. During the bypass sampling, Station No. 1 was discharging approximately 1,010 on September 24, 2015 between 0100 and 1600 and dropped to 0 cfs (no generation) until midnight. Thus, the combined flow in the bypass reach just below Station No. 1 was approximately 1,130 cfs (excluding Fall River flow, Table 4.1-1).

Water quality did not vary significantly among stations during either sampling event, nor between the two sampling events. Temperatures ranged from 20.5 to 25.7 ^{o}C during the June-July survey and 20.6 to 21.4 ^{o}C during the September survey; dissolved oxygen ranged from 6.4 to 11.7 ppm during the June-July survey and 7.8 to 9.6 ppm during the September survey (Table 4.1 -1). Conductivity was slightly lower in June-July (97 to 118 μS/cm) than in September (150 to 155 μS/cm).

Table 4.1-1: Connecticut River Water Quality and Flow during Boat Electrofishing, Seining and Gill Net Sampling (Including Electrofishing Seine Substitution) in the Turners Falls Impoundment and Bypass Reach

Date	Station	Sampling Method	Naturally Routed Flow (cfs)	Impoundment Water Temp (C°)	D.O. (ppm)	Conductivity (µS/cm)	pH
Turners Falls Impoundment							
6/22/2015	85.5-E	boat electrofishing	17,799	21.0	6.5	103	7.5
7/7/2015	74.3-P	boat electrofishing	8,007	20.5	9.3	102	6.9
7/8/2015	76.2-E	boat electrofishing	8,899	20.6	9.4	107	6.6
7/7/2015	73.9-E	boat electrofishing	8,007	20.5	9.3	104	6.4
6/22/2015	82-E	boat electrofishing	17,799	20.6	6.6	99	7.8
7/8/2015	71.1-P	boat electrofishing	8,899	21.2	8.8	97	6.7
7/8/2015	72.9-E	boat electrofishing	8,899	21.2	8.7	101	6.7
7/8/2015	80.1-P	boat electrofishing	8,899	20.6	9.1	108	6.8
6/22/2015	84-E	boat electrofishing	17,799	20.7	6.8	100	7.7
6/23/2015	84.5-E	boat electrofishing	26,210	20.8	6.4	100	7.6
7/8/2015	69.9-E	boat electrofishing	8,899	21.5	8.8	104	7.2
7/9/2015	69.5-P	boat electrofishing	8,256	21.0	8.1	110	7.1
6/22/2015	84.3-G	gill net	17,799	20.7	6.8	100	7.6
6/22/2015	81.3-G	gill net	17,799	20.6	6.6	98	7.8
7/7/2015	79.1-G	gill net	8,007	20.6	9.3	109	6.5
7/8/2015	69.8-G	gill net	8,899	21.0	8.7	105	6.8
7/8/2015	69.1-G	gill net	8,899	21.6	9.1	105	6.3
7/8/2015	70.1-VS	seine (electrofishing)	8,899	25.7	10.7	107	7.7
7/8/2015	69.6-VS	seine (electrofishing)	8,899	24.7	11.4	118	7.4
9/21/2015	85.2-P	boat electrofishing	3,031	21.4	9.0	151	7.8
9/22/2015	82-E	boat electrofishing	2,054	21.2	8.8	152	7.9
9/23/2015	70.0-P	boat electrofishing	2,001	20.9	7.8	155	7.7
9/21/2015	87-P	boat electrofishing	3,031	21.4	9.6	150	7.7
9/22/2015	76.1-P	boat electrofishing	2,054	20.9	8.4	150	7.8
9/22/2015	80.1-E	boat electrofishing	2,054	21.0	8.4	151	7.9
9/21/2015	84.3-P	boat electrofishing	3,031	21.4	8.8	152	7.9
9/23/2015	80.8-P	boat electrofishing	2,001	20.7	8.0	150	7.7
9/23/2015	71.2-E	boat electrofishing	2,001	21.4	8.6	151	7.8
9/23/2015	69.5-P	boat electrofishing	2,001	21.1	7.8	155	7.8
9/22/2015	77-E	boat electrofishing	2,054	20.6	8.5	151	7.7
9/23/2015	70.5-E	boat electrofishing	2,001	21.0	8.4	153	7.8
9/21/2015	85.5-G	gill net	3,031	21.4	9.0	151	7.8

Date	Station	Sampling Method	Naturally Routed Flow (cfs)	Impoundment Water Temp (C°)	D.O. (ppm)	Conductivity (µS/cm)	pH
9/21/2016	84.3-G	gill net	3,031	21.4	9.0	151	7.8
9/22/2015	81.6-G	gill net	2,054	21.0	8.2	151	7.8
9/22/2015	79.1-G	gill net	2,054	20.9	8.3	151	7.8
9/23/2015	68.9-G	gill net	2,001	20.7	8.2	152	7.7
9/23/2015	68.7-G	gill net	2,001	21.0	8.4	155	7.8
9/21/2015	82.1-VS	seine (electrofishing)	3,031	21.3	8.7	150	7.9
9/22/2015	VS-78.2	seine (electrofishing)	2,054	20.7	8.3	151	7.9
9/23/2015	71.1-VS	seine (electrofishing)	2,001	21.3	8.9	154	7.8
Bypass Reach							
9/24/2015	Plunge Pool	boat electrofishing	120	20.5	8.4	163	7.8
9/24/2015	Pool-run	boat electrofishing	120	20.8	8.7	167	7.9
9/24/2015	Riffle-run	boat electrofishing	1,130	21.5	7.8	159	7.9
9/24/2015	Rock Dam pool	boat electrofishing	1,130	21.4	9.6	161	7.9

4.2 Biological Sampling

4.2.1 Effort

A total of 29 boat electrofishing samples were collected throughout both seasons, with 24 conventional TFI samples evenly divided among the two sampling events and among the TFI strata, and four additional samples taken in the bypass reach in September (Table 4.2.1-1, Figure 2.0-1). Sampling tracks are presented in GIS format in Appendix B.

TFI electrofishing sample durations ranged from 1,119 to 2,339 seconds and each sampling event encompassed 500 linear meters of shoreline (Table 4.2.1-2). Samples taken in the bypass ranged from 1,079 to 2,601 seconds in duration and encompassed 520 to 1,000 meter linear distance. Sampling tracks are attached as Appendix B.

A total of 11 gill net sets was completed, five in June-July and six in September. Relatively high flows and heavy debris loads impaired gill netting during June-July; however, gill nets were successfully deployed at five stations among all three TFI strata with a goal of two sets per stratum. A sixth net set in the upper impoundment stratum was lost due to entanglement on a submerged object in a pool. Soak times ranged from 4 h to 4 h 45 min. Although the study plan specified a minimum soak time of 4 h, this amount of time produced limited results. The catch abundance for this gear rose slightly when sampling duration was increased to nearly 24 h. However, catches were still small, and all the species collected were also collected during the boat electrofishing. A total of six gill net sets (two per stratum) were used to sample in September with soak times ranging from 5 h 20 min 23 h 20 min (Table 4.2.1-2).

A total of six beach seine (or alternate electrofishing of seine-type sites) samples was conducted. Sites were distributed evenly among TFI strata for each of the two seasonal sampling events. Distance sampled ranged from 200 ft (conventional seine haul) to 1,000 ft (500-second electrofishing alternate sample) (Table 4.2.1-2).

Catch Summary

A total of 5,908 fish representing 28 species (inclusive of hybrid sunfish) was collected (Table 4.2.1-2). Electrofishing collected 100% of these species; gill nets collected 14.2% and conventional beach seining collected 18% of the species. Boat electrofishing accounted for 54% of the catch in June-July; as a single beach seine haul intercepted a large (n= 1,050) school of spottail shiner that dominated the seine haul. If this irruptive collection is eliminated from the catch statistics, then electrofishing accounted for 84% of the catch. In September, electrofishing accounted for 99% of the catch. Detailed data for individual samples and length frequency data for the nine most abundant species are included as Appendix C.

4.2.2 Turners Falls Impoundment

4.2.2.1 Species Abundance and Distribution

Relative abundance of various species among impoundment strata varied according to season and stratum within the impoundment. Data from the 24 boat electrofishing sampling sites are discussed here for purposes of quantitative comparison, since these data are the most robust single-gear sampling data from the study.

June-July

Spottail shiner were the most dominant species, accounting for 44% of the catch, followed by smallmouth bass, and yellow perch which accounted for 16% and 14%, respectively. These three species collectively accounted for 74% of the catch and were ubiquitous (occurring in all samples across all three strata, with

the exception of smallmouth bass which was absent from one station) (Table 4.2.2.1-1). Both adult and juvenile life stages were collected.

Smallmouth bass were consistently abundant at stations in the upper two strata, and relatively scarce in the lower stratum. Other species that tended to be more abundant in the upper stratum included fallfish, rock bass, mimic shiner and American eel. Conversely, species such as bluegill, pumpkinseed, and largemouth bass typically exhibited greater abundance in the lower stratum. Species such as white sucker and walleye exhibited no specific spatial pattern throughout the impoundment, and other species were encountered too infrequently to infer a distributional pattern.

September

A similar pattern was evident during the late summer survey. Spottail shiner were the most dominant species, accounting for 48% of the catch, followed by smallmouth bass, yellow perch, and fallfish, which accounted for 15% , 9% and 7%, respectively. Smallmouth bass and spottail shiner were ubiquitous (occurring in all samples across all three strata, with the exception of spottail shiner, which was absent from one station) (Table 4.2.2.1-2). Adult, juvenile and Young-Of-Year (YOY) life stages were collected.

Smallmouth bass abundance was greater in upstream areas, a trend that was consistent with earlier sampling in June-July. Other species that tended to be more abundant in the upper stratum include fallfish, rock bass, tessellated darter and American eel. Conversely, species such as bluegill, pumpkinseed, largemouth bass, banded killifish, white sucker and yellow perch tended toward greater abundance in the lower stratum. Species such as rock bass and walleye exhibited no specific spatial pattern in the impoundment, and other species were encountered too infrequently to infer a distributional pattern. Sea lamprey ammocetes were detected at stations 87.0 and 85.2 in close proximity to where adults had been sampled in June-July and where evidence of spawning had been observed (See Study Report No. 3.3.15 *Assessment of Adult Sea Lamprey Spawning within the Turners Falls Project and Northfield Mountain Project Area*). YOY American shad were distributed throughout the impoundment but were least common in the middle stratum. Shifts in spatial abundance of some species such as smallmouth bass, white sucker and fallfish were observable but not pronounced, and reflect increases in YOY abundance.

4.2.2.2 Differences among Impoundment Strata

Species Composition

Species dominance varied slightly between seasons within each stratum. For example, in the upper impoundment, smallmouth bass, fallfish and white sucker were consistently dominant, however spottail shiner, yellow perch and rock bass were also dominant in the early summer, whereas diadromous species (*American eel and American shad*) became dominant in the late summer (Tables 4.2.2.2-1 and 4.2.2.2-2). The middle impoundment stratum had an early summer species dominance structure identical to that in the upper impoundment that did not change in late summer. The lower impoundment stratum was dominated by spottail shiner, yellow perch, white sucker, bluegill and rock bass in early summer; this shifted in late summer to an assemblage dominated by spottail shiner, yellow perch, white sucker, pumpkinseed and smallmouth bass.

Shannon Wiener Diversity

The Shannon-Wiener (SW) diversity index was calculated for all gear types (Table 4.2.2.2-3). However, the low sampling efficiency of gill net and beach seine biases the estimates from those gear types and therefore these data are not analyzed. Individual TFI SW index scores ranged from 0.96 at a poor habitat site in the lower TFI to a 2.0 at a rich habitat site in the upper TFI. Gill net SW scores ranged from 0.00 to 0.32, and beach seine SW diversity was 0.57

To generate a standard error estimate, a method was required for combining samples to create replicates. To discern differences between impoundment strata and habitat quality, electrofishing samples were pooled

across seasons within each impoundment stratum, and stratified by whether they occurred in rich or poor habitat. This yielded an n = 4 within each group (Table 4.2.2.2-3).

Higher SW scores were associated with rich habitat sites and the upper TFI stratum (Figure 4.2.2.2-1). In rich habitat SW ranged from 1.36 (lower TFI) to 1.83 (upper TFI); in poor habitat, SW scores ranged from 1.29 to 1.77. SW scores and standard error calculations are summarized in Table 4.2.2.2-3.

Habitat Complexity

Habitat complexity somewhat influenced fish assemblage metrics. Mean QHEI was 55.79, whereas poor habitat sites had a mean score of 51.64 (Table 4.2.2.2-4). The mean QHEI score for all rich habitat stations correlated positively with Mean SW diversity. SW diversity was only slightly different between the two categories: 1.57 (rich habitat, vs. 1.43 poor habitat), reflecting only a 10% change. Mean species richness was slightly negatively correlated with QHEI and did not vary much between habitat categories: n= 9.9 (rich habitat, vs. n =10.7 poor habitat), reflecting only an 8% change.

Figure 4.2.2.2-2 illustrates the distribution of individual site metric values relative to QHEI score. There is a high degree of variability with no clear pattern at sites with a QHEI score less than 60. However, sites with a QHEI score greater than 60 do not exhibit SW index cores lower than 1.8.

Catch Per Unit Effort

Boat electrofishing CPUE was standardized by distance sampled (fish per m). Distance sampled was equal among strata and stations. Table 4.2.2.2-5 summarizes overall CPUE for each boat electrofishing sample during early and late summer and provides a mean CPUE for each stratum and sampling season. CPUE was more variable in June-July than in September, and ranged from 0.02 at two (2) stations up to 0.26 at station 71.1-P. The highest mean CPUE per stratum was consistently in the lower impoundment (0.14 in June-July and 0.19 in September). CPUE also increased in all strata in September, primarily due to the contribution of YOY to most catches.

Species-specific CPUE (fish per m) is presented for species where more than 50 specimens were captured. This included smallmouth bass, bluegill, rock bass, fallfish, yellow perch, white sucker and spottail shiner. Figure 4.2.2.2-3 and Figure 4.2.2.2-4 summarize the results. Appendix C provides a detailed breakdown of CPUE for all species and size classes (adult, juvenile, and YOY) per sampling station. CPUE for the most abundant species remained relatively consistent within each stratum among early and late summer sampling with the exception of smallmouth bass. CPUE for bluegill, spottail shiner, yellow perch and white sucker was consistently highest in the lower impoundment stratum. Fallfish CPUE was consistently highest in the upper impoundment becoming progressively lower in the middle and lower impoundment. Smallmouth bass CPUE was highest in the upper impoundment in early summer and progressively lower moving downstream. In the late summer smallmouth bass CPUE was highest in the middle impoundment stratum. CPUE was higher in late summer for fallfish, spottail shiner and yellow perch. Bluegill, rock bass and white sucker CPUE was similar between seasons, and smallmouth bass CPUE was lower overall in late summer.

4.2.3 Bypass Reach

The bypass reach was divided into four stations based on mesohabitat, and sampled during a single late summer sampling event. The two uppermost stations were located between the TF dam and Station No. 1, and the two lower stations were located between Station No.1 and Rock Dam. Overall bypass reach QHEI habitat complexity scores ranged from 78 to 89 (Table 4.2.3-1).

4.2.3.1 Species Abundance and Distribution

A total of 269 individuals representing 16 species were collected (Table 4.2.3.1-1). Smallmouth bass were the most abundant species, accounting for 62.5% of the catch, followed by American eel, and bluegill, which accounted for 9.7% and 8.2% of the catch, respectively. These three species collectively account for 80.2% of the catch; smallmouth bass, American eel and tessellated darter were ubiquitous (occurring in all

samples) (Table 4.2.3.1-1). The Rock Dam pool had the greatest species richness (N=12), followed by the plunge pool below the Turners Falls Dam (N= 9). The plunge pool had the largest catch; the Rock Dam pool the smallest catch.

Shannon Wiener Diversity

Shannon-Weiner diversity scores for the bypass reach were highly variable, reflecting the contrasting mesohabitat types. SW scores ranged from 0.9 in the run-riffle to 1.95 in the plunge pool (Table 4.2.3.1-2**)**. The standard error of these four samples was 0.097.

CPUE

Table 4.2.3.1-3 summarizes overall CPUE (fish per meter) for each bypass reach station. The distance sampled was variable because each station was sampled based on mesohabitat boundaries rather than a standardized length of shoreline as in the TFI. In all cases, the distance exceeded 500m. CPUE ranged from 0.20 in the riffle run, up to 0.52 at the plunge pool station.

CPUE is presented for smallmouth bass (the only species with an n > 50), American eel (n = 26) and bluegill (n = 22). Figure 4.2.3.1-1 summarizes the results. Appendix C provides a detailed breakdown of CPUE by species and size class (adult, juvenile, and YOY) per sampling station for all species. CPUE for smallmouth bass was generally highest for juveniles, and remained relatively consistent among stations other than the run-pool where the CPUE (0.05 fish/m) was over twice the magnitude for any other sampling site. A similar trend was evident for YOY smallmouth bass. Conversely, adult smallmouth bass CPUE was lowest in the run-pool station.

CPUE for American eel and bluegill did not exhibit strong trends; this may be result of small sample sizes. Eel CPUE was greatest in the plunge pool and lowest in the run-pool. The run-pool was the only station where an adult American eel was collected. Bluegill CPUE did not follow any trend but was relatively high in the plunge pool (adult) and run-pool stations (YOY).

Table 4.2.1-1: QHEI Habitat Complexity Scores for Boat Electrofishing, Seining (Including Electrofishing Seine Substitution) Stations in the Turners Falls Impoundment

June-July QHEI Impoundment Scores			September Impoundment QHEI Scores		
Station[6]	Sampling Method	Score	Station	Sampling Method	Score
85.5-E	Boat Electrofishing	69	87-E	Boat electrofishing	80.75
84.5-P	Boat Electrofishing	54	85.2-P	Boat electrofishing	54
84-P	Boat Electrofishing	55	84.3-P	Boat electrofishing	60.25
82-E	Boat Electrofishing	47	82.1-VS	Seine (electrofishing)	53.75
80.1-P	Boat Electrofishing	52.5	82-E	Boat electrofishing	47
77.6-S	Beach Seine	42.5	80.8-P	Boat electrofishing	52.5
76.2-E	Boat Electrofishing	59.5	80.1-E	Boat electrofishing	52.5
74.3-P	Boat Electrofishing	47.5	78.2-VS	Seine (*electrofishing*)	46.5
73.9-E	Boat Electrofishing	53.5	77-E	Boat electrofishing	56.75
72.9-E	Boat Electrofishing	57	76.1-P	Boat electrofishing	43
71.1-P	Boat Electrofishing	58	71.2-E	Boat electrofishing	60
70.1-VS	Seine (*electrofishing*)	50.5	71.1-VS	Seine (*electrofishing*)	53.5
69.9-E	Boat Electrofishing	46	70.5-E	Boat electrofishing	49.5
69.6-VS	Seine (*electrofishing*)	46	70.0-P	Boat electrofishing	50
69.5-P	Boat Electrofishing	43	69.5-P	Boat electrofishing	53

Table 4.2.1-2: Fish Assemblage Sampling Effort for Boat Electrofishing, Seining (including electrofishing seine substitution) Stations in the Turners Falls Impoundment and Bypassed Reach

Station	Sampling Method	Start Date	Start Time	Distance Sampled	Duration
77.6-S	beach seine	7/7/2015	16:00	200 feet	45 minutes
85.5-E	boat electrofishing	6/22/2015	20:45	500 m	1,587 seconds
74.3-P	boat electrofishing	7/7/2015	23:25	500 m	1,119 seconds
76.2-E	boat electrofishing	7/8/2015	01:26	500 m	1,310 seconds
73.9-E	boat electrofishing	7/7/2015	22:24	500 m	1,322 seconds
82-E	boat electrofishing	6/22/2015	00:40	500 m	1,441 seconds
71.1-P	boat electrofishing	7/8/2015	22:33	500 m	1,473 seconds
72.9-E	boat electrofishing	7/8/2015	21:27	500 m	1,481 seconds
80.1-P	boat electrofishing	7/8/2015	02:00	500 m	1,486 seconds
84-E	boat electrofishing	6/22/2015	23:40	500 m	1,514 seconds
84.5-E	boat electrofishing	6/23/2015	22:30	500 m	1,519 seconds
69.9-E	boat electrofishing	7/8/2015	23:52	500 m	1,559 seconds
69.5-P	boat electrofishing	7/9/2015	00:38	500 m	1,672 seconds
84.3-G	gill net	6/22/2015	18:00	30.5 m (100 feet)	4 hrs 00 min.
81.3-G	gill net	6/22/2015	17:30	30.5 m (100 feet)	*Unable to retrieve net*
79.1-G	gill net	7/7/2015	15:20	30.5 m (100 feet)	4 hrs. 40 min.
69.8-G	gill net	7/8/2015	15:45	30.5 m (100 feet)	4 hrs. 45 min.
69.1-G	gill net	7/8/2015	15:30	30.5 m (100 feet)	4 hrs. 00 min
70.1-VS	seine (*electrofishing*)	7/8/2015	17:45	128 m	500 seconds
69.6-VS	seine (*electrofishing*)	7/8/2015	18:35	185 m	500 seconds

[6] An "E" suffix refers to a boat electrofishing site with characteristics consistent with those used by Yoder, *et al.* (2010); sites with a "P" suffix correspond to sites with poor cover habitat characteristics. A "VS" suffix refers to an alternate electrofishing seine site. An "S" refers to a seine site.

Station	Sampling Method	Start Date	Start Time	Distance Sampled	Duration
87.0-E	boat electrofishing	9/21/2015	19:00	500 m	1768 seconds
85.2-P	boat electrofishing	9/21/2015	20:41	500 m	1439 seconds
85.5-G	gill net	9/21/2015	18:00	30.5 m (100 feet)	23 hrs. 20 min
84.3-G	gill net	9/21/2015	17:30	30.5 m (100 feet)	23 hrs. 30 min
84.3-P	boat electrofishing	9/21/2015	22:00	500 m	1880 seconds
82.1-VS	seine (*electrofishing*)	9/21/2015	22:50	300 m	1500 seconds
82.0-E	boat electrofishing	9/22/2015	01:04	500 m	1491 seconds
81.6-G	seine (*electrofishing*)	9/22/2015	18:00	30.5 m (100 feet)	5 hrs. 46 min.
80.8-P	boat electrofishing	9/23/2015	00:05	500 m	1880 seconds
80.1-E	boat electrofishing	9/22/2015	22:50	500 m	1856 seconds
79.1-G	gill net	9/22/2015	18:15	30.5 m (100 feet)	5 hrs. 20 min.
VS-78.2	seine (*electrofishing*)	9/22/2015	18:40	205 m	500 seconds
77.0-E	boat electrofishing	9/22/2015	20:45	500 m	2260 seconds
76.1-P	boat electrofishing	9/22/2015	19:25	500 m	1849 seconds
71.2-E	boat electrofishing	9/23/2015	19:15	500 m	1929 seconds
71.1-VS	seine (*electrofishing*)	9/23/2015	18:32	147 m	500 seconds
70.5-E	boat electrofishing	9/23/2015	20:25	500 m	2339 seconds
70.0-P	boat electrofishing	9/23/2015	22:05	500 m	1674 seconds
69.5-P	boat electrofishing	9/232015	23:40	500 m	2116 seconds
68.9-G	gill net	9/23/2015	17:30	30.5 m (100 feet)	5 hrs. 45 min.
68.7-G	gill net	9/23/2015	17:15	30.5 m (100 feet)	6 hrs. 20 min.
plunge pool	boat electrofishing	9/24/2015	14:10	1,000 m	2,601 seconds
pool-run	boat electrofishing	9/24/2015	16:15	775 m	1,609 seconds
riffle-run	boat electrofishing	9/24/2015	17:10	660 m	1079 seconds
Rock Dam pool	boat electrofishing	9/24/2015	17:45	520 m	1800 seconds

Table 4.2.1-3: Fish Species Collected During 2015 at the Turners Falls Project

Common Name	Scientific Name	June-July	September	Electrofishing	Gill Net	Seine
American eel	*Anguilla rostrata*	X	X	X		
American shad	*Alosa sapidissima*	X	X	X		
banded killifish	*Fundulus diaphanus*		X	X		
black crappie	*Pomoxis nigromaculatus*	X	X	X		
bluegill sunfish	*Lepomis macrochirus*	X	X	X		
brown bullhead	*Ictalurus nebulosus*	X	X	X		
chain pickerel	*Esox niger*	X	X	X		
channel catfish	*Ictalurus punctatus*	X	X	X	X	
common carp	*Cyprinus carpio*	X	X	X		
common shiner	*Luxilis cornutus*		X	X		X
fallfish	*Semotilus corporalis*	X	X	X		
golden shiner	*Notemigonus crysoleucas*	X	X	X		
hybrid sunfish			X			X
largemouth bass	*Micropterus salmoides*	X	X	X		
longnose dace	*Rhinichthys cataractae*		X	X		
mimic shiner	*Notorpis volucellus*	X	X	X		
northern pike	*Esox lucius*	X	X	X		
pumpkinseed sunfish	*Lepomis gibbosus*	X	X	X	X	
rock bass	*Ambloplites rupestris*	X	X	X		
rosyface shiner	*Notropis rubellus*		X	X		
sea lamprey	*Petromyzon marinus*	X	X	X		
smallmouth bass	*Micropterus dolomieui*	X	X	X		
spottail shiner	*Notropis hudsonius*	X	X	X		X
tessellated darter	*Etheostoma olmstedi*	X	X	X		X
walleye	*Stizostedion vitreum vitreum*	X	X	X	X	
white perch	*Morone americana*		X	X		
white sucker	*Catostomus commersoni*	X	X	X	X	X
yellow perch	*Perca flavescens*	X	X	X		X
			TFI June-July	2,901		

Common Name	Scientific Name	June-July	September	Electrofishing	Gill Net	Seine
			TFI September	2,738		
			Bypass reach September	269		

Method	June-July		September	
electrofishing[7]	1,558	*54%*	2,724	*99%*
gill net	3	*0%*	14	*1%*
beach seine	1340	*46%*	*n/a*	*n/a*

[7] Includes electrofishing samples substituted for beach seine

Table 4.2.2.1-1: Species Abundance at Boat Electrofishing Stations in the Turners Falls Impoundment during Early Summer 2015

E-series stations conform to IBI-type electrofishing conditions; P-series stations are poor habitat complexity. Green-shaded stations are upper impoundment stations; blue-shaded stations are middle impoundment stations and yellow-shaded stations are lower impoundment stations.

JUNE-JULY	Electrofishing Station												Total	%
	85.5-E	84.5-P	84-P	82-E	80.1-P	76.2-E	74.3-P	73.9-E	72.9-E	71.1-P	69.9-E	69.5-P		
spottail shiner	52	26	4	27	54	1	8	1	3	290	2	175	643	44%
smallmouth bass	25	15	15	25	20	36	38	17	39	2	0	4	236	16%
yellow perch	20	5	3	6	8	1	7	8	7	38	21	74	198	14%
bluegill sunfish	4	0	2	0	0	1	1	2	0	10	11	63	94	6%
fallfish	15	14	4	14	19	10	7	1	0	2	0	0	86	6%
rock bass	11	3	2	3	1	7	2	5	14	0	0	7	55	4%
white sucker	2	4	0	4	6	1	2	5	10	6	2	7	49	3%
pumpkinseed	0	0	0	0	0	0	0	1	0	17	1	6	25	2%
walleye	2	0	2	1	3	0	1	0	0	5	0	2	16	1%
tessellated darter	0	0	0	0	0	12	0	0	0	1	0	0	13	1%
mimic shiner	0	1	0	6	0	0	0	0	0	0	0	0	7	0.5%
American eel	0	2	1	1	0	0	0	3	0	0	0	0	7	0.5%
largemouth bass	0	0	0	0	0	0	0	0	0	3	0	2	5	0.3%
black crappie	1	0	0	1	0	0	0	0	0	2	0	1	5	0.3%
golden shiner	2	0	0	0	0	1	0	0	0	0	0	1	4	0.3%
brown bullhead	0	0	0	0	0	0	0	0	0	1	0	2	3	0.2%
chain pickerel	0	0	0	1	0	0	0	0	0	0	0	1	2	0.1%
channel catfish	1	0	0	0	0	0	0	0	1	0	0	0	2	0.1%
sea lamprey	1	1	0	0	0	0	0	0	0	0	0	0	2	0.1%
common carp	0	0	0	0	0	0	0	1	0	1	0	0	2	0.1%
northern pike	0	0	0	1	0	0	0	0	0	0	0	0	1	0.1%
American shad	0	1	0	0	0	0	0	0	0	0	0	0	1	0.1%

Table 4.2.2.1-2: Species Abundance at Boat Electrofishing Stations in the Turners Falls Impoundment during Late Summer 2015

E-series stations conform to IBI-type electrofishing conditions; P-series stations are poor habitat complexity. Green-shaded stations are upper impoundment stations; blue-shaded stations are middle impoundment stations and yellow-shaded stations are lower impoundment stations.

September	Electrofishing Station												Total	%
	87.0-E	85.2-P	84.3-P	82-E	80.8-P	80.1-E	77-E	76.1-P	71.2-E	70.5-E	70.0-P	69.5-P		
spottail shiner	0	2	28	7	2	41	164	18	77	320	211	271	1141	48%
smallmouth bass	48	18	59	27	33	12	51	33	45	12	3	4	345	15%
yellow perch	0	0	5	7	11	0	12	1	9	68	44	58	215	9%
fallfish	0	11	31	36	11	32	31	19	3	0	0	0	174	7%
bluegill sunfish	12	1	1	0	0	2	5	0	14	44	17	24	120	5%
American shad	0	19	2	15	1	6	4	0	3	10	1	20	81	3%
white sucker	10	8	2	3	2	0	1	6	1	5	4	13	55	2%
largemouth bass	1	0	1	1	0	0	2	2	10	13	12	8	50	2%
rock bass	0	4	5	4	3	1	7	8	6	5	3	2	48	2%
pumpkinseed	2	0	0	0	0	0	0	0	1	18	7	14	42	2%
banded killifish	0	0	0	0	0	0	5	0	1	0	12	4	22	1%
tessellated darter	4	0	2	4	3	0	1	1	1	0	0	2	18	1%
mimic shiner	0	2	2	6	0	0	0	0	0	2	3	1	16	1%
golden shiner	0	0	1	0	0	0	0	0	0	2	6	1	10	0.4%
black crappie	0	0	0	1	0	0	0	0	0	1	2	2	6	0.3%
walleye	1	0	1	0	0	0	0	0	2	0	0	1	5	0.2%
northern pike	0	0	1	2	1	0	0	0	0	0	1	0	5	0.2%
channel catfish	0	0	0	0	1	0	1	0	1	0	1	0	4	0.2%
American eel	0	0	1	1	0	0	0	1	0	0	0	0	3	0.1%
sea lamprey	1	1	0	0	1	0	0	0	0	0	0	0	3	0.1%
white perch	0	0	0	0	0	0	0	1	0	0	0	0	1	0.0%
rosyface shiner	0	0	0	0	0	0	0	0	0	0	0	0	1	0.0%
common carp	0	0	0	0	0	0	0	0	0	0	0	1	1	0.0%
chain pickerel	0	0	0	0	0	0	0	0	0	0	1	0	1	0.0%
brown bullhead	0	0	0	0	0	0	0	0	0	0	0	1	1	0.0%

Table 4.2.2.2-1: Dominance of Species during Early Summer 2015, in the Turners Falls Impoundment
Shading indicates the six most dominant species in each stratum

Impoundment Location	Sampling Station				
Upper Impoundment	**85.5**	**84.5**	**84**	**82**	**Rank Score Analysis**
spottail shiner	5	5	4	5	19
smallmouth bass	4	4	5	4	17
yellow perch	3	2	3	2	10
fallfish	2	3	2	3	10
rock bass	1		3		4
white sucker		1	2	1	4
bluegill sunfish			2		2
mimic shiner				2	2
walleye			1		1
American eel			1		1
Middle Impoundment	**80.1**	**76.2**	**74.3**	**73.9**	
spottail shiner	4	5	5	5	19
smallmouth bass	5	2	4	1	12
yellow perch	3	2	3	3	11
fallfish	2		3	4	9
rock bass		3	1	3	7
white sucker		2		2	4
bluegill sunfish		4			4
pumpkinseed	1	2			3
mimic shiner				2	2
tessellated darter		2			2
golden shiner				1	1
walleye			1		1
American eel			1		1
Lower Impoundment	**72.9**	**71.1**	**69.9**	**69.5**	
spottail shiner	1	5	3	5	14
yellow perch	1	4	5	4	14
white sucker	3	1	3	2	9
bluegill sunfish		2	4	3	9
rock bass	4			2	6
pumpkinseed		3	2	1	6
smallmouth bass	5				5

Table 4.2.2.2-2: Dominance of Species during Late Summer 2015, in the Turners Falls Impoundment
Shading indicates the six most dominant species in each stratum

Location/Species	Sampling Station				
Upper Impoundment	**87.0**	**85.2**	**84.3**	**82.0**	**Rank Score Analysis**
smallmouth bass	5	4	5	4	18
fallfish		3	4	5	12
American shad		5	1	3	9
white sucker	2	2	1		5
American eel	4				4
rock bass		1	2	1	4
bluegill sunfish	3				3
mimic shiner			1	2	3
spottail shiner			3		3
tessellated darter			1	1	2
yellow perch			2		2
northern pike			1		1
pumpkinseed	1				1
walleye			1		1
Middle Impoundment	**80.8**	**80.1**	**77**	**76.1**	
smallmouth bass	5	3	4	5	17
Fallfish	4	4	3	4	15
spottail shiner		5	5	3	13
yellow perch	4		2		6
rock bass	3		1	2	6
American shad	1	2			3
white sucker	2			1	3
bluegill sunfish		1			1
northern pike	1				1
channel catfish	1				1
sea lamprey	1				1
Lower Impoundment	**71.2**	**70.5**	**70.0**	**69.5**	
spottail shiner	5	5	5	5	20
bluegill sunfish	3	3	3	3	12
yellow perch		4	4	4	12
pumpkinseed		2	1	1	4
smallmouth bass	4				4
largemouth bass	2	1			3
rock bass	1		2		3
American shad				2	2
banded killifish			2		2

Table 4.2.2.2-3: Turners Falls Project, Shannon-Wiener Diversity Index Scores for Turners Falls Impoundment Electrofishing Sites

STUDY REACH	Habitat Quality	Sampling Method	Sample Size	S-W Stratum Mean	S-W Habitat Mean	S-W *min.*	S-W *max.*	Standard Error
upper impoundment	rich habitat	*electrofishing*	4	1.83		*1.70*	*2.00*	0.021
middle impoundment	rich habitat	*electrofishing*	4	1.50		*1.30*	*1.84*	0.021
lower impoundment	rich habitat	*electrofishing*	4	1.36		*1.10*	*1.69*	0.023
Rich habitat (all)			12		1.56			
upper impoundment	poor habitat	*electrofishing*	4	1.77		*1.70*	*1.84*	0.002
middle impoundment	poor habitat	*electrofishing*	4	1.31		*1.02*	*1.46*	0.024
lower impoundment	poor habitat	*electrofishing*	4	1.29		*0.96*	*1.41*	0.018
Poor habitat (all)			12		1.46			
upper impoundment	*n/a*	*gill netting*	*3*	*0.00*		*0*	*0*	*0.00*
middle impoundment	*n/a*	*gill netting*	*4*	*0.00*		*0*	*0*	*0.00*
lower impoundment	*n/a*	*gill netting*	*4*	*0.32*	*0.11*	*0*	*1.272*	*0.152*
middle impoundment	*n/a*	*beach seine*	*2*	*0.57*		*0.57*	*0.57*	*0*

Table 4.2.2.2-4: Comparison of Habitat and Fish Assemblage Metrics between Rich-Habit vs. Poor-Habitat Sampling Sites

	Mean (rich habitat)	Mean (poor habitat)	t	df	p
QHEI score	55.79	51.64	1.3553	18.514	0.1916
Species Richness	9.9	10.70	-0.5765	20.9	0.5704
Numeric Abundance	114.93	128.00	-0.3282	21.65	0.7459
S-W Diversity	1.57	1.43	1.1007	21.797	0.283

Table 4.2.2.2-5: Turners Falls Project CPUE for 24 Impoundment Boat Electrofishing Samples during Early and Late Summer 2015

June-July Station	CPUE (fish/m)	Mean CPUE (*Standard error*)	September Station	CPUE	Mean CPUE (*Standard error*)
85.5-E	0.08		87.0-E	0.11	
84.5-P	0.05		85.2-P	0.04	
84.0-P	0.02		84.3-P	0.07	
82.0-E	0.06	0.05 (*0.013*)	82.0-E	0.08	0.08 (*0.014*)
80.1-P	0.08		80.8-P	0.04	
76.2-E	0.05		80.1-E	0.05	
74.3-P	0.06		77.0-E	0.13	
73.9-E	0.03	0.06 (*0.010*)	76.1-P	0.05	0.07 (*0.021*)
72.9-E	0.05		71.2-E	0.09	
71.1-P	0.26		70.5-E	0.25	
69.9-E	0.02		70.0-P	0.20	
69.5-P	0.21	0.14 (*0.059*)	69.5-P	0.20	0.19 (*0.034*)

Green-shaded stations are in the upper impoundment; blue-shaded station are in the middle impoundment and yellow-shaded stations are in the lower impoundment.

Table 4.2.3-1: QHEI Habitat Complexity Scores for Boat Electrofishing Stations in the Turners Falls Bypass Reach

Station	River Mile	Sampling Method	QHEI Score
plunge pool	67.8	Boat Electrofishing	78.0
pool run above station No. 1	67.5	Boat Electrofishing	80.5
riffle-run below Station No. 1	67	Boat Electrofishing	89.0
pool above Rock Dam	66.5	Boat Electrofishing	84.5

Table 4.2.3.1-1: Species Abundance at Each Boat Electrofishing Station within the Turners Falls Bypass Reach during Late Summer 2015

Species	Plunge Pool	Pool-Run Above Station No. 1	Riffle-Run Below Station No. 1	Pool Above Rock Dam	Total	% of Total
Smallmouth Bass	48	67	30	23	168	62.5%
American Eel	16	1	7	2	26	9.7%
Bluegill Sunfish	12	9		1	22	8.2%
Pumpkinseed	8	8			16	5.9%
White Sucker	10		2	1	13	4.8%
Tessellated Darter	4	2	2	4	12	4.5%
Sea Lamprey	1		1	1	3	1.1%
Largemouth Bass	1				1	0.4%
Yellow Perch				1	1	0.4%
Spottail Shiner				1	1	0.4%
Mimic Shiner				1	1	0.4%
Walleye	1				1	0.4%
Northern Pike				1	1	0.4%
Brown Bullhead				1	1	0.4%
Hybrid Sunfish		1			1	0.4%
Longnose Dace			1		1	0.4%
Total	**101**	**88**	**43**	**37**	**269**	

Table 4.2.3.1-2: Turners Falls Project Shannon-Wiener Diversity Index Scores for Bypass Reach Electrofishing Sites

Station	Shannon-Wiener Score
Plunge Pool	1.95
pool run above Station No. 1	1.01
Riffle-Run below Station No. 1	0.90
pool above Rock Dam	1.45

Table 4.2.3.1-3: Turners Falls Project CPUE for 4 Bypass Reach Boat Electrofishing Samples during Late Summer 2015.

Station	Distance Sampled (m)	CPUE
Plunge Pool	1,000	0.052
pool run above Station No. 1	775	0.027
Riffle-Run below Station No. 1	660	0.020
pool above Rock Dam	520	0.027

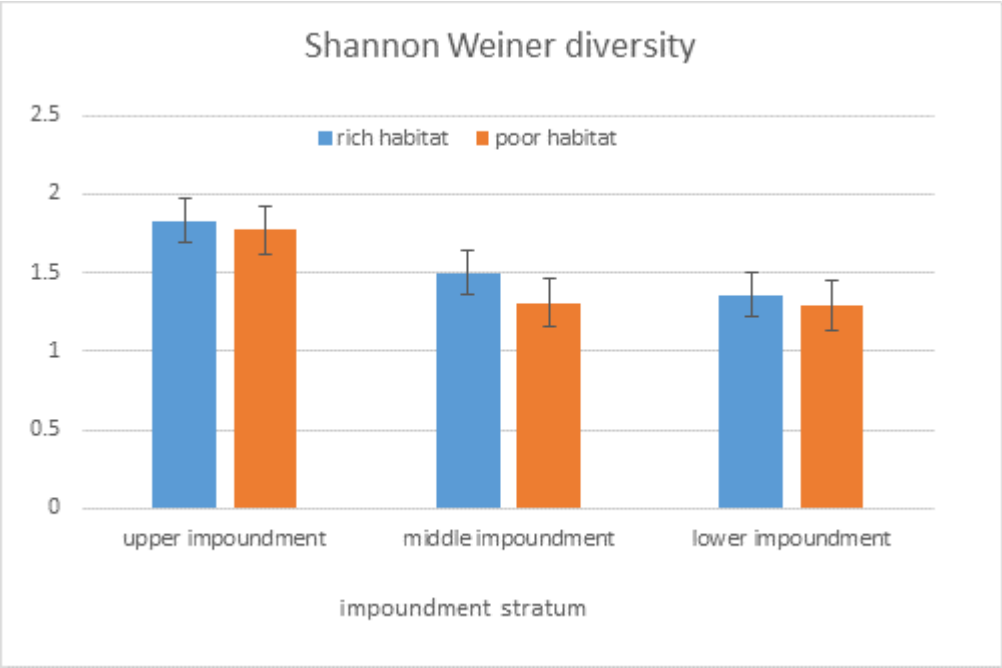


Figure 4.2.2.2-1: Shannon-Weiner diversity scores in Rich-Habitat vs Poor-Habitat Sampling Sites in the upper middle and lower TFI strata

Early and late summer samples combined (n=24)

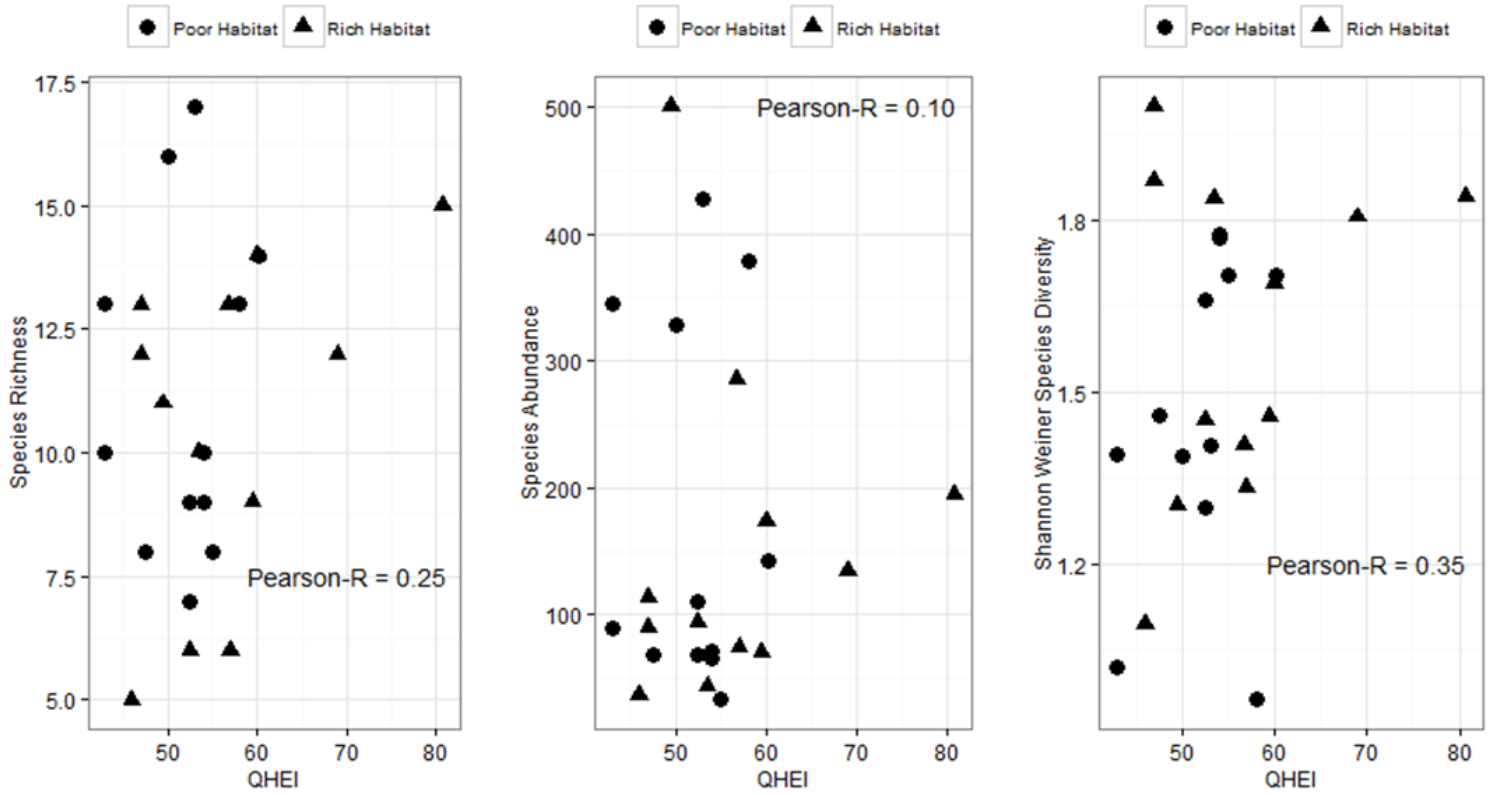
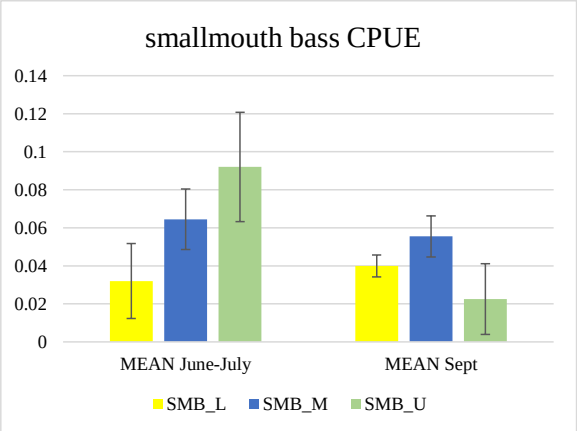
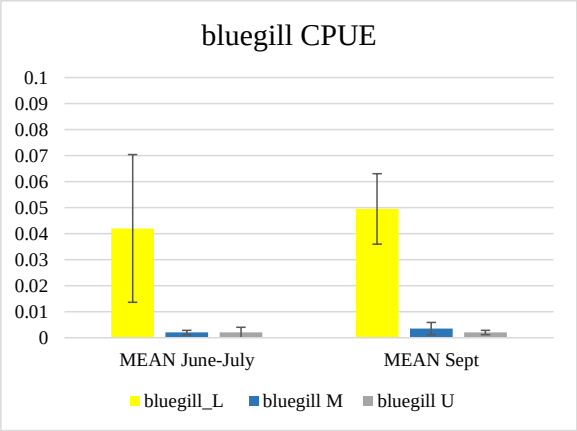
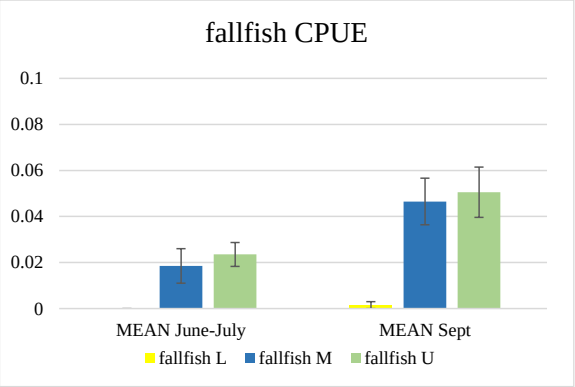
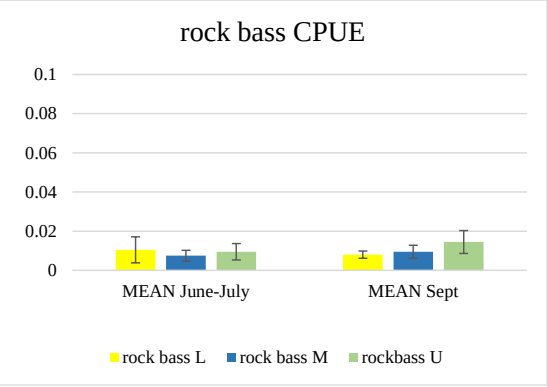


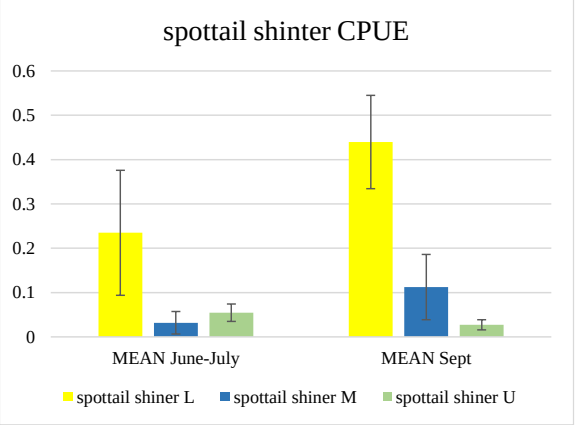
Figure 4.2.2.2-2: Distribution of Habitat and Fish Assemblage Metrics at Individual Rich-Habit vs Poor-Habitat Sampling Sites

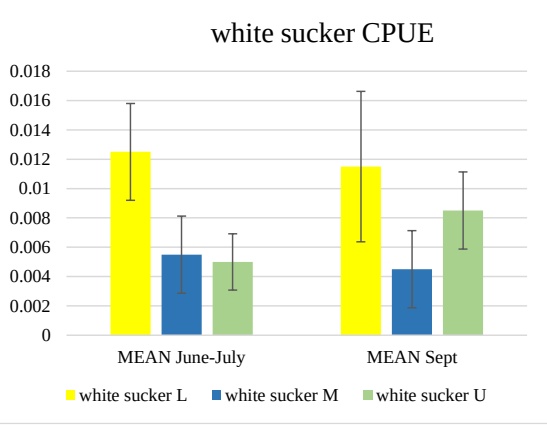

smallmouth bass CPUE
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
MEAN June-July
MEAN Sept
SMB_L
SMB_M
SMB_U


bluegill CPUE
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
MEAN June-July
MEAN Sept
bluegill_L
bluegill M
bluegill U


fallfish CPUE
0.1
0.08
0.06
0.04
0.02
0
MEAN June-July
MEAN Sept
fallfish L
fallfish M
fallfish U


rock bass CPUE
0.1
0.08
0.06
0.04
0.02
0
MEAN June-July
MEAN Sept
rock bass L
rock bass M
rockbass U


spottail shinter CPUE
0.6
0.5
0.4
0.3
0.2
0.1
0
MEAN June-July
MEAN Sept
spottail shiner L
spottail shiner M
spottail shiner U


white sucker CPUE
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
MEAN June-July
MEAN Sept
white sucker L
white sucker M
white sucker U

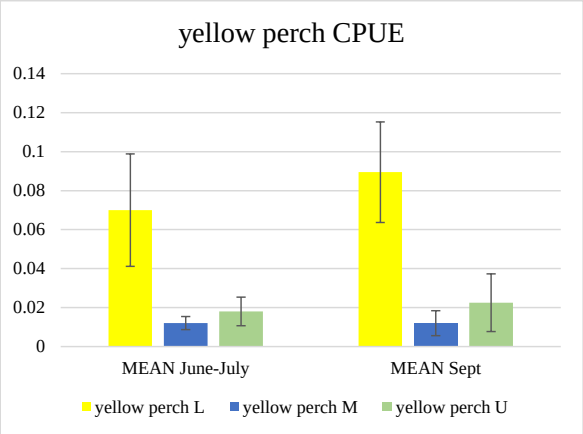


Figure 4.2.2.2-3: Turners Falls Project CPUE for Fish Species (n>50) in 24 Impoundment Boat Electrofishing Samples During Early and Late Summer 2015

Green data are from the upper impoundment stratum; blue data are from the middle impoundment stratum and yellow data are from the lower impoundment stratum.

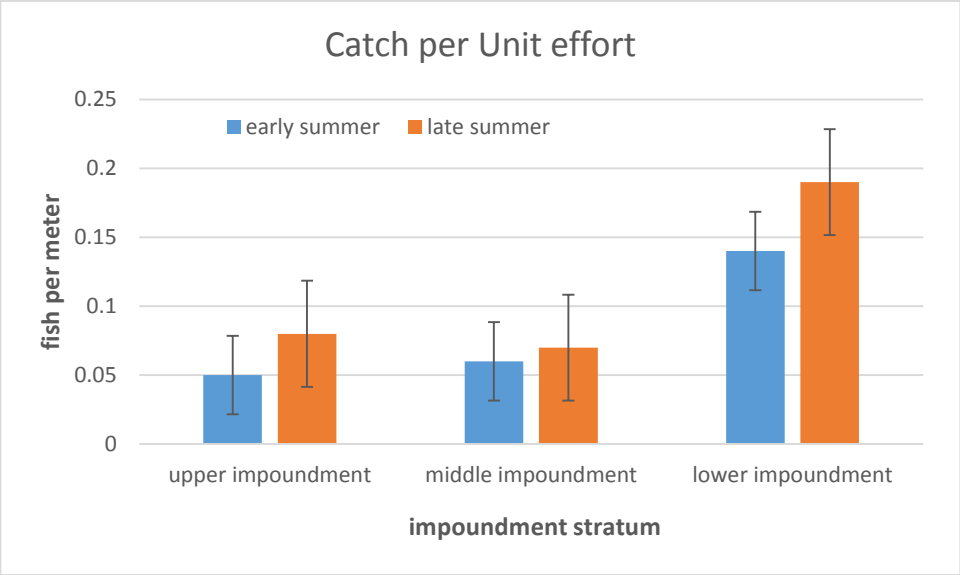


Figure 4.2.2.2-4: Turners Falls Project CPUE in Upper Middle and Lower TFI strata (N=24)
Boat Electrofishing Samples During Early and Late Summer 2015

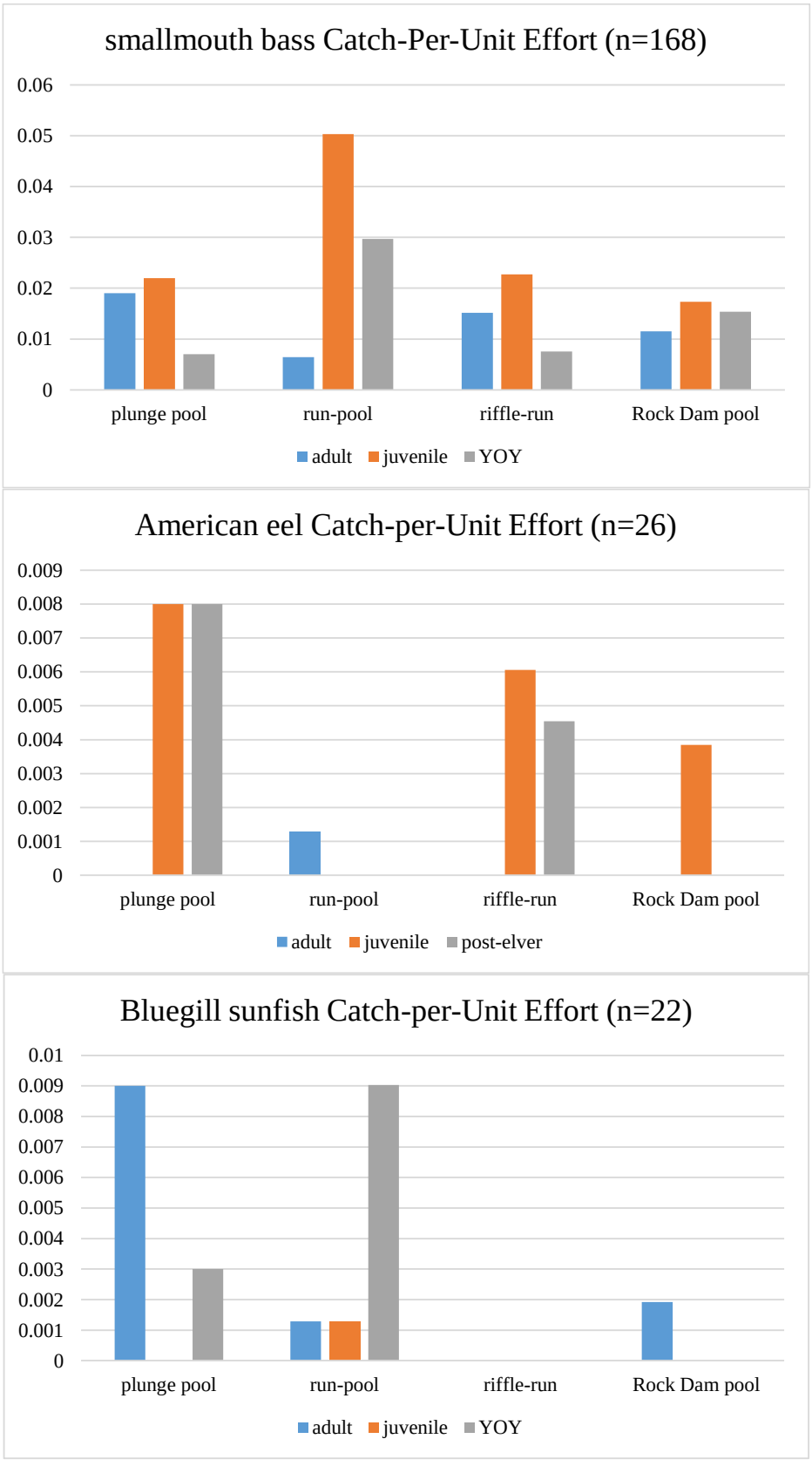


Figure 4.2.3.1-1: Turners Falls Project CPUE for Selected Fish Species in Four Bypass Reach Boat Electrofishing Stations During Late Summer 2015

4.3 Historic Data

Two prior studies of the TFI provide data that may be compared to the present study. MDFG (1978) summarizes data collected in the study area during 1971-1975. Yoder *et al.* (2010) and MBI (2014) sampled the study area in 2008 and 2009 using methods similar to those in the present study (Table 4.3-1).

4.3.1 Massachusetts Division of Fisheries and Game (MDFG) (1978)

MDFG (1978) included resident species composition sampling, as well creel census, mark-and-recapture, and population assessment of key game species, macroinvertebrate and Northfield Mountain sampling data. MDFG (1978) species composition data were gathered using a 220VAC electrofishing boat at seven stations every other week April through October, conditions permitting. Sampling details (*e.g.* exact station locations, habitat, sampling effort, efficiency, prevailing water quality, *etc*.) were not documented. Thus, only qualitative comparisons to the present study can be made.

MDFG (1978) collected 19-22 species annually during 1971-1975, and McCaig (1968) as cited in MDFG (1978), documented 22 species (Table 4.3-1). The present study collected a total of 28 species. Species reported by MDFG (1978) but absent from the present study include Atlantic salmon, brook trout, brown trout, longnose sucker, rainbow trout, and yellow bullhead. The presence of salmonid species likely reflects stocking intervention and also spring and fall sampling conducted under periods of cooler ambient seasonal conditions than those of the present summer-season study. Species encountered in the present study but absent from MDFG (1978) include: American shad, channel catfish, hybrid sunfish, longnose dace, northern pike, rosyface shiner, and sea lamprey.

MDFG (1978) provided an impoundment-wide estimate of species dominance by ranking and scoring relative abundance across all electrofishing samples both annually and across all years. Table 4.3.1-1 compares the dominant ranking species from both MDFG (all years combined) and the present study[8].

Four (4) of the six (6) most dominant species (smallmouth bass, yellow perch, bluegill and spottail shiner remained the same between the 1970's and 2015. This suggests that overall the resident fish assemblage is relatively stable. Variations between catch data from MDFG (1978) and the present study may reflect a degree of ecological change but are probably also influenced by natural inter-annual variability and also differences in sampling methodology. Fallfish were dominant in both 2015 sampling efforts but not dominant in the 1970's, and diadromous American eel and American shad (YOY) were dominant in 2015 but absent during the 1970's. 2008-2009 Yoder, *et al*. (2010) and Midwest Biodiversity Institute (MBI) (2014).

Yoder *et al.* (2010) and MBI (2014) collected data using a methodology similar to that of the present study, with sampling performed during late summer. Each sampling station was 1,000 m in length, and included five stations in the TFI study area and two in the bypass reach. The similarities in sampling design allow for site-specific quantitative comparisons. A total of 19 species were collected by Yoder *et al*. (2010) in the impoundment including all the same species found in the present study. Species that the present study detected but were not sampled by Yoder *et al.* (2010) include banded killifish, black crappie, channel catfish, common shiner, longnose dace, mimic shiner, northern pike, rosyface shiner, white perch.

Stations 69.5, 71.2, 80.1, 82.0 and 87.0 in the present study are late summer sampling stations that approximate the locations of the five 2008 stations, and were paired for purposes of this comparison. Species richness, total catch and CPUE generally follow the same spatial trends in both studies, but the values tended to be higher for a corresponding pair of sites in 2015, with the exception of species richness at Station 80.1 and numeric abundance at Station 69.5 (Table 4.3.2-2, Figure 4.3.2-1). Although the 2015

[8] For purposes of this analysis, the spatially-stratified species dominance rankings from the present study (Tables 4.2.2.2.-1 through 4.2.2.2.-2) were pooled as an impoundment-wide ranking to facilitate comparison to MDFG (1978).

raw abundance at Station 69.5 was lower than the corresponding 2008 catch (station 68.8), this reflects a 500 m (present study) *vs.*1,000 m (Yoder *et al.*, 2010) sampling effort. However, when normalized as CPUE, the 2015 value at this station was higher than in 2008. In general, metrics were higher at stations in the upstream and downstream strata of the study area and lower at stations positioned in the middle stratum.

Table 4.3.2-1 compares the dominant ranking species from both 2008 (Yoder *et al.*, 2010) and the present study[9]. Four (4) of the six (6) most dominant species (smallmouth bass, yellow perch, fallfish and spottail shiner) remained the same between 2008 and 2015; and YOY of different anadromous species were among the six (6) most dominant species in both surveys. This suggests that overall the resident fish assemblage remained relatively stable within comparable habitats. Variations between catch data from 2008 and the present study may reflect natural inter-annual variability. Fallfish were relatively dominant in both 2015 sampling efforts but as noted above not dominant in the 1970's. Anadromous sea lamprey YOY were dominant in 2008, whereas American shad (YOY) and catadromous American eel were dominant in 2015; neither were dominant during the 1970's.

Bypass Reach

MBI (2014) documented the fish assemblage in the bypass reach based on sampling in 2009 using the same electrofishing apparatus, personnel and methods as the present study, but at slightly different stations. The Rock Dam pool and riffle-run stations in the present study correspond to Station 66.9 (lower bypass reach) in MBI (2014) and the pool-run and plunge pool stations in the present study correspond to Station 67.9 from 200. The presents study stations were paired accordingly for purposes of this comparison.

Table 4.3.2-3 lists all species collected in declining order of abundance, from both 2009 (MBI, 2014) and the present study. Three of the six most dominant species (smallmouth bass, American eel, and white sucker) remained the same in both 2009 and 2015. Tessellated darter and bluegill were more common in 2015 than in 2009. Sea lamprey YOY were evident in both surveys but were not among the most common species. Species richness, abundance and CPUE generally follow the same spatial trends in both studies (Table 4.3.2-4). The lower areas of the bypass reach had slightly greater species richness in both studies, and the upper areas of the bypass reach exhibited greater abundance and CPUE than the lower areas in both studies.

[9] For purposes of this analysis, dominance rankings from the five sampling stations from the present study most directly overlapping 2008 study sites were pooled to facilitate comparison of both data sets.

Table 4.3-1: Summary of Fish Species Collected at the Turners Falls Project during 2015 (Present Study), 2008 and 2009 (Yoder *et al.*, 2010; MBI, 2014), and 1964-76 (MDFG, 1978)

Common Name	2015	2008	1964	1971	1972	1973	1974	1975
American eel	X	X	X	X	X	X	X	X
American shad	X	X						
Atlantic salmon						X		
banded killifish	X		X	X	X	X	X	X
black crappie	X		X	X	X	X	X	X
bluegill	X	X	X	X	X	X	X	X
brook trout				X			X	X
brown bullhead	X	X	X	X	X	X	X	X
brown trout			X	X				X
common carp	X	X	X	X	X	X	X	X
chain pickerel	X	X	X	X	X	X	X	X
channel catfish	X							
common shiner	X							
fallfish	X	X	X	X	X	X	X	X
golden shiner	X	X	X	X	X	X	X	
hybrid x sunfish	X	X						
largemouth bass	X	X	X	X	X	X	X	X
longnose dace	X							
longnose sucker			X					
mimic shiner	X							
northern pike	X							
pumpkinseed	X	X	X	X	X	X	X	X
rainbow trout					X	X	X	X
rock bass	X	X	X					
rosyface shiner	X			X	X	X	X	X
sea lamprey	X	X						
smallmouth bass	X	X	X					

Common Name	2015	2008	1964	1971	1972	1973	1974	1975
spottail shiner	X	X	X	X	X	X	X	X
tessellated darter	X	X	X	X	X	X	X	X
walleye	X	X	X	X		X	X	
white catfish				X	X	X	X	X
white perch	X		X					
white sucker	X	X	X	X	X	X	X	X
yellow bullhead			X	X	X	X	X	X
yellow perch	X	X	X	X	X	X	X	X
Number of species	**28**	**19**	**22**	**21**	**19**	**21**	**21**	**20**

Table 4.3.1-1: Species Dominance Patterns in the Turners Falls Impoundment From the 1970's and 2015. Species Listed in Declining Order of Rank Score Dominance

MDFG (1978)	June-July 2015	September 2015
yellow perch	spottail shiner	smallmouth bass
pumpkinseed	smallmouth bass	spottail shiner
smallmouth bass	yellow perch	fallfish
largemouth bass	fallfish	yellow perch
bluegill	rock bass	bluegill
spottail shiner	white sucker	American shad
white sucker	bluegill	rock bass
walleye	pumpkinseed	white sucker
golden shiner	mimic shiner	pumpkinseed
black crappie	tessellated darter	American eel
white perch	golden shiner	largemouth bass
rock bass	walleye	mimic shiner
brown bullhead	American eel	banded killifish
chain pickerel	common carp	tessellated darter

Table 4.3.2-1: Turners Falls Impoundment Species Dominance Patterns Comparison of Data from 2008 and 2015

Species listed in declining order of rank score dominance.

2008	2015 (*September*)
smallmouth bass	smallmouth bass
sea lamprey	spottail shiner
spottail shiner	bluegill
yellow perch	fallfish
fallfish	American shad
white sucker	American eel
pumpkinseed	yellow perch
rock bass	white sucker
largemouth bass	rock bass
chain pickerel	mimic shiner
bluegill	pumpkinseed
	largemouth bass
	tessellated darter

Table 4.3.2-2: Turners Falls Impoundment Comparison of Species Richness, Abundance, and Catch-per Unit –Effort (CPUE) from 2008 (Yoder *et al.*, 2010) and the Present Study

2008 Station	2015 Station	Species Richness		Abundance		CPUE	
		2008	2015	2008	2015	2008	2015
68.8	69.5	13	17	571	427	0.571	0.854
72.2	71.2	13	14	75	174	0.075	0.348
79.2	80.1	8	6	20	94	0.02	0.188
83.3	82.0	9	13	5	114	0.005	0.228
88.4	87.0	11	15	71	195	0.071	0.39

Table 4.3.2-3: Comparison of Fish Species Abundance in the Turners Falls Bypass Reach in 2009 and 2015

2009	Upper Bypass Reach 2015	2009	Lower Bypass Reach 2015
smallmouth bass	smallmouth bass	smallmouth bass	smallmouth bass
longnose dace	American eel	spottail shiner	bluegill
American eel	tessellated darter	longnose dace	American eel
Atlantic salmon	white sucker	tessellated darter	pumpkinseed
white sucker	sea lamprey	white sucker	white sucker
rock bass	yellow perch	American eel	tessellated darter
sea lamprey	spottail shiner	brown trout	largemouth bass
tessellated darter	mimic shiner	common carp	walleye
	bluegill	rock bass	sea lamprey
	northern pike	bluegill	hybrid sunfish
	brown bullhead		
	longnose dace		
	largemouth bass		

Table 4.3.2-4: Comparison of Species Richness, Abundance, and Catch-per-Unit–Effort (CPUE) from 2009 and the Present Study

	Species Richness		Abundance		CPUE (fish/m)	
	2009	2015	2009	2015	2009	2015
Upper Bypass Reach stations	7	10	94	189	0.085	0.11
Lower Bypass Reach stations	9	11	78	80	0.078	0.07

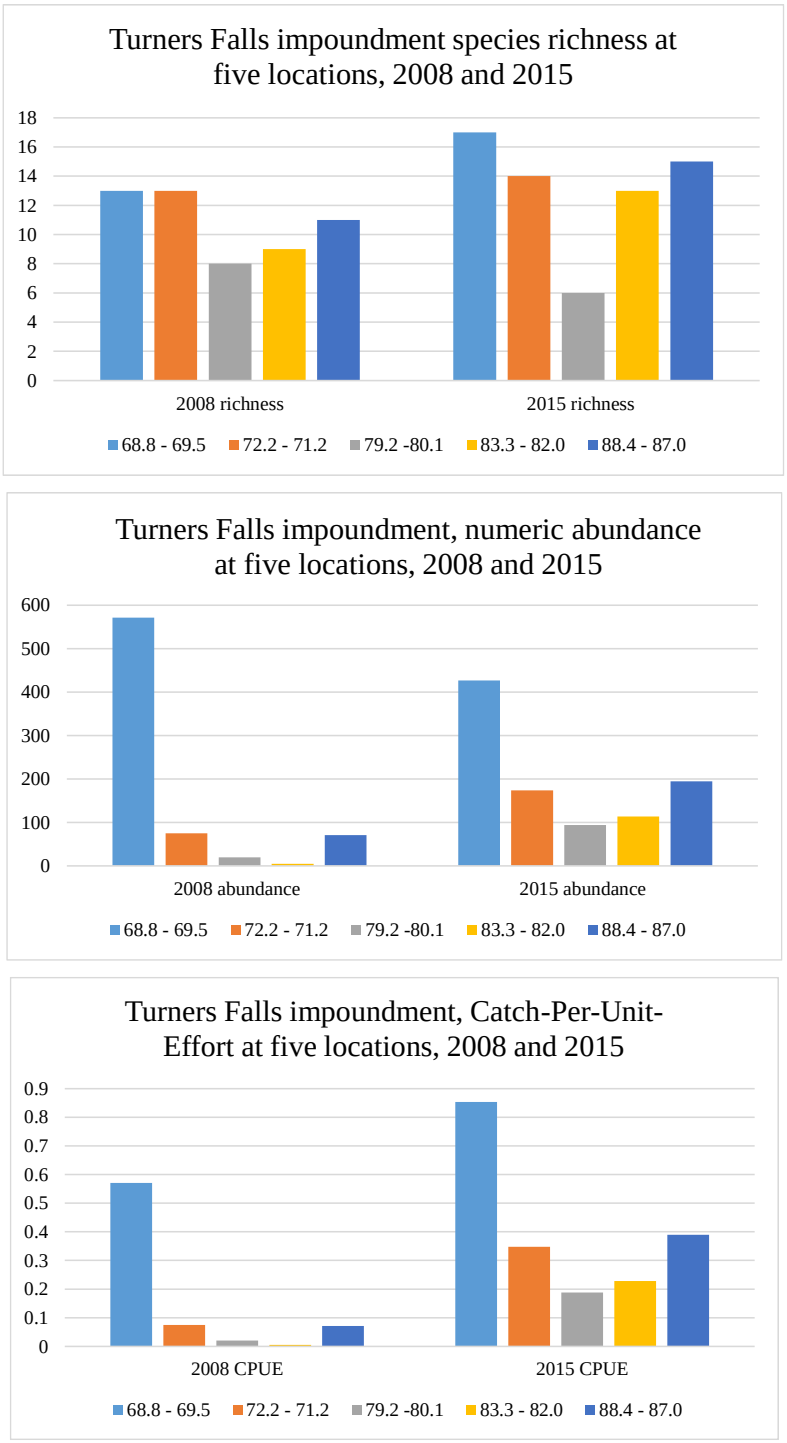


Figure 4.3.2-1: Turners Falls Impoundment Comparison of Species Richness, Abundance, and Catch-per Unit –Effort (CPUE) from 2008 (Yoder *et al.*, 2010) and the Present Study.

5 DISCUSSION

Habitat Effects on Community Structure

Fish assemblage metrics were influenced by relative spatial position in the impoundment, which is indirectly related to habitat conditions. For example the upstream stratum of the TFI was dominated by smallmouth bass and fallfish, whereas the lowermost stratum of the TFI is dominated by bluegill, pumpkinseed and yellow perch. Largemouth bass are 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), 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).

Comparisons to Historic Data

Boat electrofishing datasets from the present study provide the best comparison to similar sampling data from 1971-78, 2008 and 2009 as they were obtained using similar methodology and spatial effort. Although ambiguity about the details of the 1971-75 sampling methods preclude highly quantitative comparisons, qualitative trends were evident. Data collected in 2008-2009 were more readily quantitatively comparable to the present study.

MDFG (1978) concluded based on multiple consecutive years of sampling the TFI that resident fish species composition and relative abundance was stable. MDFG observed similar spatial trends to those from the present study, such as the widespread spatial dominance of yellow perch, and the inverse upstream to downstream distribution of smallmouth bass and largemouth bass, which appeared to be driven by distribution of preferred habitat types. This suggests that the resident fish community composition remains stable, although the number of species has increased somewhat. Fallfish and American shad were virtually absent from dominance during 1971-75 but were fairly dominant in 2015 surveys. Fallfish require relatively clear water quality, it is possible that since the 1970's, reduction in pollution described by MDFG (1978) has decreased ambient turbidity to the extent that fallfish can better utilize study area habitat. The relative dominance of American shad YOY likely reflects improved recruitment to the study area due to construction of fishways at Turners Falls, Cabot Station and Holyoke that were not present in the 1970's.

Yoder *et al.* (2010), MBI (2014) and the present study reflect more contemporary sampling and provide more quantitative station-specific results. Both the 2008-09 and 2015 data sets exhibit similar trends relative to fish assemblage metrics. Despite the passage of more than three decades, the same general species dominance pattern and spatial distribution is evident among resident species when MDFG (1978) is compared to both of the more contemporary data. Salmonid species are less prevalent than in the 1970's, likely due to changes in stocking and management practices combined with the contemporary study's study summer sampling design which, coincides with warmer water temperatures.

Seining vs. electrofishing alternative

As noted in section 3, beach seining, as described in the study scope was intended to provide data in areas not accessible to boat electrofishing. Although data from seining is not quantitatively comparable to boat electrofishing data, they could potentially document species not otherwise sampled. However, beach seining proved impractical due to wadability and snag concerns; and few if any segments of the shoreline were too shallow to navigate an electrofishing vessel. Supplemental 500-second duration boat electrofishing was therefore conducted in littoral areas meeting general beach seining conditions (*i.e.* shallow, relatively limited snags).

Sampling distance for electrofishing covered distances ranging from 420 to 984 ft, or approximately 2 to 5 times the distance covered by a seining site (Table 5.0-1) as scoped in the RSP. Seining yielded a total of 4 species, whereas the alternative electrofishing of similar shorelines yielded 1-14 species (mean of 6.1). The only species detected in beach seining but not collected via other means was a single hybrid sunfish, whereas electrofishing detected all other species in the study. These data indicate that the alternative sampling using the boat electrofishing resulted in greater sampling effort per sample and yielded more overall species on average than did beach seining. Thus this deviation from the study plan did not likely impact the study's ability to detect fish species.

Table 5.0-1: Comparison of Beach Seining to Electrofishing in Seining –Type Shorelines

Station	Distance Sampled	No. of Species
77.6-S	200 ft	4
70.1-VS	420 ft	6
82.1-VS	984 ft	14
78.2-VS	675 ft	1
71.1-VS	482 ft	6
69.6-VS	607 ft	5

6 LITERATURE CITED

Bonar, S.A., Hubert, W.A., & Willis, D.W. (Eds.). (2009). *Standard methods for sampling North American freshwater fishes*. Bethesda, MD: American Fisheries Society.

Coble, D.W. (1975). Smallmouth bass. In R.H. and H. Clepper (Eds.), *Black bass biology and management: National Symposium on the Biology and Management of the Centrarchid Basses, Tulsa, Oklahoma* (pp. 21-33). Washington DC: Sport Fishing Inst.

Heidinger, R.C. (1975). Life history and biology of the largemouth bass. In R.H. and H. Clepper (Eds.), *Black bass biology and management: National Symposium on the Biology and Management of the Centrarchid Basses*, Tulsa, Oklahoma (pp. 11-20). Washington DC: Sport Fishing Inst.

Midwest Biodiversity Institute (2014). Unpublished data. Electrofishing data Holyoke MA to Vernon, VT. Columbus, OH: Author.

Massachusetts Division of Fisheries and Game (MDFG). (1978). Northfield Mountain pumped storage hydroelectric project. Resident fish study, 1971-1976. Final report to Northeast Utilities Service Co. Berlin, CT: Author.

R Foundation. (2015). R: A Language and Environment for Statistical Computing. Vienna, Austria. Retrieved January 11, 2016 from https://www.r-project.org/foundation/.

Rankin, E. T. (1995). Habitat Indices in Water Resource Quality Assessments. In W. Davis and T. Simon (Eds.), Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making (pp. 181-208). Boca Raton, FL: Lewis Publishers.

Rankin, E. T. (1989). *The qualitative habitat evaluation index (QHEI), rationale, methods, and application*. Columbus, OH: Ohio EPA, Division of Water Quality Planning and Assessment, Ecological Assessment Section.

Scott W.B. & Crossman, E.J. (1973). *Freshwater fishes of Canada*. Bull. 184. Ottawa, CA: Fisheries Research Board of Canada. 966 pp.

Trial, J.G., Wade, C.S., Stanley, J.G., & Nelson, P.C. (1983). Habitat Suitability information: fallfish (FWS/OBS-82/10.48). Washington, DC: USFWS.

Yoder, C.O. (2002). Quality assurance project plan: fish assemblage assessment of the Kennebec River mainstem, Bingham to Merrymeeting Bay, Maine. Columbus, OH: Midwest Biodiversity Institute.

Yoder, C.O., Hersha, L.E., & Apell, B. (2010). Fish assemblage and habitat assessment of the Upper Connecticut River: preliminary results and data presentation. Final Project Report to: U.S. EPA, Region 1, Boston, MA. Center for Applied Bioassessment & Biocriteria. Columbus, OH: Midwest Biodiversity Institute.

Yoder, C.O. & Kulik, B. (2003). The development and application of multimetric indices for the assessment of impacts to fish assemblages in large rivers: a review of current science and applications. *Canadian Water Resources Journal*, *28*, 301-328.

APPENDIX A –
TURNERS FALLS IMPOUNDMENT FISH ASSEMBLAGE STUDY SAMPLING PLAN

1 INTRODUCTION

The goal of this study is to provide baseline information pertaining to the fish assemblage structure within the study area. The study area includes the Connecticut River from Vernon Dam to the Cabot Tailwater. Sampling methods include boat electrofishing, gill nets, and seine nets. Sampling will be performed during the early summer (June) and again in the fall (September).

Early summer sampling will be restricted to the impoundment to avoid potential impacts to shortnose sturgeon in the remainder of the study area. The purpose of this memo is to document the sampling plan for the Turners Falls impoundment. A separate sampling plan will be developed for the bypass reach.
As dictated by the study plan, a stratified-random sampling design is utilized; sub-strata in the Turners Falls Impoundment were derived from bathymetry data, because the impoundment contains areas with relatively deep water. Data will be collected primarily by boat electrofishing and supplemented by experimental gill net sets in areas too deep for electrofishing (such as deep channels and scour pools), and by beach seine in suitable shoal areas too shallow for boat electrofishing.

2 SAMPLING PLAN

Boat Electrofishing

Electrofishing will be conducted in a downstream manner, following standardized methods developed specifically for large river quantitative electrofishing surveys (MBI, 2002, Yoder and Kulik, 2003). The start point, end point, and boat track for each sampling station will be geo-referenced using a handheld GPS instrument. MBI (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".*

The Turners Falls impoundment geomorphology varies, with a lengthy, shallow, upper portion from the upstream end of the impoundment (approximately 13 miles) to the Northfield Mountain intake that is relatively riverine, with only a few pronounced bends. Much of the shoreline in the upper impoundment reaches is relatively barren of optimal cover and substrates. However there are several river bends with stretches of rich, suitable substrate (*i.e.* gravel/cobble/ boulder), object cover or vegetation for a sufficient linear distance of shoreline that will attract a diverse species assemblage. Downstream from Northfield Mountain, the impoundment enters an approximately 5.4 miles reach of much richer habitat, including bedrock-controlled, diverse shoreline areas with outside bends, weed beds, varied substrates, a deep channel, partially embayed geometry and abundant cover.

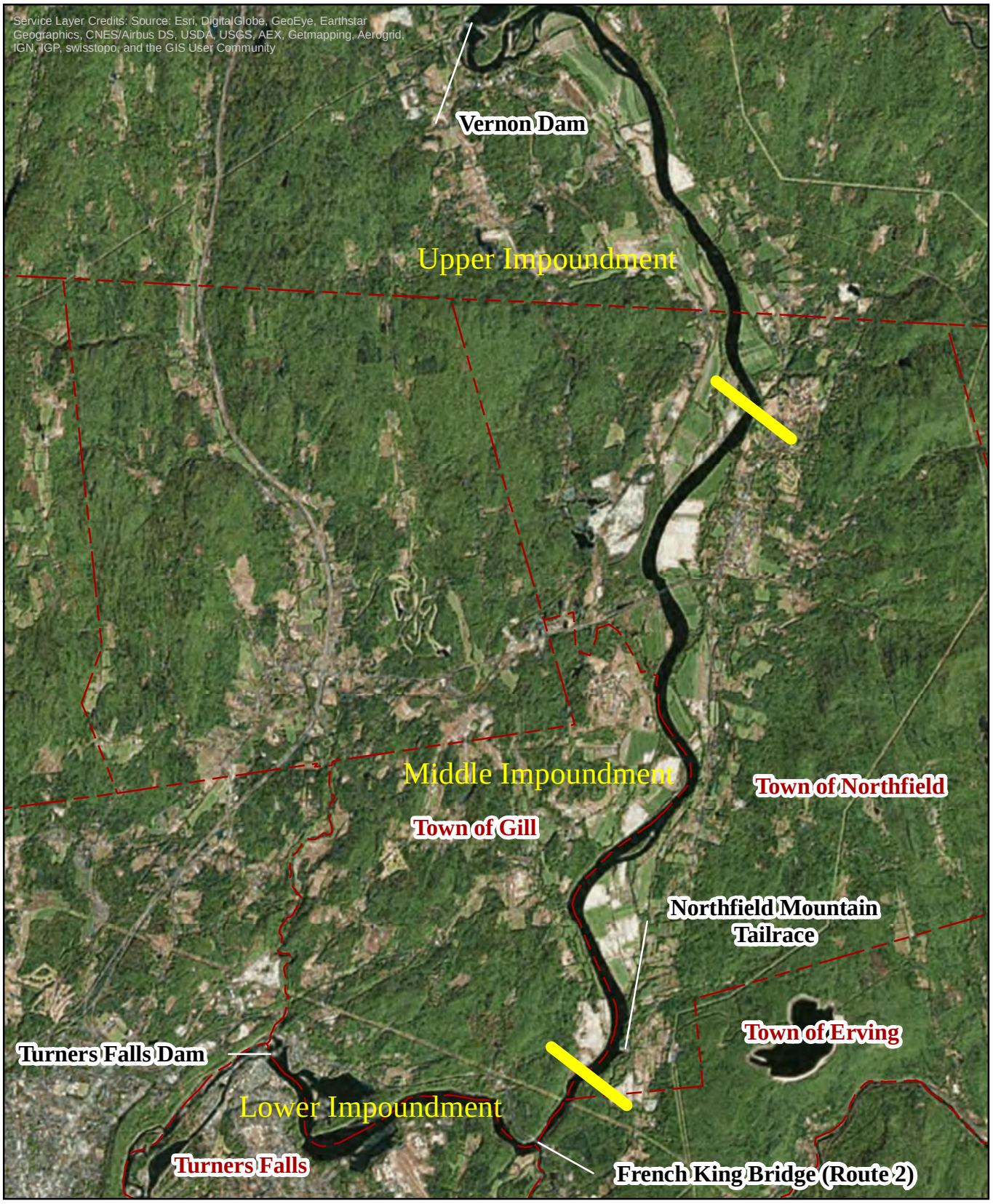
From a strictly bathymetric perspective there are essentially two strata. However due to the relatively long impoundment reach above Northfield Mountain, the upstream reach is further stratified into "*upper*" and "*middle*" sub-strata, to provide better survey resolution and to potentially distinguish "transition zone" habitat/assemblage responses associated with the semi-riverine upstream extremity of the impoundment (Figure A-1).

Table 1 and Figure A-2 depict the distribution of qualifying rich-habitat electrofishing stations in each of the three strata. A total of 17 candidate rich-habitat electrofishing stations are available, with four, four, and nine stations in the upper, middle and lower strata, respectively. For each of the two sampling events, two stations will be selected at random from each stratum for electrofishing sampling. Additionally, a minimum of two 0.5 km stations will be selected at random from the remainder of the shorelines within each stratum.

Table 1. Candidate boat electrofishing stations in the Turners Falls Project Impoundment

Mesohabitat stratum	Station *(rivermile)*[2]	Description
Upper impoundment	87.0	Vernon tailwater transition zone
Upper impoundment	85.5	Transition zone, boulder & riprap shoreline
Upper impoundment	84.3	Cobble and scattered woody debris
Upper impoundment	82.0	Cobble and scattered woody debris
Middle Impoundment	80.1	Cobble and scattered woody debris, submerged aquatic vegetation
Middle Impoundment	77.0	Cobble and gravel, submerged aquatic vegetation
Middle Impoundment	76.2	Rip rap on river left bank along Kidd's Island
Middle Impoundment	73.9	Cobble and boulder, upstream from Northfield Mountain intake
Lower Impoundment	72.9	Bedrock and boulder in upper French King gorge
Lower Impoundment	71.8	Bedrock and scattered woody debris
Lower Impoundment	71.2	Bedrock and scattered woody debris
Lower Impoundment	70.5	Emergent and submergent vegetation bed
Lower Impoundment	69.9	submergent vegetation bed
Lower Impoundment	69.0	Cobble and woody debris
Lower Impoundment	68.8A	Submergent vegetation bed between island and shoreline
Lower Impoundment	68.8B	Riprap and cobble in Barton's Cove

[2] Based on rivermile convention established in the MBI 2008 Connecticut River IBI survey (Yoder, *et al.*, 2009)



FirstLight™
GDF SUEZ

Northfield Mountain Pumped Storage Project (No. 2485) and Turners Falls Hydroelectric Project (No. 1889)
Study No. 3.3.11
Fish Assemblages Assessment

N

0 0.75 1.5 3 Miles

Figure A-1. Turners Falls Impoundment Fish Assemblage Study Area

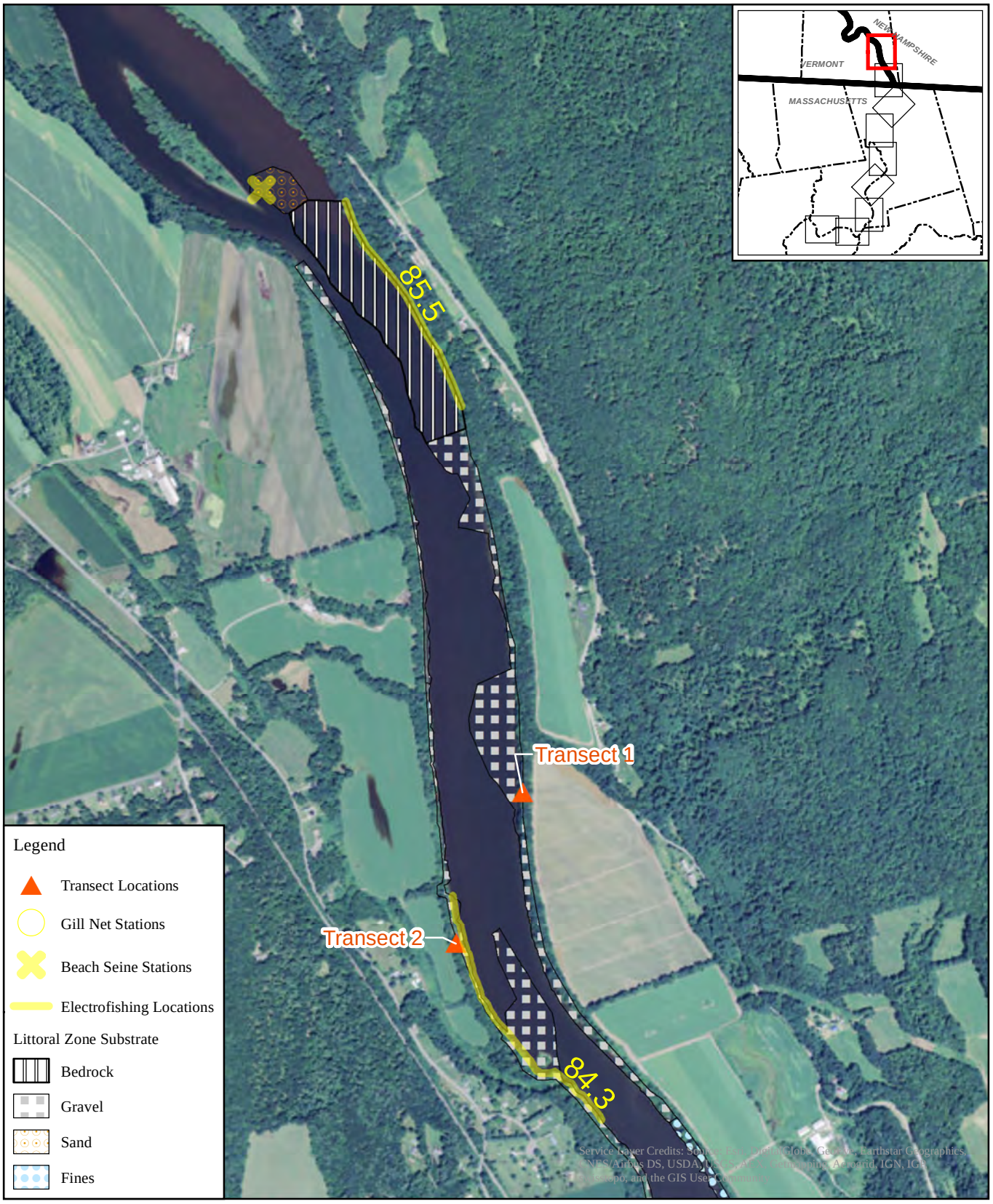
Path: W:\gis\studies\3_3_11\maps\Figure_A-1.mxd

Gill Net Sampling

Gill nets will be deployed to supplement electrofishing data at depths where electrofishing will not be effective. The nets will be deployed to maximize capture area where water depths are greater than net height. Figures 3-1-3 – 3.1.11 illustrate *potential* net set locations where known areas of suitable depth and cover exist. However, the exact locations of each net set will be determined based on field observations, and recorded using a handheld GPS device. In the upper impoundment stratum, there are relatively few deep areas, however there is a known deep scour hole (Figure3-1-2) which will be sampled. Most other suitable deep water gill net sampling areas are likely to occur in the lower impoundment stratum.

Beach Seine Sampling

Sampling will be performed in shallow shoreline locations where boat access is not be feasible and where safe wading is possible. Seining stations must also be free of debris and snags. Figures 3-1-3 – 3.1.11 indicate *potential* seining stations, however these may vary depending on field conditions. This will be determined based on field observations, and the exact locations of each seine haul recorded using a handheld GPS device.



FirstLight™
GDF SUEZ

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

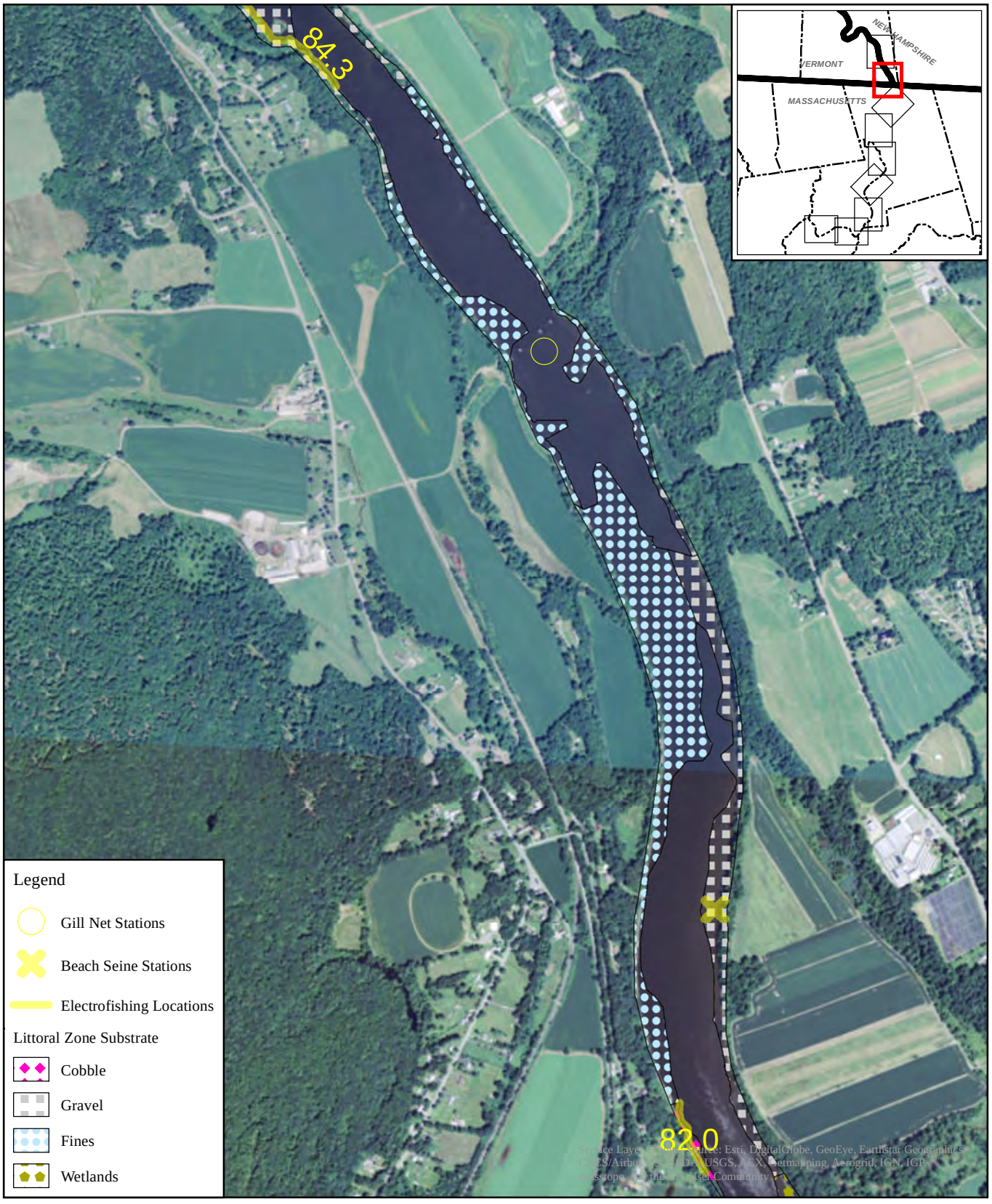
Study No. 3.3.11
Fish Assemblages
Assessment

N

0 500 1,000 2,000 Feet

Figure A-2, Page 1
Distribution of qualifying rich-habitat electrofishing stations

Path: W:\gis\studies\3_3_11\maps\Figure_A-2.mxd



FirstLight™
GDF SUEZ

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

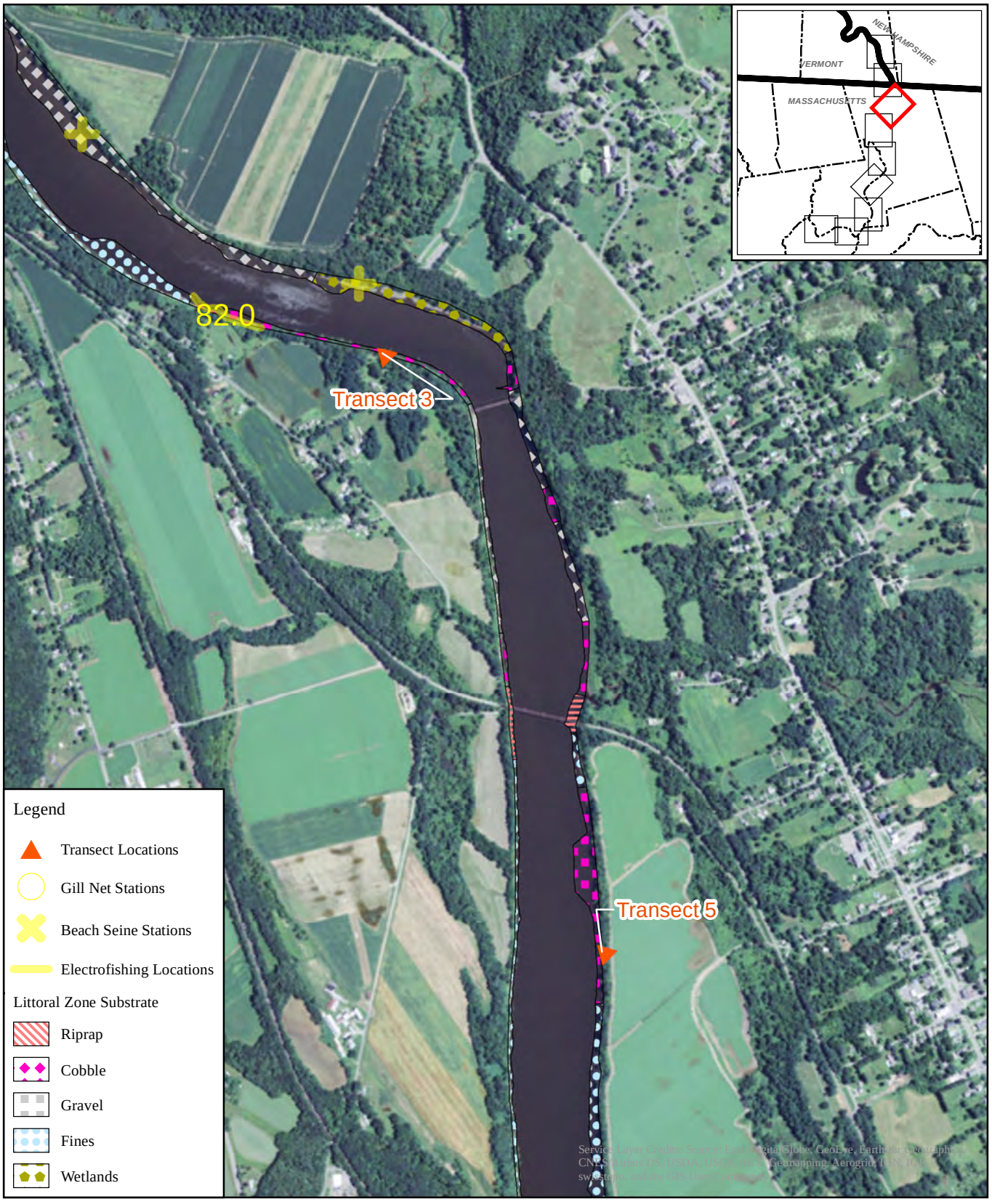
Study No. 3.3.11
Fish Assemblages
Assessment

N

0 500 1,000 2,000
Feet

Figure A-2, Page 2
Distribution of qualifying rich-habitat electrofishing stations

Path: W:\gis\studies\3_3_11\maps\Figure_A-2.mxd



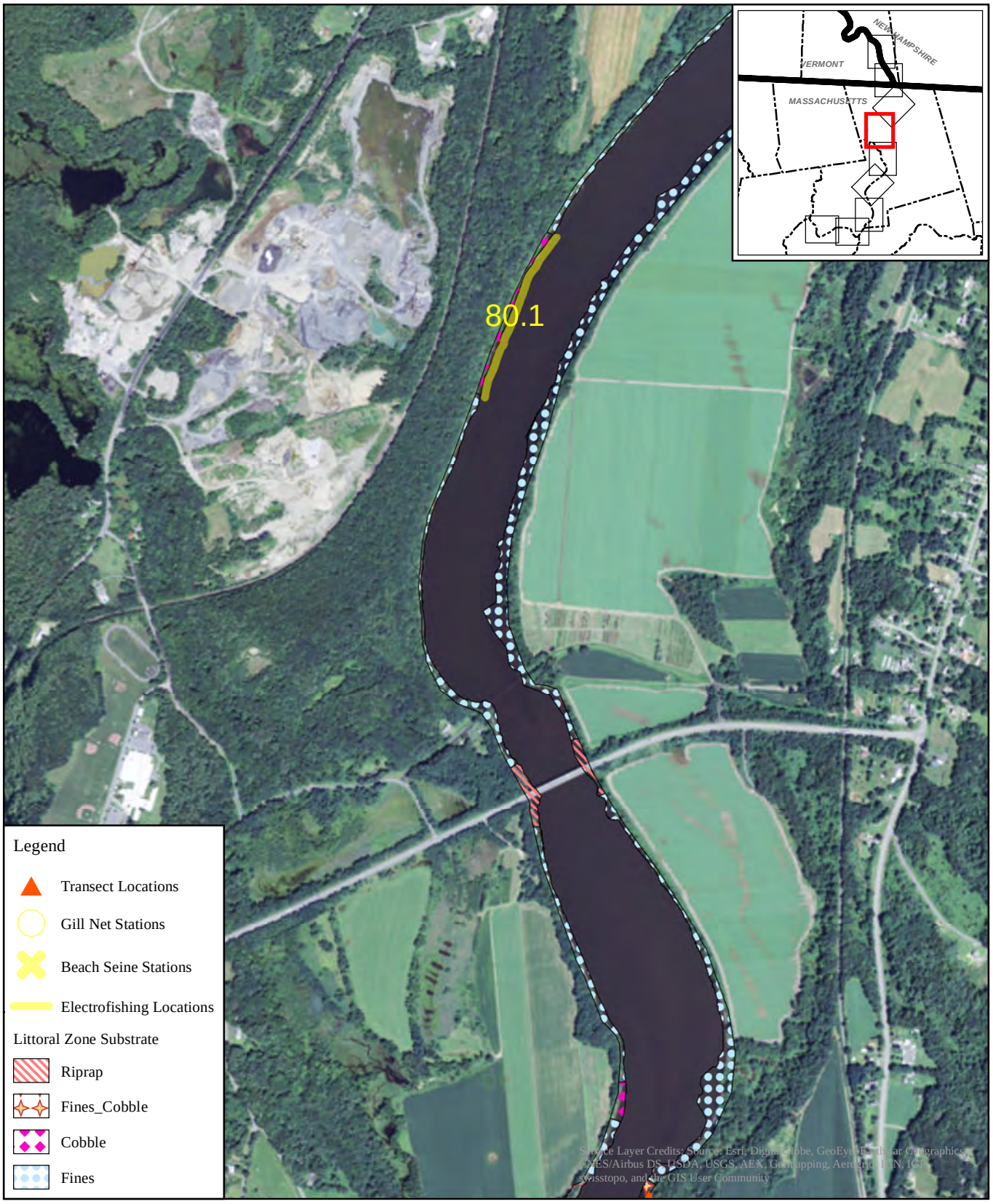
Northfield Mountain Pumped Storage Project (No. 2485) and Turners Falls Hydroelectric Project (No. 1889)

Study No. 3.3.11
Fish Assemblages
Assessment

0 500 1,000 2,000 Feet

Figure A-2, Page 3
Distribution of qualifying rich-habitat electrofishing stations

Path: W:\gis\studies\3_3_11\maps\Figure_A-2.mxd



FirstLight™
GDF SUEZ

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

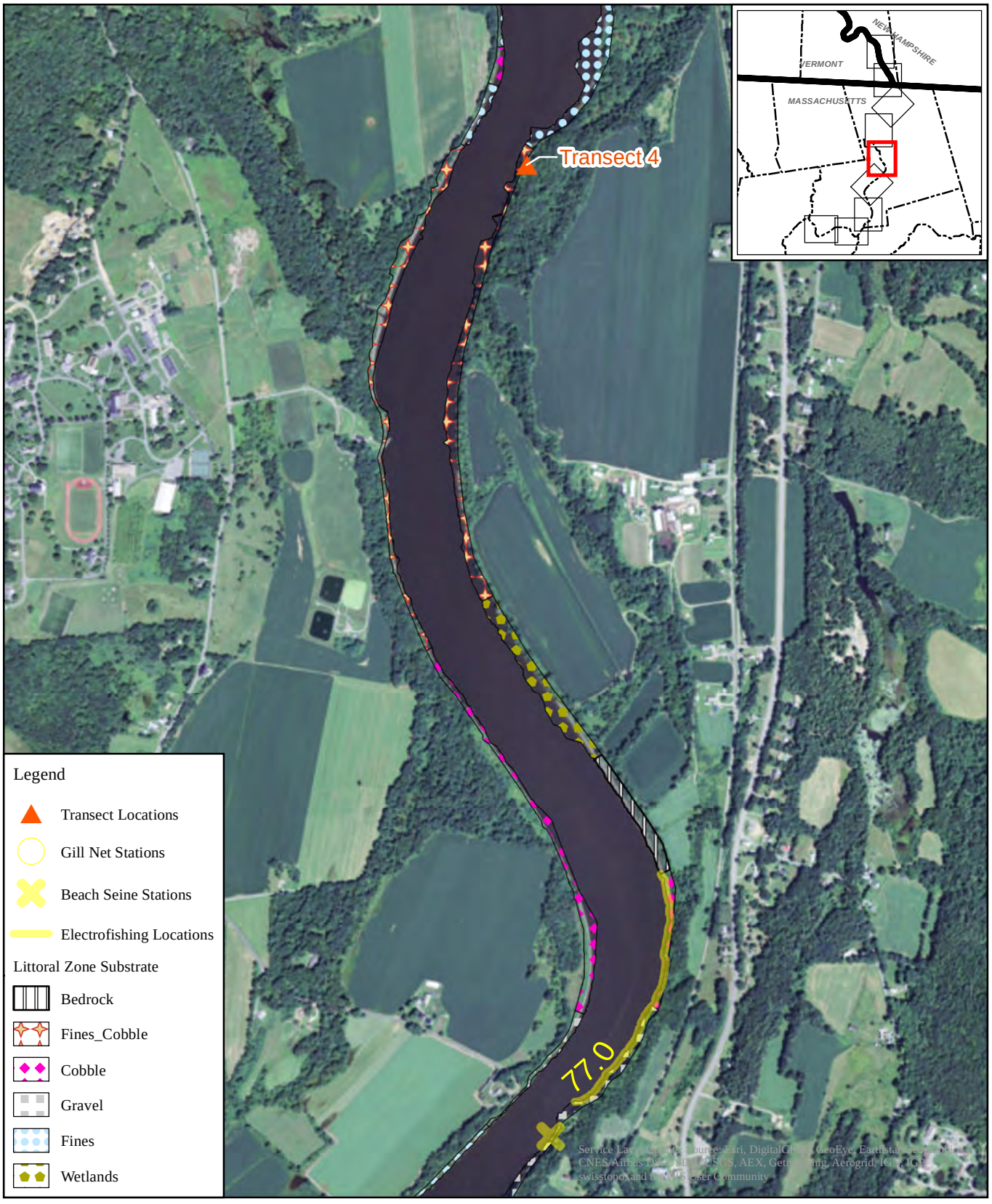
Study No. 3.3.11
Fish Assemblages
Assessment

N

0 500 1,000 2,000 Feet

Figure A-2, Page 4
Distribution of qualifying rich-habitat electrofishing stations

Path: W:\gis\studies\3_3_11\maps\Figure_A-2.mxd



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

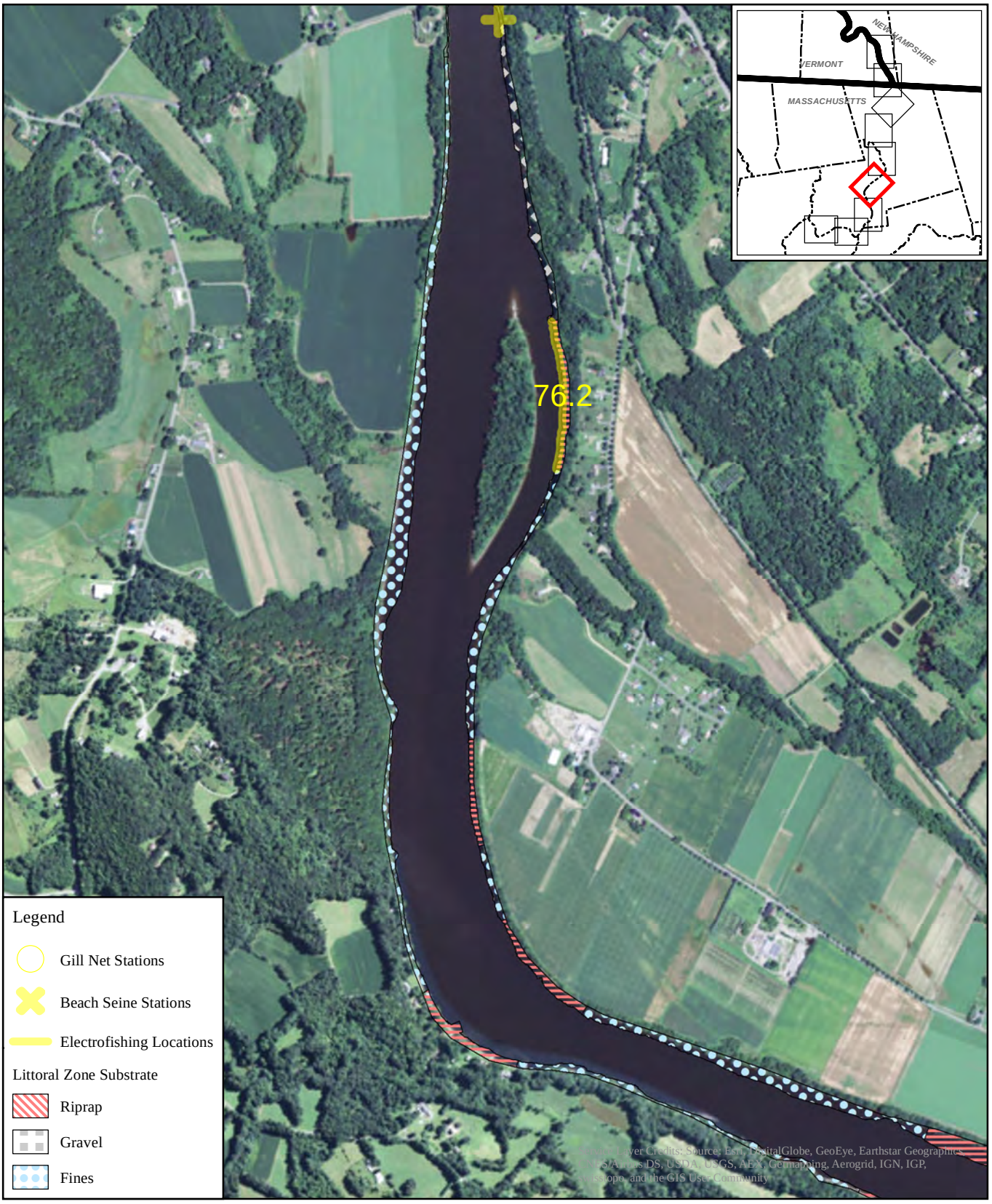
Study No. 3.3.11
Fish Assemblages
Assessment

N

0 500 1,000 2,000 Feet

Figure A-2, Page 5
Distribution of qualifying rich-habitat electrofishing stations

Path: W:\gis\studies\3_3_11\maps\Figure_A-2.mxd



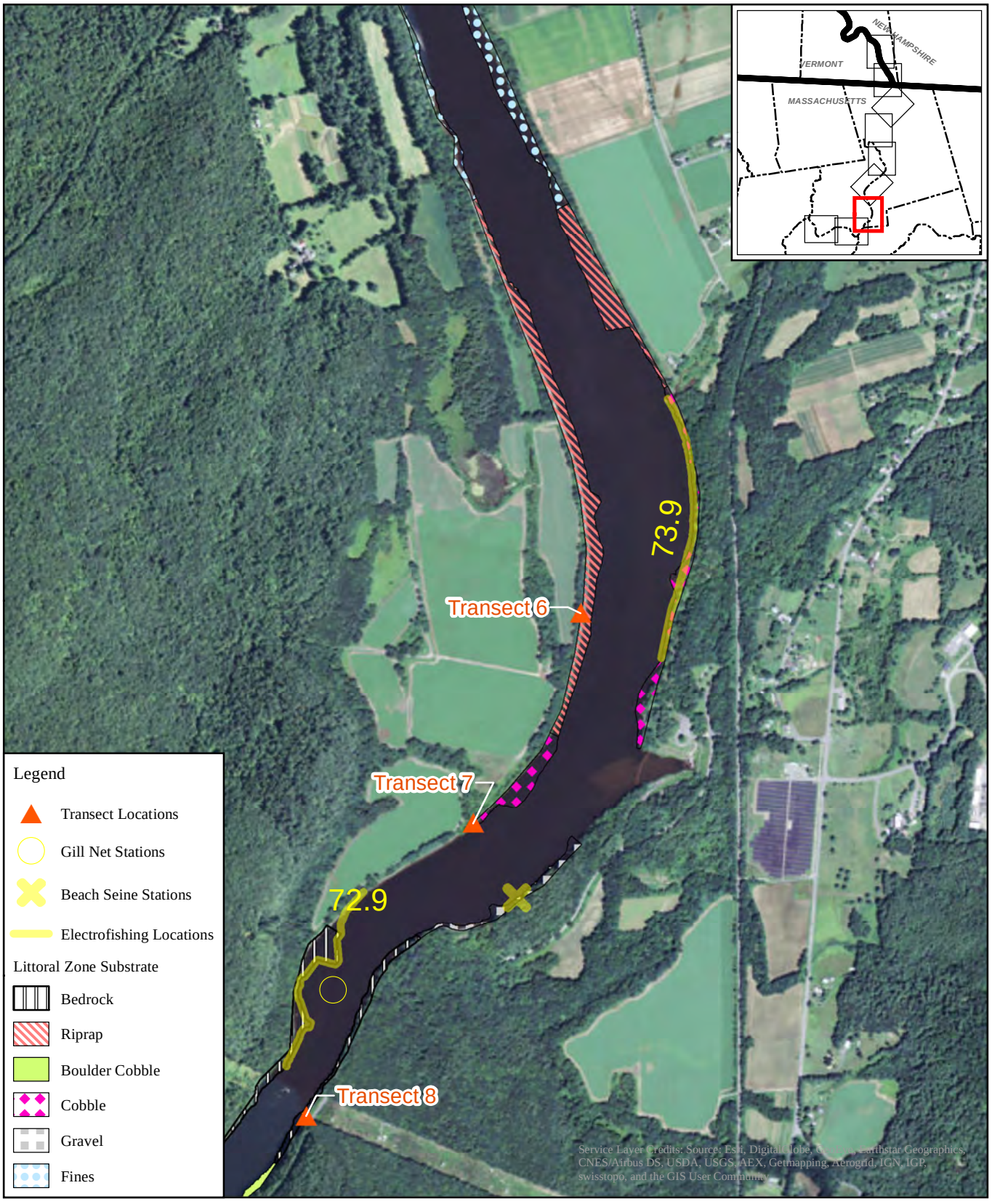
Northfield Mountain Pumped Storage Project (No. 2485) and Turners Falls Hydroelectric Project (No. 1889)

Study No. 3.3.11
Fish Assemblages
Assessment

0 500 1,000 2,000 Feet

Figure A-2, Page 6
Distribution of qualifying rich-habitat electrofishing stations

Path: W:\gis\studies\3_3_11\maps\Figure_A-2.mxd



FirstLight™
GDF SUEZ

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

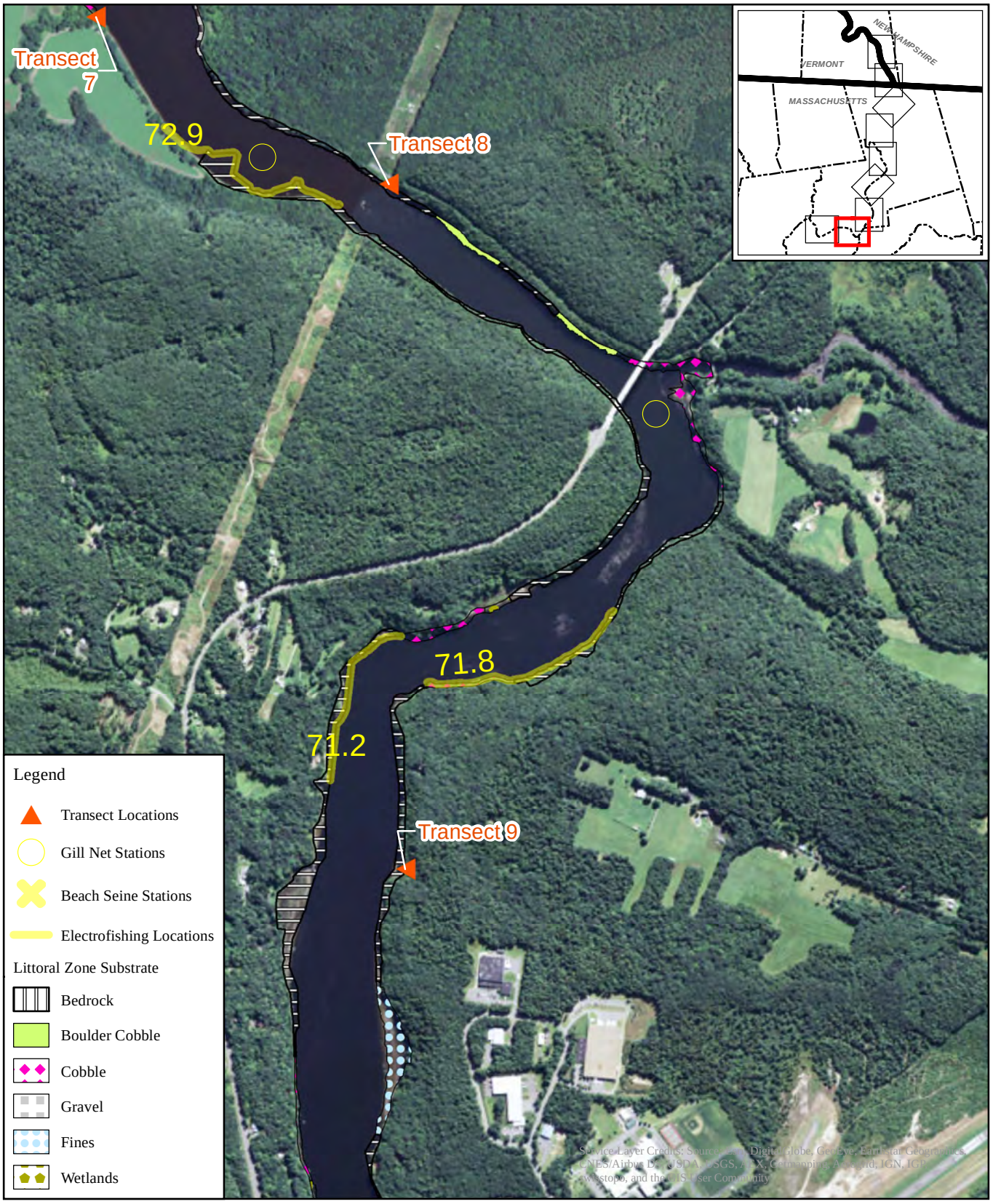
Study No. 3.3.11
Fish Assemblages
Assessment

N

0 500 1,000 2,000 Feet

Figure A-2, Page 7
Distribution of qualifying rich-habitat electrofishing stations

Path: W:\gis\studies\3_3_11\maps\Figure_A-2.mxd



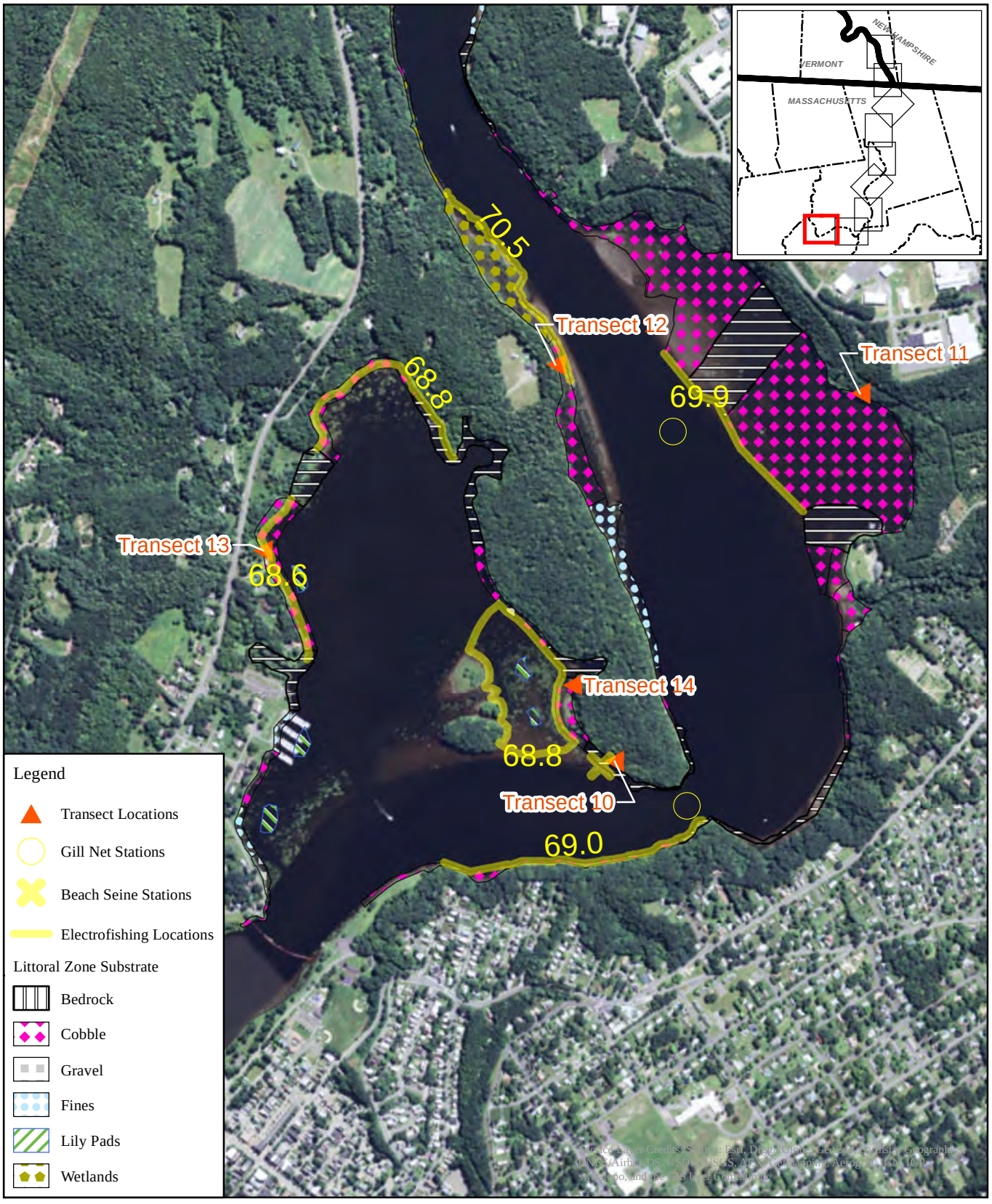
Northfield Mountain Pumped Storage Project (No. 2485) and Turners Falls Hydroelectric Project (No. 1889)

Study No. 3.3.11
Fish Assemblages Assessment

0 500 1,000 2,000 Feet

Figure A-2, Page 8
Distribution of qualifying rich-habitat electrofishing stations

Path: W:\gis\studies\3_3_11\maps\Figure_A-2.mxd



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

Study No. 3.3.11
Fish Assemblages Assessment

0 500 1,000 2,000 Feet

Figure A-2, Page 9
Distribution of qualifying rich-habitat electrofishing stations

Path: W:\gis\studies\3_3_11\maps\Figure_A-2.mxd

3 LITERATURE CITED

Midwest Biodiversity Institute. (2002). Quality assurance project plan: fish assemblage assessment of Maine and New England large rivers. Columbus, Ohio: MBI. 38 pp. plus appendices.

Yoder, C.O. & Kulik, B.H.. (2003). The development and application of multimetric indices for the assessment of impacts to fish assemblages in large rivers: a review of current science and applications. Canadian Water Res. Journal. 28(2):302-328.

Yoder, C.O., Hersha, L.E., & Apell, B. (2009). Fish assemblage and habitat assessment of the Upper Connecticut River: preliminary results and data presentation. Final Project Report to: U.S. EPA, Region 1, Boston, MA. Center for Applied Bioassessment & Biocriteria. Columbus, OH: Midwest Biodiversity Institute

APPENDIX B -
BOAT ELECTROFISHING SAMPLING TRACKS

FirstLight™ GDF SUEZ

N

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

Relicensing Study 3.3.11

0 0.5 1 2
Miles

Appendix B:
Sampling Tracks

Map Index

Path: W:\gis\studies\3_3_11\maps\Appendix_B_Overview.mxd

FirstLight™ GDF SUEZ

N

Northfield Mountain Pumped Storage Project (No. 2485)
and Turners Falls Hydroelectric Project (No. 1889)
Relicensing Study 3.3.11

0 0.05 0.1 0.2
Miles

Appendix B:
Sampling Tracks

Map 1

Path: W:\gis\studies\3_3_11\maps\Appendix_B.mxd

Start Point
85.5

85.5

Gill Net
85.5

End Point
85.5

Start Point
85.2

85.2

End Point
85.2

Legend

- Project Area
- End Point
- Gill Net
- Start Point
- Electro-fishing
- Virtual Seine

FirstLight™
GDF SUEZ

N

0 0.05 0.1 0.2
Miles

Northfield Mountain Pumped Storage Project (No. 2485)
and Turners Falls Hydroelectric Project (No. 1889)
Relicensing Study 3.3.11

Appendix B:
Sampling Tracks

Map 2

Path: W:\gis\studies\3_3_11\maps\Appendix_B.mxd

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

Relicensing Study 3.3.11

Appendix B:
Sampling Tracks

Map 3

0 0.05 0.1 0.2
Miles

Path: W:\gis\studies\3_3_11\maps\Appendix_B.mxd

Start Point
84.0

84.0

End Point
84.0

82.1

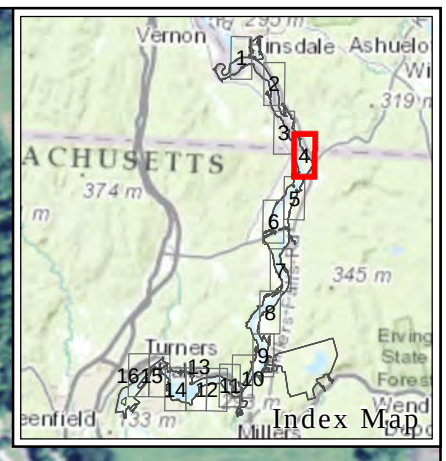
End Point
82.1

Start Point
82.0

82.0

End Point
82.0

Gill Net
81.6



Legend

- Project Area
- End Point
- Gill Net
- Start Point
- Electro-fishing
- Virtual Seine

FirstLight™
GDF SUEZ

N

Northfield Mountain Pumped Storage Project (No. 2485)
and Turners Falls Hydroelectric Project (No. 1889)
Relicensing Study 3.3.11

0 0.05 0.1 0.2
Miles

Appendix B:
Sampling Tracks

Map 4

Path: W:\gis\studies\3_3_11\maps\Appendix_B.mxd

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

Relicensing Study 3.3.11

Appendix B:
Sampling Tracks

Map 5

N

0 0.05 0.1 0.2
Miles

Path: W:\gis\studies\3_3_11\maps\Appendix_B.mxd

Start Point
80.1

80.1

80.1

End Point
80.1

Gill Net
79.1

Gill Net
79.1

Index Map

Legend

- Project Area
- End Point
- Gill Net
- Start Point
- Electro-fishing
- Virtual Seine

FirstLight
GDF SUEZ

N

0 0.05 0.1 0.2
Miles

Northfield Mountain Pumped Storage Project (No. 2485)
and Turners Falls Hydroelectric Project (No. 1889)
Relicensing Study 3.3.11

Appendix B:
Sampling Tracks

Map 6

Path: W:\gis\studies\3_3_11\maps\Appendix_B.mxd

Start Point
78.2

78.2

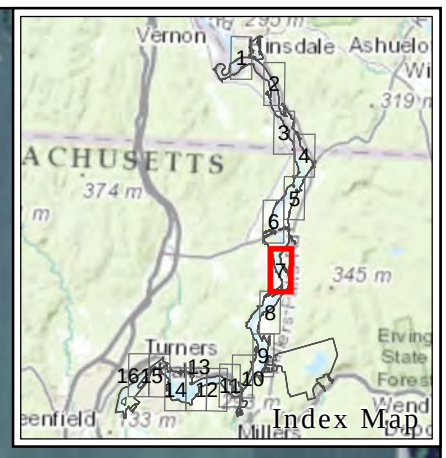
End Point
78.2

Seine Station
77.6

Start Point
77.0

77.0

End Point
77.0



Index Map

Legend

- Project Area
- End Point
- Seine Station
- Start Point
- Electro-fishing
- Virtual Seine

Northfield Mountain Pumped Storage Project (No. 2485)
and Turners Falls Hydroelectric Project (No. 1889)
Relicensing Study 3.3.11

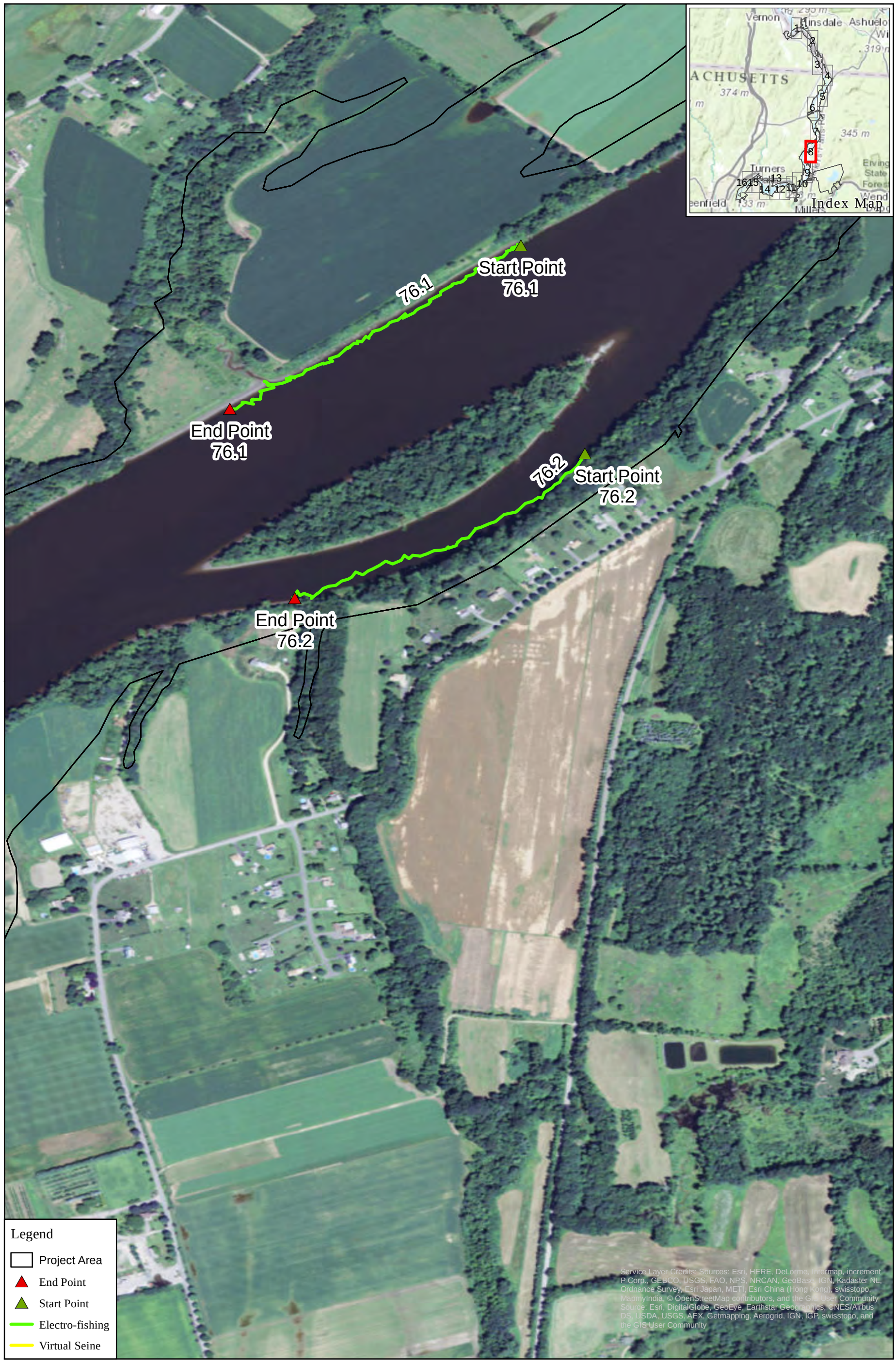
Appendix B:
Sampling Tracks

Map 7

N

0 0.05 0.1 0.2
Miles

Path: W:\gis\studies\3_3_11\maps\Appendix_B.mxd



Northfield Mountain Pumped Storage Project (No. 2485)
and Turners Falls Hydroelectric Project (No. 1889)
Relicensing Study 3.3.11

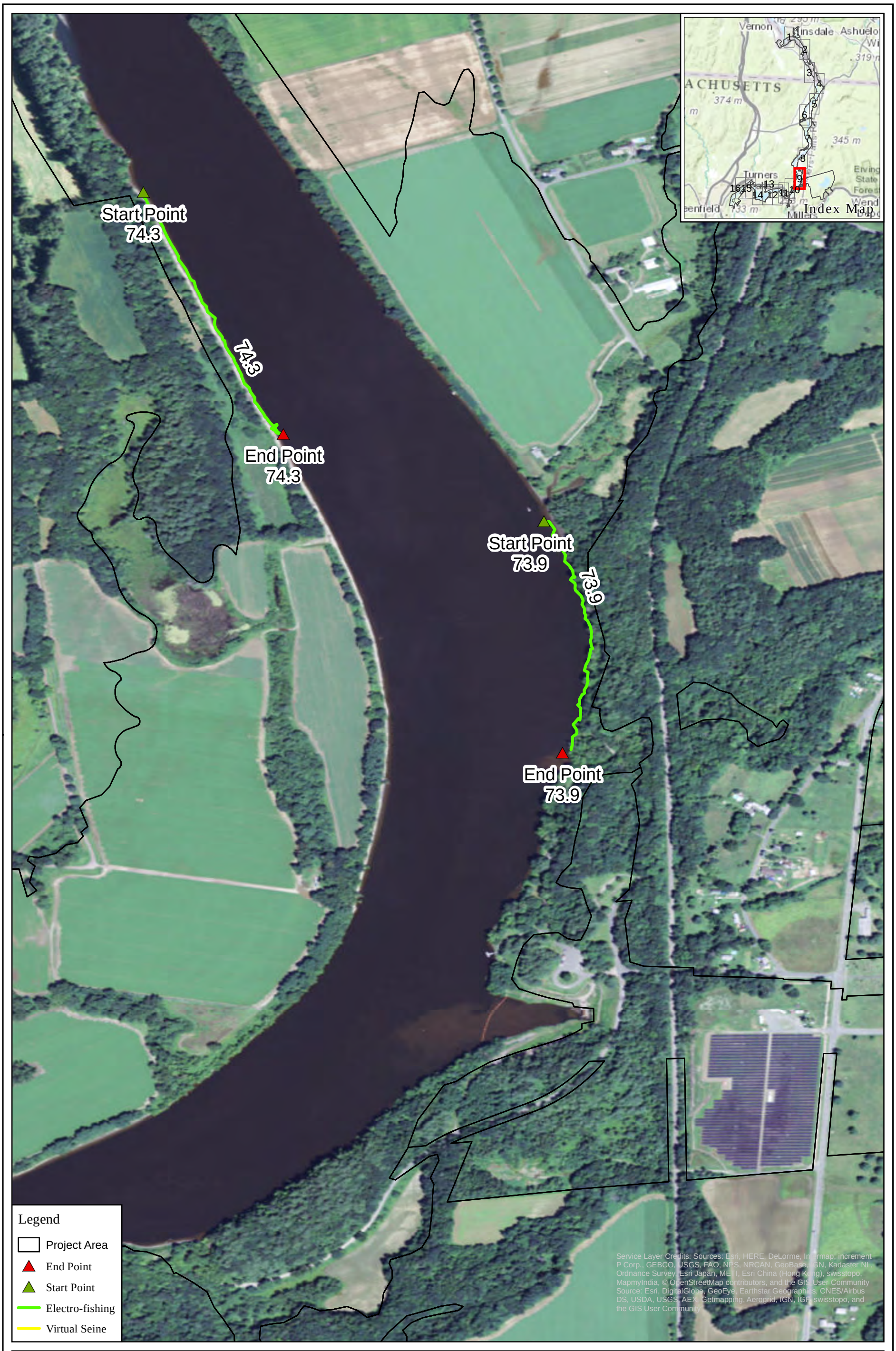
Appendix B:
Sampling Tracks

Map 8

N

0 0.05 0.1 0.2
Miles

Path: W:\gis\studies\3_3_11\maps\Appendix_B.mxd



FirstLight GDF SUEZ

N

Northfield Mountain Pumped Storage Project (No. 2485)
and Turners Falls Hydroelectric Project (No. 1889)
Relicensing Study 3.3.11

0 0.05 0.1 0.2
Miles

Appendix B:
Sampling Tracks

Map 9

Path: W:\gis\studies\3_3_11\maps\Appendix_B.mxd

FirstLight™ GDF SUEZ

N

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

Relicensing Study 3.3.11

0 0.05 0.1 0.2 Miles

Appendix B:
Sampling Tracks

Map 10

Path: W:\gis\studies\3_3_11\maps\Appendix_B.mxd

FirstLight™ GDF SUEZ

N

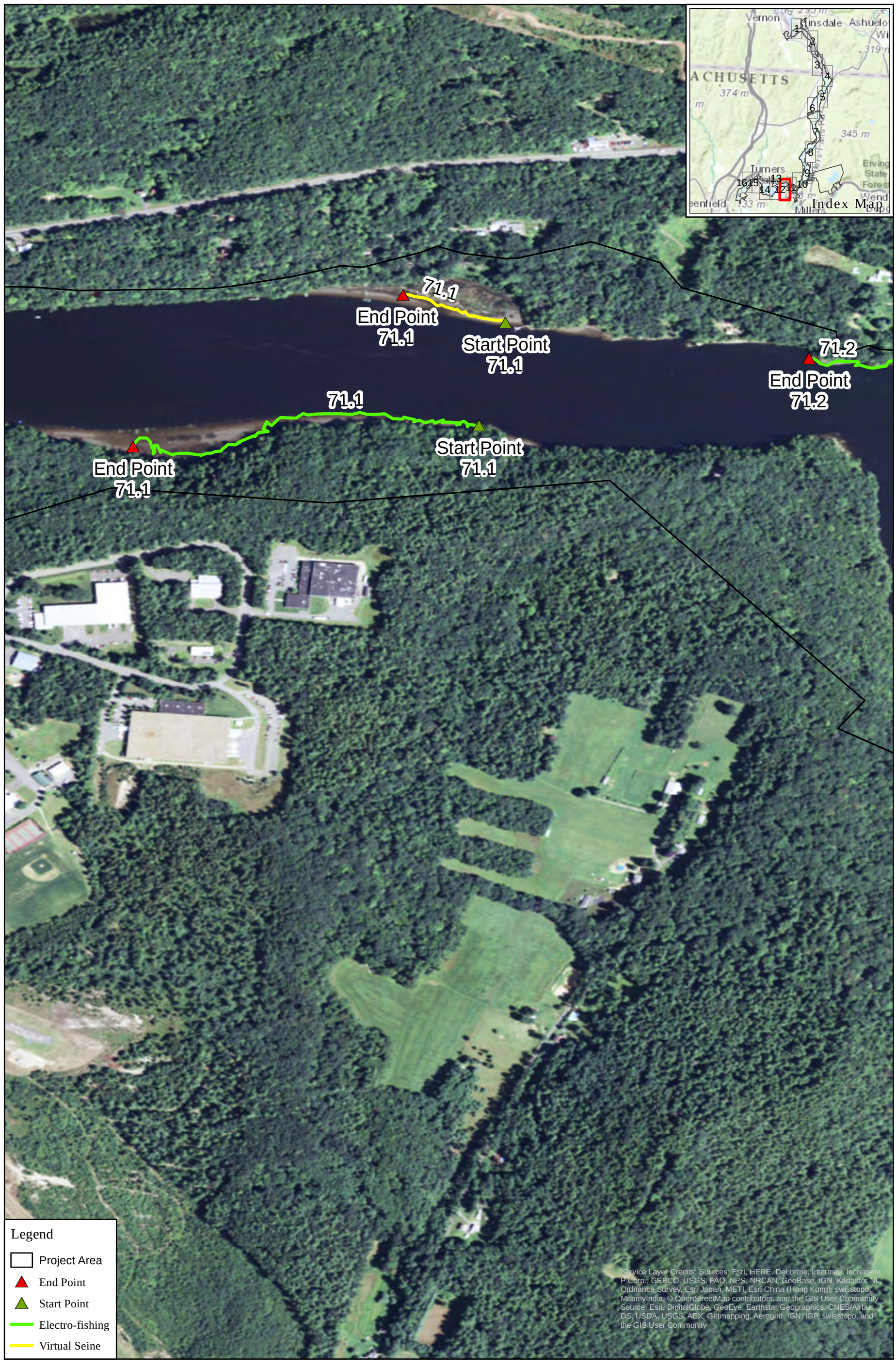
Northfield Mountain Pumped Storage Project (No. 2485)
and Turners Falls Hydroelectric Project (No. 1889)
Relicensing Study 3.3.11

0 0.05 0.1 0.2
Miles

Appendix B:
Sampling Tracks

Map 11

Path: W:\gis\studies\3_3_11\maps\Appendix_B.mxd



FirstLight™ GDF SUEZ

N

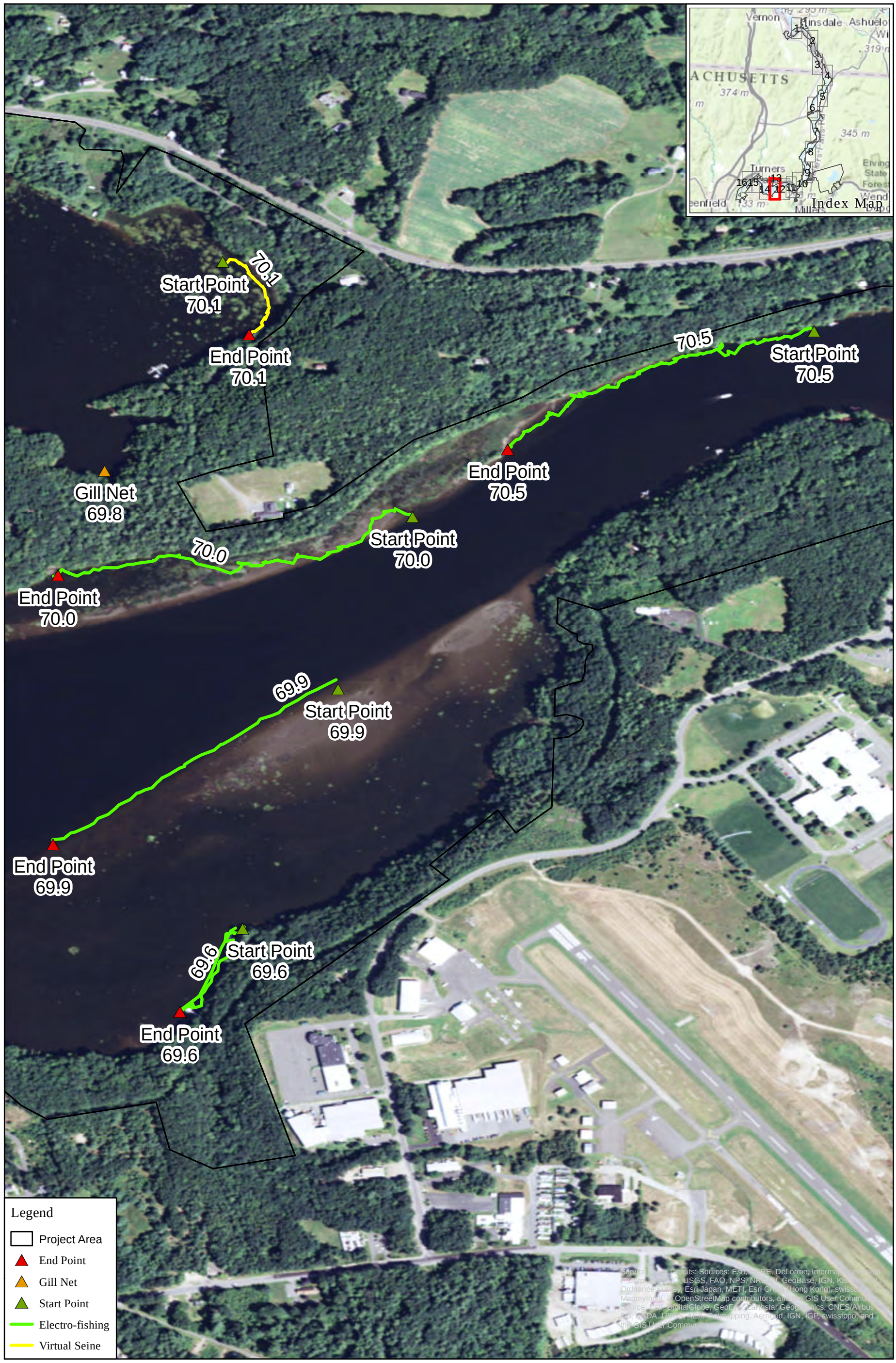
Northfield Mountain Pumped Storage Project (No. 2485)
and Turners Falls Hydroelectric Project (No. 1889)
Relicensing Study 3.3.11

0 0.05 0.1 0.2
Miles

Appendix B:
Sampling Tracks

Map 12

Path: W:\gis\studies\3_3_11\maps\Appendix_B.mxd



Northfield Mountain Pumped Storage Project (No. 2485)
and Turners Falls Hydroelectric Project (No. 1889)
Relicensing Study 3.3.11

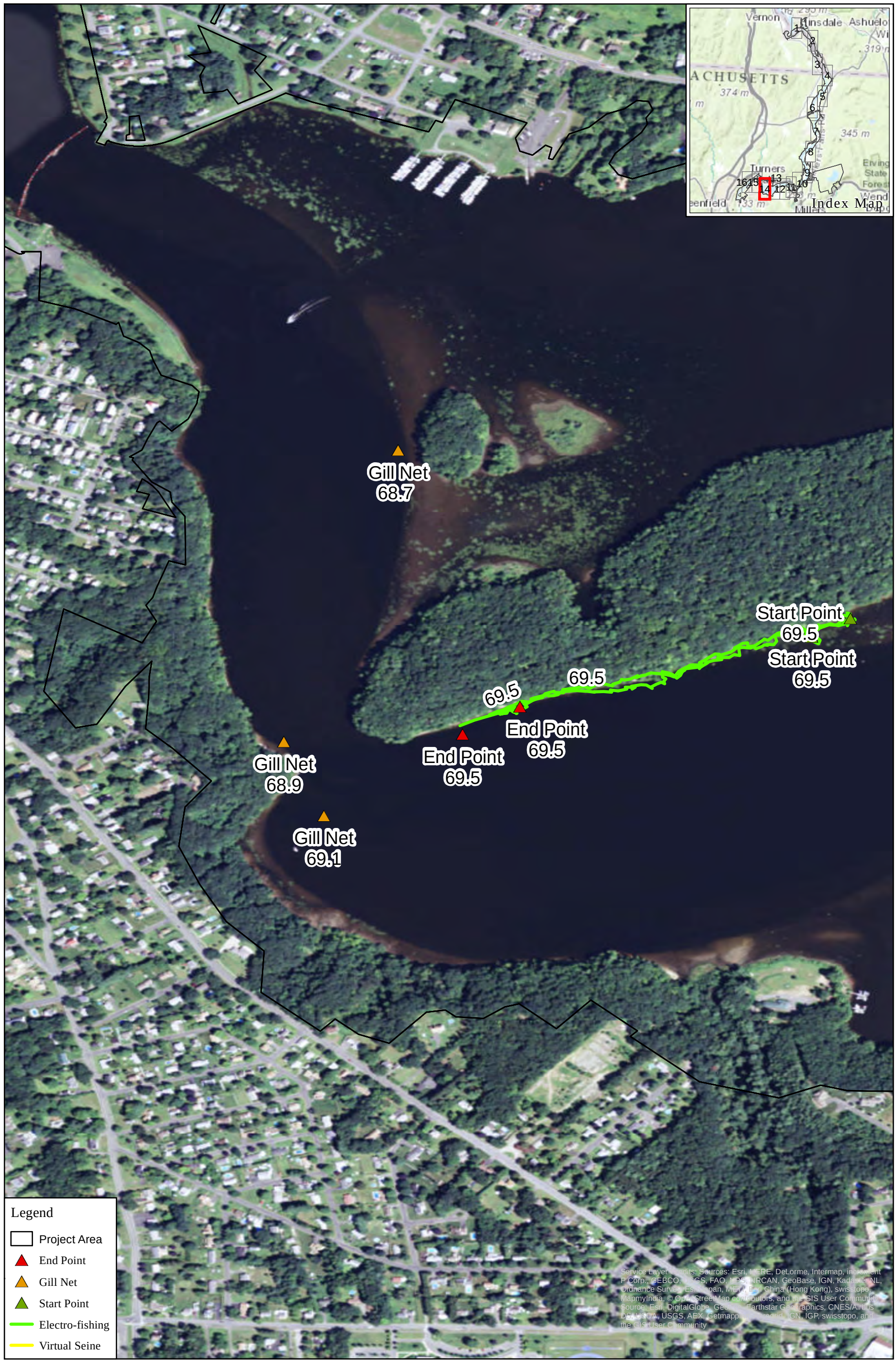
Appendix B:
Sampling Tracks

Map 13

N

0 0.05 0.1 0.2
Miles

Path: W:\gis\studies\3_3_11\maps\Appendix_B.mxd



FirstLight™ GDF SUEZ

N

Northfield Mountain Pumped Storage Project (No. 2485)
and Turners Falls Hydroelectric Project (No. 1889)
Relicensing Study 3.3.11

0 0.05 0.1 0.2
Miles

Appendix B:
Sampling Tracks

Map 14

Path: W:\gis\studies\3_3_11\maps\Appendix_B.mxd

Northfield Mountain Pumped Storage Project (No. 2485)
and Turners Falls Hydroelectric Project (No. 1889)
Relicensing Study 3.3.11

Appendix B:
Sampling Tracks

Map 15

N

0 0.05 0.1 0.2
Miles

Path: W:\gis\studies\3_3_11\maps\Appendix_B.mxd

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

Relicensing Study 3.3.11

Appendix B:
Sampling Tracks

Map 16

N

0 0.05 0.1 0.2
Miles

Path: W:\gis\studies\3_3_11\maps\Appendix_B.mxd

APPENDIX C -
DETAILED SAMPLING DATA

APPENDIX B

DETAILED SAMPLING DATA

Impoundment June-July 2015

STATION 85.5	Number of Individuals				CPUE by Distance (500m)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	25	16	9		0.05	0.032	0.018	0
Largemouth Bass	0				0	0	0	0
White Sucker	2	2			0.004	0.004	0	0
Yellow Perch	20	18	2		0.04	0.036	0.004	0
Spottail Shiner	52	40	12		0.104	0.08	0.024	0
Fallfish	15	1	14		0.03	0.002	0.028	0
Mimic Shiner	0				0	0	0	0
Golden Shiner	2		2		0.004	0	0.004	0
Common Shiner	0				0	0	0	0
American Eel	0				0	0	0	0
Walleye	2	2			0.004	0.004	0	0
Black Crappie	1				0.002	0	0	0
Rock Bass	11	6	5		0.022	0.012	0.01	0
Bluegill Sunfish	4	4			0.008	0.008	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			0.002	0.002	0	0
Brown Bullhead	0				0	0	0	0
Tessellated Darter	0				0	0	0	0
Sea Lamprey	1		1		0.002	0	0.002	0
American Shad	0				0	0	0	0
Common Carp	0				0	0	0	0
	136	90	45	0	0.272	0.18	0.09	0

84.5 Electrofishing	Number of Individuals				CPUE by Distance (500m)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	15	8	7		0.03	0.016	0.014	0
Largemouth Bass	0				0	0	0	0
White Sucker	4	4			0.008	0.008	0	0
Yellow Perch	5	2	3		0.01	0.004	0.006	0
Spottail Shiner	26	26			0.052	0.052	0	0
Fallfish	14	7	7		0.028	0.014	0.014	0
Mimic Shiner	1		1		0.002	0	0.002	0
Golden Shiner	0				0	0	0	0
Common Shiner	0				0	0	0	0
American Eel	2		2		0.004	0	0.004	0
Walleye	0				0	0	0	0
Black Crappie	0				0	0	0	0
Rock Bass	3	3			0.006	0.006	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		0.002	0	0.002	0
American Shad	1	1			0.002	0.002	0	0
Common Carp	0				0	0	0	0
	72	51	21	0	0.144	0.102	0.042	0

84.3 (Gill Net)	Number of Individuals				CPUE by Distance (100 ft)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	0	0	0	0	0	0	0	0
Largemouth Bass	0	0	0	0	0	0	0	0
White Sucker	0	0	0	0	0	0	0	0
Yellow Perch	0	0	0	0	0	0	0	0
Spottail Shiner	0	0	0	0	0	0	0	0
Fallfish	0	0	0	0	0	0	0	0
Mimic Shiner	0	0	0	0	0	0	0	0
Golden Shiner	0	0	0	0	0	0	0	0
Common Shiner	0	0	0	0	0	0	0	0
American Eel	0	0	0	0	0	0	0	0
Walleye	0	0	0	0	0	0	0	0
Black Crappie	0	0	0	0	0	0	0	0
Rock Bass	0	0	0	0	0	0	0	0
Bluegill Sunfish	0	0	0	0	0	0	0	0
Pumpkinseed Sunfish	0	0	0	0	0	0	0	0
Northern Pike	0	0	0	0	0	0	0	0
Chain Pickerel	0	0	0	0	0	0	0	0
Channel Catfish	0	0	0	0	0	0	0	0
Brown Bullhead	0	0	0	0	0	0	0	0
Tessellated Darter	0	0	0	0	0	0	0	0
Sea Lamprey	0	0	0	0	0	0	0	0
American Shad	0	0	0	0	0	0	0	0
Common Carp	0	0	0	0	0	0	0	0

84.3 Electrofishing	Number of Individuals				CPUE by Distance (500m)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	15	10	5		0.03	0.02	0.01	0
Largemouth Bass	0				0	0	0	0
White Sucker	0				0	0	0	0
Yellow Perch	3	2	1		0.006	0.004	0.002	0
Spottail Shiner	4	2		2	0.008	0.004	0	0.004
Fallfish	4	1	3		0.008	0.002	0.006	0
Mimic Shiner	0				0	0	0	0
Golden Shiner	0				0	0	0	0
Common Shiner	0				0	0	0	0
American Eel	1		1		0.002	0	0.002	0
Walleye	2		2		0.004	0	0.004	0
Black Crappie	0				0	0	0	0
Rock Bass	2	2			0.004	0.004	0	0
Bluegill Sunfish	2	2			0.004	0.004	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	0				0	0	0	0
American Shad	0				0	0	0	0
Common Carp	0				0	0	0	0
	33	19	12	2	0.066	0.038	0.024	0.004

82.0 Electrofishing	Number of Individuals				CPUE by Distance (500m)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	25	11	14		0.05	0.022	0.028	0
Largemouth Bass					0	0	0	0
White Sucker	4	3	1		0.008	0.006	0.002	0
Yellow Perch	6	3	3		0.012	0.006	0.006	0
Spottail Shiner	27	27			0.054	0.054	0	0
Fallfish	14	12	2		0.028	0.024	0.004	0
Mimic Shiner	6	6			0.012	0.012	0	0
Golden Shiner					0	0	0	0
Common Shiner					0	0	0	0
American Eel	1		1		0.002	0	0.002	0
Walleye	1		1		0.002	0	0.002	0
Black Crappie	1	1			0.002	0.002	0	0
Rock Bass	3	3			0.006	0.006	0	0
Bluegill Sunfish					0	0	0	0
Pumpkinseed Sunfish					0	0	0	0
Northern Pike	1	1			0.002	0.002	0	0
Chain Pickerel	1	1			0.002	0.002	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	0.18	0.136	0.044	0

81.3 (Gill Net)	Number of Individuals				CPUE by Distance (100 ft)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	0	0	0	0	0	0	0	0
Largemouth Bass	0	0	0	0	0	0	0	0
White Sucker	0	0	0	0	0	0	0	0
Yellow Perch	0	0	0	0	0	0	0	0
Spottail Shiner	0	0	0	0	0	0	0	0
Fallfish	0	0	0	0	0	0	0	0
Mimic Shiner	0	0	0	0	0	0	0	0
Golden Shiner	0	0	0	0	0	0	0	0
Common Shiner	0	0	0	0	0	0	0	0
American Eel	0	0	0	0	0	0	0	0
Walleye	0	0	0	0	0	0	0	0
Black Crappie	0	0	0	0	0	0	0	0
Rock Bass	0	0	0	0	0	0	0	0
Bluegill Sunfish	0	0	0	0	0	0	0	0
Pumpkinseed Sunfish	0	0	0	0	0	0	0	0
Northern Pike	0	0	0	0	0	0	0	0
Chain Pickerel	0	0	0	0	0	0	0	0
Channel Catfish	0	0	0	0	0	0	0	0
Brown Bullhead	0	0	0	0	0	0	0	0
Tessellated Darter	0	0	0	0	0	0	0	0
Sea Lamprey	0	0	0	0	0	0	0	0
American Shad	0	0	0	0	0	0	0	0
Common Carp	0	0	0	0	0	0	0	0

80.1 Electrofishing	Number of Individuals				CPUE by Distance (500m)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	20	8	11	1	0.04	0.016	0.022	0
Largemouth Bass	0				0	0	0	0
White Sucker	6	4	1	1	0.012	0.008	0.002	0
Yellow Perch	8	2	6		0.016	0.004	0.012	0
Spottail Shiner	54	54			0.108	0.108	0	0
Fallfish	19	11	8		0.038	0.022	0.016	0
Mimic Shiner	0				0	0	0	0
Golden Shiner	0				0	0	0	0
Common Shiner	0				0	0	0	0
American Eel	0				0	0	0	0
Walleye	3		3		0.006	0	0.006	0
Black Crappie	0				0	0	0	0
Rock Bass	1	1			0.002	0.002	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	0				0	0	0	0
American Shad	0				0	0	0	0
Common Carp	0				0	0	0	0
	111				0.222			

79.1 (Gill Net)	Number of Individuals				CPUE by Distance (100 ft)				CPUE/hr by Time (4.7 hrs)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**A**	**B**	**Y**
Smallmouth Bass	0											
Largemouth Bass	0											
White Sucker	0											
Yellow Perch	0											
Spottail Shiner	0											
Fallfish	0											
Mimic Shiner	0											
Golden Shiner	0											
Common Shiner	0											
American Eel	0											
Walleye	0											
Black Crappie	0											
Rock Bass	0											
Bluegill Sunfish	0											
Pumpkinseed Sunfish	0											
Northern Pike	0											
Chain Pickerel	0											
Channel Catfish	1	1			0.01					0.21		
Brown Bullhead	0											
Tessellated Darter	0											
Sea Lamprey	0											
American Shad	0											
Common Carp	0											
	1				0.01				0			

77.6 (Beach Seine)	Number of Individuals				CPUE by Distance (200 ft)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	0				0	0	0	0
Largemouth Bass	0				0	0	0	0
White Sucker	277			277	0.18	0	0	0.179
Yellow Perch	1			1	0	0	0	6E-04
Spottail Shiner	1050	1050			0.68	0.68	0	0
Fallfish	1	1			0	0	0	0
Mimic Shiner	0				0	0	0	0
Golden Shiner	0				0	0	0	0
Common Shiner	7			7	0	0	0	0.005
American Eel	0				0	0	0	0
Walleye	0				0	0	0	0
Black Crappie	0				0	0	0	0
Rock Bass	0				0	0	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	4			4	0	0	0	0.003
Sea Lamprey	0				0	0	0	0
American Shad	0				0	0	0	0
Common Carp	0				0	0	0	0
	1340				0.86			

76.2 Electrofishing	Number of Individuals				CPUE by Distance (500 m)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	36	16	19	1	0.072	0.032	0.038	0.002
Largemouth Bass	0				0	0	0	0
White Sucker	1	1			0.002	0.002	0	0
Yellow Perch	1	1			0.002	0.002	0	0
Spottail Shiner	1	1			0.002	0.002	0	0
Fallfish	10	6	4		0.02	0.012	0.008	0
Mimic Shiner	0				0	0	0	0
Golden Shiner	1		1		0.002	0	0.002	0
Common Shiner	0				0	0	0	0
American Eel	0				0	0	0	0
Walleye	0				0	0	0	0
Black Crappie	0				0	0	0	0
Rock Bass	7	4	3		0.014	0.008	0.006	0
Bluegill Sunfish	1	1			0.002	0.002	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	12	11		1	0.024	0.022	0	0.002
Sea Lamprey	0				0	0	0	0
American Shad	0				0	0	0	0
Common Carp	0				0	0	0	0
	70				0.14			

74.3 Electrofishing	Number of Individuals				CPUE by Distance (500 m)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	38	11	27		0.076	0.022	0.054	0
Largemouth Bass	0				0	0	0	0
White Sucker	5	2	3		0.01	0.004	0.006	0
Yellow Perch	7	6	1		0.014	0.012	0.002	0
Spottail Shiner	8	8			0.016	0.016	0	0
Fallfish	7	4	3		0.014	0.008	0.006	0
Mimic Shiner	0				0	0	0	0
Golden Shiner	0				0	0	0	0
Common Shiner	0				0	0	0	0
American Eel	0				0	0	0	0
Walleye	1		1		0.002	0	0.002	0
Black Crappie	0				0	0	0	0
Rock Bass	2	1	1		0.004	0.002	0.002	0
Bluegill Sunfish	1	1			0.002	0.002	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	0				0	0	0	0
American Shad	0				0	0	0	0
Common Carp	0				0	0	0	0
	69				0.138			

73.9 Electrofishing	Number of Individuals				CPUE by Distance (500 m)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	17	6	11		0.034	0.012	0.022	0
Largemouth Bass	0				0	0	0	0
White Sucker	5	4	1		0.01	0.008	0.002	0
Yellow Perch	8	6	2		0.016	0.012	0.004	0
Spottail Shiner	1	1			0.002	0.002	0	0
Fallfish	1	1			0.002	0.002	0	0
Mimic Shiner	0				0	0	0	0
Golden Shiner	0				0	0	0	0
Common Shiner	0				0	0	0	0
American Eel	3	2	1		0.006	0.004	0.002	0
Walleye	0				0	0	0	0
Black Crappie	0				0	0	0	0
Rock Bass	5	2	3		0.01	0.004	0.006	0
Bluegill Sunfish	2	2			0.004	0.004	0	0
Pumpkinseed Sunfish	1	1			0.002	0.002	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	0				0	0	0	0
American Shad	0				0	0	0	0
Common Carp	1	1			0.002	0.002	0	0
	44				0.088			

72.9 Electrofishing	Number of Individuals				CPUE by Distance (500 m)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	39	16	23		0.078	0.032	0.046	0
Largemouth Bass	0				0	0	0	0
White Sucker	10	7	3		0.02	0.014	0.006	0
Yellow Perch	7	5	1	1	0.014	0.01	0.002	0.002
Spottail Shiner	3	2	0	1	0.006	0.004	0	0.002
Fallfish	0				0	0	0	0
Mimic Shiner	0				0	0	0	0
Golden Shiner	0				0	0	0	0
Common Shiner	0				0	0	0	0
American Eel	0				0	0	0	0
Walleye	0				0	0	0	0
Black Crappie	0				0	0	0	0
Rock Bass	14	3	11		0.028	0.006	0.022	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	1	1			0.002	0.002	0	0
Brown Bullhead	0				0	0	0	0
Tessellated Darter	0				0	0	0	0
Sea Lamprey	0				0	0	0	0
American Shad	0				0	0	0	0
Common Carp	0				0	0	0	0
	74				0.148			

71.1 Electrofishing	Number of Individuals				CPUE by Distance (500 m)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	2	2			0.004	0.004	0	0
Largemouth Bass	3	1		2	0.006	0.002	0	0.004
White Sucker	6	6			0.012	0.012	0	0
Yellow Perch	38	36	2		0.076	0.072	0.004	0
Spottail Shiner	290	290			0.58	0.58	0	0
Fallfish	2		2		0.004	0	0.004	0
Mimic Shiner	0				0	0	0	0
Golden Shiner	0				0	0	0	0
Common Shiner	0				0	0	0	0
American Eel	0				0	0	0	0
Walleye	5	5			0.01	0.01	0	0
Black Crappie	2	2			0.004	0.004	0	0
Rock Bass	0				0	0	0	0
Bluegill Sunfish	10	10			0.02	0.02	0	0
Pumpkinseed Sunfish	17	16	1		0.034	0.032	0.002	0
Northern Pike	0				0	0	0	0
Chain Pickerel	0				0	0	0	0
Channel Catfish	0				0	0	0	0
Brown Bullhead	1	1			0.002	0.002	0	0
Tessellated Darter	1	1			0.002	0.002	0	0
Sea Lamprey	0				0	0	0	0
American Shad	0				0	0	0	0
Common Carp	1	1			0.002	0.002	0	0
	378				0.756			

70.1 (*virtual seine*)	Number of Individuals				CPUE by Distance (128 m)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	0				0	0	0	0
Largemouth Bass	0				0	0	0	0
White Sucker	0				0	0	0	0
Yellow Perch	22	18	2	2	0.1719	0.141	0.016	0.016
Spottail Shiner	0				0	0	0	0
Fallfish	0				0	0	0	0
Mimic Shiner	0				0	0	0	0
Golden Shiner	1	1			0.0078	0.008	0	0
Common Shiner	0				0	0	0	0
American Eel	0				0	0	0	0
Walleye	0				0	0	0	0
Black Crappie	0				0	0	0	0
Rock Bass	0				0	0	0	0
Bluegill Sunfish	7	4	1	2	0.0547	0.031	0.008	0.016
Pumpkinseed Sunfish	6	6			0.0469	0.047	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	0				0	0	0	0
American Shad	0				0	0	0	0
Common Carp	1	1			0.0078	0.008	0	0
	37				0.2891			

69.9 Electrofishing	Number of Individuals				CPUE by Distance (500 m)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	0				0	0	0	0
Largemouth Bass	0				0	0	0	0
White Sucker	2	2			0.004	0.004	0	0
Yellow Perch	21	20	1		0.042	0.04	0.002	0
Spottail Shiner	2	2			0.004	0.004	0	0
Fallfish	0				0	0	0	0
Mimic Shiner	0				0	0	0	0
Golden Shiner	0				0	0	0	0
Common Shiner	0				0	0	0	0
American Eel	0				0	0	0	0
Walleye	0				0	0	0	0
Black Crappie	0				0	0	0	0
Rock Bass	0				0	0	0	0
Bluegill Sunfish	11	11			0.022	0.022	0	0
Pumpkinseed Sunfish	1	1			0.002	0.002	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	0				0	0	0	0
American Shad	0				0	0	0	0
Common Carp	0				0	0	0	0
	37				0.074			

69.8 (Gill Net)	Number of Individuals				CPUE by Distance (100 ft)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	0	0	0	0	0	0	0	0
Largemouth Bass	0	0	0	0	0	0	0	0
White Sucker	0	0	0	0	0	0	0	0
Yellow Perch	0	0	0	0	0	0	0	0
Spottail Shiner	0	0	0	0	0	0	0	0
Fallfish	0	0	0	0	0	0	0	0
Mimic Shiner	0	0	0	0	0	0	0	0
Golden Shiner	0	0	0	0	0	0	0	0
Common Shiner	0	0	0	0	0	0	0	0
American Eel	0	0	0	0	0	0	0	0
Walleye	0	0	0	0	0	0	0	0
Black Crappie	0	0	0	0	0	0	0	0
Rock Bass	0	0	0	0	0	0	0	0
Bluegill Sunfish	0	0	0	0	0	0	0	0
Pumpkinseed Sunfish	0	0	0	0	0	0	0	0
Northern Pike	0	0	0	0	0	0	0	0
Chain Pickerel	0	0	0	0	0	0	0	0
Channel Catfish	0	0	0	0	0	0	0	0
Brown Bullhead	0	0	0	0	0	0	0	0
Tessellated Darter	0	0	0	0	0	0	0	0
Sea Lamprey	0	0	0	0	0	0	0	0
American Shad	0	0	0	0	0	0	0	0
Common Carp	0	0	0	0	0	0	0	0

69.6 (V*irtual Seine*)	Number of Individuals				CPUE by Distance (185 m)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	0				0	0	0	0
Largemouth Bass	2			2	0.0108	0	0	0.0108
White Sucker	0				0	0	0	0
Yellow Perch	23	21	1	1	0.1243	0.1135	0.0054	0.0054
Spottail Shiner	25	25			0.1351	0.1351	0	0
Fallfish	0				0	0	0	0
Mimic Shiner	0				0	0	0	0
Golden Shiner	0				0	0	0	0
Common Shiner	0				0	0	0	0
American Eel	0				0	0	0	0
Walleye	1	1			0.0054	0.0054	0	0
Black Crappie	0				0	0	0	0
Rock Bass	0				0	0	0	0
Bluegill Sunfish	4	4			0.0216	0.0216	0	0
Pumpkinseed Sunfish	7	7			0.0378	0.0378	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	0				0	0	0	0
American Shad	0				0	0	0	0
Common Carp	0				0	0	0	0
	62				0.3351			

69.5 Electrofishing	Number of Individuals				CPUE by Distance (500 m)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	4	2	2		0.008	0.004	0.004	0
Largemouth Bass	2	2			0.004	0.004	0	0
White Sucker	7	4	2	1	0.014	0.008	0.004	0.002
Yellow Perch	74	59	14	1	0.148	0.118	0.028	0.002
Spottail Shiner	175	125	50		0.35	0.25	0.1	0
Fallfish	0				0	0	0	0
Mimic Shiner	0				0	0	0	0
Golden Shiner	1	1			0.002	0.002	0	0
Common Shiner	0				0	0	0	0
American Eel	0				0	0	0	0
Walleye	2	2			0.004	0.004	0	0
Black Crappie	1	1			0.002	0.002	0	0
Rock Bass	7	6	1		0.014	0.012	0.002	0
Bluegill Sunfish	63	63			0.126	0.126	0	0
Pumpkinseed Sunfish	6	6			0.012	0.012	0	0
Northern Pike	0				0	0	0	0
Chain Pickerel	1	1			0.002	0.002	0	0
Channel Catfish	0				0	0	0	0
Brown Bullhead	2	2			0.004	0.004	0	0
Tessellated Darter	0				0	0	0	0
Sea Lamprey	0				0	0	0	0
American Shad	0				0	0	0	0
Common Carp	0				0	0	0	0
	345				0.69			

69.1 (Gill Net)	Number of Individuals				CPUE by Distance (100 ft)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	0							
Largemouth Bass	0							
White Sucker	0							
Yellow Perch	0							
Spottail Shiner	0							
Fallfish	0							
Mimic Shiner	0							
Golden Shiner	0							
Common Shiner	0							
American Eel	0							
Walleye	0							
Black Crappie	0							
Rock Bass	0							
Bluegill Sunfish	0							
Pumpkinseed Sunfish	0							
Northern Pike	0							
Chain Pickerel	0							
Channel Catfish	2	2			0.02	0.02		
Brown Bullhead	0							
Tessellated Darter	0							
Sea Lamprey	0							
American Shad	0							
Common Carp	0							
	2				0.02			

All Stations Combined	Length Range (TL mm)			Weight Range (g)		
Species	**ADULT**	**JUV.**	**YOY**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	160-470	80-135	35-45	55-1315	10-55	1-9
Largemouth Bass	160-410		25-50	55-880	10-55	1-4
White Sucker	370-520	130-330	27-42	600-1660	30-420	2-8
Yellow Perch	125-360	95-125	40-50	20-420	8-25	2-5
Spottail Shiner	70-120	50-60	40-48	4-20	2-4	1-2
Fallfish	115-430	70-110	50-60	20-760	5-20	2-4
Mimic Shiner	58-64			6		
Golden Shiner	185	75		80	10	
Common Shiner			30-45			1-2
American Eel	835-920	420-750		1200-1600	160-700	
Walleye	215-420	190-315		85-620	50-140	
Black Crappie	195-280	170		135-360	50	
Rock Bass	135-250	70-145		50-320	8-45	
Bluegill Sunfish	120-200			30-240		
Pumpkinseed Sunfish	140-205	75		60-200	12	
Northern Pike	440			610		
Chain Pickerel	410-430			400-420		
Channel Catfish	272-345			240-440		
Brown Bullhead	325-355			610-640		
Tessellated Darter	50-70		19-25	2-10		1
Sea Lamprey						
American Shad	380			420		
Common Carp	620-930			3600-11000		

Impoundment September 2015

87.0 Electrofishing	Number of Individuals				CPUE by Distance (500m)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	80	7	33	40	0.160	0.014	0.066	0.080
Largemouth Bass	2		2		0.004	0.000	0.004	0.000
White Sucker	4	1	3		0.008	0.002	0.006	0.000
Yellow Perch	33	6	22	5	0.066	0.012	0.044	0.010
Spottail Shiner	18	14	3	1	0.036	0.028	0.006	0.002
Fallfish	23	16	3	4	0.046	0.032	0.006	0.008
Mimic Shiner					0.000	0.000	0.000	0.000
Golden Shiner					0.000	0.000	0.000	0.000
Common Shiner					0.000	0.000	0.000	0.000
American Eel					0.000	0.000	0.000	0.000
Walleye	1	1			0.002	0.002	0.000	0.000
Black Crappie					0.000	0.000	0.000	0.000
Rock Bass	16	5	10	1	0.032	0.010	0.020	0.002
Bluegill Sunfish	2	2			0.004	0.004	0.000	0.000
Pumpkinseed Sunfish	1	1			0.002	0.002	0.000	0.000
White Perch					0.000	0.000	0.000	0.000
Northern Pike	1	1			0.002	0.002	0.000	0.000
Chain Pickerel					0.000	0.000	0.000	0.000
Channel Catfish					0.000	0.000	0.000	0.000
Brown Bullhead					0.000	0.000	0.000	0.000
Tessellated Darter	1	1			0.002	0.002	0.000	0.000
Sea Lamprey	11			11	0.022	0.000	0.000	0.022
American Shad	1			1	0.002	0.000	0.000	0.002
Common Carp	1	1			0.002	0.002	0.000	0.000
Rosyface Shiner					0.000	0.000	0.000	0.000
Banded Killifish					0.000	0.000	0.000	0.000
	195				0.39			

85.2 Electrofishing	Number of Individuals				CPUE by Distance (500m)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	18	5	10	3	0.036	0.010	0.020	0.006
Largemouth Bass					0.000	0.000	0.000	0.000
White Sucker	8	7	1		0.016	0.014	0.002	0.000
Yellow Perch					0.000	0.000	0.000	0.000
Spottail Shiner	2		2		0.004	0.000	0.004	0.000
Fallfish	11	11			0.022	0.022	0.000	0.000
Mimic Shiner	2	2			0.004	0.004	0.000	0.000
Golden Shiner					0.000	0.000	0.000	0.000
Common Shiner					0.000	0.000	0.000	0.000
American Eel					0.000	0.000	0.000	0.000
Walleye					0.000	0.000	0.000	0.000
Black Crappie					0.000	0.000	0.000	0.000
Rock Bass	4	2	1	1	0.008	0.004	0.002	0.002
Bluegill Sunfish	1	1			0.002	0.002	0.000	0.000
Pumpkinseed Sunfish					0.000	0.000	0.000	0.000
White Perch					0.000	0.000	0.000	0.000
Northern Pike					0.000	0.000	0.000	0.000
Chain Pickerel					0.000	0.000	0.000	0.000
Channel Catfish					0.000	0.000	0.000	0.000
Brown Bullhead					0.000	0.000	0.000	0.000
Tessellated Darter					0.000	0.000	0.000	0.000
Sea Lamprey	1			1	0.002	0.000	0.000	0.002
American Shad	19			19	0.038	0.000	0.000	0.038
Common Carp					0.000	0.000	0.000	0.000
Rosyface Shiner					0.000	0.000	0.000	0.000
Banded Killifish					0.000	0.000	0.000	0.000
	66				0.132			

85.5 (Gill Net)	Number of Individuals				CPUE by Distance (100 ft)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	1	1			0.01	0.01		
Largemouth Bass								
White Sucker								
Yellow Perch								
Spottail Shiner								
Fallfish								
Mimic Shiner								
Golden Shiner								
Common Shiner								
American Eel								
Walleye								
Black Crappie								
Rock Bass								
Bluegill Sunfish								
Pumpkinseed Sunfish								
White Perch								
Northern Pike								
Chain Pickerel								
Channel Catfish								
Brown Bullhead								
Tessellated Darter								
Sea Lamprey								
American Shad								
Common Carp								
Rosyface Shiner								
Banded Killifish								
	1				0.01			

84.3 Electrofishing	Number of Individuals				CPUE by Distance (500m)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	59	15	26	18	0.118	0.030	0.052	0.036
Largemouth Bass	1		1		0.002	0.000	0.002	0.000
White Sucker	2	1	1		0.004	0.002	0.002	0.000
Yellow Perch	5	3	2		0.010	0.006	0.004	0.000
Spottail Shiner	28	21	7		0.056	0.042	0.014	0.000
Fallfish	31	18	11	2	0.062	0.036	0.022	0.004
Mimic Shiner	2	2			0.004	0.004	0.000	0.000
Golden Shiner	1			1	0.002	0.000	0.000	0.002
Common Shiner					0.000	0.000	0.000	0.000
American Eel	1	1			0.002	0.002	0.000	0.000
Walleye	1		1		0.002	0.000	0.002	0.000
Black Crappie					0.000	0.000	0.000	0.000
Rock Bass	5	1	1	3	0.010	0.002	0.002	0.006
Bluegill Sunfish	1	1			0.002	0.002	0.000	0.000
Pumpkinseed Sunfish					0.000	0.000	0.000	0.000
White Perch					0.000	0.000	0.000	0.000
Northern Pike	1	1			0.002	0.002	0.000	0.000
Chain Pickerel					0.000	0.000	0.000	0.000
Channel Catfish					0.000	0.000	0.000	0.000
Brown Bullhead					0.000	0.000	0.000	0.000
Tessellated Darter	2	2			0.004	0.004	0.000	0.000
Sea Lamprey					0.000	0.000	0.000	0.000
American Shad	2			2	0.004	0.000	0.000	0.004
Common Carp					0.000	0.000	0.000	0.000
Rosyface Shiner					0.000	0.000	0.000	0.000
Banded Killifish					0.000	0.000	0.000	0.000

84.3 Gill Net	Number of Individuals				CPUE by Distance (100 ft)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass								
Largemouth Bass								
White Sucker	1	1			0.01	0.01		
Yellow Perch								
Spottail Shiner								
Fallfish								
Mimic Shiner								
Golden Shiner								
Common Shiner								
American Eel								
Walleye								
Black Crappie								
Rock Bass								
Bluegill Sunfish								
Pumpkinseed Sunfish								
White Perch								
Northern Pike								
Chain Pickerel								
Channel Catfish								
Brown Bullhead								
Tessellated Darter								
Sea Lamprey								
American Shad								
Common Carp								
Rosyface Shiner								
Banded Killifish								
	1				0.01			

82.1 (*Virtual Seine*)	Number of Individuals				CPUE by Distance (300m)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	16	3	10	3	0.053	0.01	0.033	0.01
Largemouth Bass	1		1		0.003	0	0.003	0
White Sucker	11		8	3	0.037	0	0.027	0.01
Yellow Perch					0	0	0	0
Spottail Shiner	108	90		18	0.36	0.3	0	0.06
Fallfish	44		35	9	0.147	0	0.117	0.03
Mimic Shiner					0	0	0	0
Golden Shiner	2		2		0.007	0	0.007	0
Common Shiner					0	0	0	0
American Eel	1	1			0.003	0.003	0	0
Walleye					0	0	0	0
Black Crappie					0	0	0	0
Rock Bass	14	1	2	11	0.047	0.003	0.007	0.037
Bluegill Sunfish	1	1			0.003	0.003	0	0
Pumpkinseed Sunfish					0	0	0	0
White Perch					0	0	0	0
Northern Pike	2	2			0.007	0.007	0	0
Chain Pickerel					0	0	0	0
Channel Catfish	2	1	1		0.007	0.003	0.003	0
Brown Bullhead					0	0	0	0
Tessellated Darter	5	4		1	0.017	0.013	0	0.003
Sea Lamprey					0	0	0	0
American Shad	15			15	0.05	0	0	0.05
Common Carp					0	0	0	0
Rosyface Shiner					0	0	0	0
Banded Killifish	1			1	0.003	0	0	0.003
	223				0.743			

82.0 Electrofishing	Number of Individuals				CPUE by Distance (500m)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	27	6	17	4	0.054	0.012	0.034	0.008
Largemouth Bass	1		1		0.002	0	0.002	0
White Sucker	3	2	1		0.006	0.004	0.002	0
Yellow Perch	7	4	3		0.014	0.008	0.006	0
Spottail Shiner	7	7			0.014	0.014	0	0
Fallfish	36	21	15		0.072	0.042	0.03	0
Mimic Shiner	6	6			0.012	0.012	0	0
Golden Shiner					0	0	0	0
Common Shiner					0	0	0	0
American Eel	1		1		0.002	0	0.002	0
Walleye					0	0	0	0
Black Crappie	1	1			0.002	0.002	0	0
Rock Bass	4		3	1	0.008	0	0.006	0.002
Bluegill Sunfish					0	0	0	0
Pumpkinseed Sunfish					0	0	0	0
White Perch					0	0	0	0
Northern Pike	2		2		0.004	0	0.004	0
Chain Pickerel					0	0	0	0
Channel Catfish					0	0	0	0
Brown Bullhead					0	0	0	0
Tessellated Darter	4	3		1	0.008	0.006	0	0.002
Sea Lamprey					0	0	0	0
American Shad	15			15	0.03	0	0	0.03
Common Carp					0	0	0	0
Rosyface Shiner					0	0	0	0
Banded Killifish					0	0	0	0
	114				0.228			

81.6 Gill Net	Number of Individuals				CPUE by Distance (100 ft)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	0	0	0	0	0	0	0	0
Largemouth Bass	0	0	0	0	0	0	0	0
White Sucker	0	0	0	0	0	0	0	0
Yellow Perch	0	0	0	0	0	0	0	0
Spottail Shiner	0	0	0	0	0	0	0	0
Fallfish	0	0	0	0	0	0	0	0
Mimic Shiner	0	0	0	0	0	0	0	0
Golden Shiner	0	0	0	0	0	0	0	0
Common Shiner	0	0	0	0	0	0	0	0
American Eel	0	0	0	0	0	0	0	0
Walleye	0	0	0	0	0	0	0	0
Black Crappie	0	0	0	0	0	0	0	0
Rock Bass	0	0	0	0	0	0	0	0
Bluegill Sunfish	0	0	0	0	0	0	0	0
Pumpkinseed Sunfish	0	0	0	0	0	0	0	0
White Perch	0	0	0	0	0	0	0	0
Northern Pike	0	0	0	0	0	0	0	0
Chain Pickerel	0	0	0	0	0	0	0	0
Channel Catfish	0	0	0	0	0	0	0	0
Brown Bullhead	0	0	0	0	0	0	0	0
Tessellated Darter	0	0	0	0	0	0	0	0
Sea Lamprey	0	0	0	0	0	0	0	0
American Shad	0	0	0	0	0	0	0	0
Common Carp	0	0	0	0	0	0	0	0
Rosyface Shiner	0	0	0	0	0	0	0	0
Banded Killifish	0	0	0	0	0	0	0	0
	0				0			

80.8 Electrofishing	Number of Individuals				CPUE by Distance (500m)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	33	6	24	3	0.066	0.01	0.05	0.01
Largemouth Bass					0	0	0	0
White Sucker	2	2			0.004	0	0	0
Yellow Perch	11	4	5	2	0.022	0.01	0.01	0
Spottail Shiner	2	2			0.004	0	0	0
Fallfish	11	8	3		0.022	0.02	0.01	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	0.006	0	0	0
Bluegill Sunfish					0	0	0	0
Pumpkinseed Sunfish					0	0	0	0
White Perch					0	0	0	0
Northern Pike	1		1		0.002	0	0	0
Chain Pickerel					0	0	0	0
Channel Catfish	1	1			0.002	0	0	0
Brown Bullhead					0	0	0	0
Tessellated Darter	3	3			0.006	0.01	0	0
Sea Lamprey	1		1		0.002	0	0	0
American Shad	1			1	0.002	0	0	0
Common Carp					0	0	0	0
Rosyface Shiner					0	0	0	0
Banded Killifish					0	0	0	0
	69				0.138			

80.8 Electrofishing	Number of Individuals				CPUE by Distance (500m)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	12	2	10		0.024	0	0.02	0
Largemouth Bass					0	0	0	0
White Sucker					0	0	0	0
Yellow Perch					0	0	0	0
Spottail Shiner	41	41			0.082	0.08	0	0
Fallfish	32	19	9	4	0.064	0.04	0.02	0.01
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	0.002	0	0	0
Bluegill Sunfish	2	1		1	0.004	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	6			6	0.012	0	0	0.01
Common Carp					0	0	0	0
Rosyface Shiner					0	0	0	0
Banded Killifish					0	0	0	0
	94				0.188			

79.1 Gill Net	Number of Individuals				CPUE by Distance (100 ft)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass								
Largemouth Bass								
White Sucker								
Yellow Perch								
Spottail Shiner								
Fallfish								
Mimic Shiner								
Golden Shiner								
Common Shiner								
American Eel								
Walleye								
Black Crappie								
Rock Bass								
Bluegill Sunfish								
Pumpkinseed Sunfish								
White Perch								
Northern Pike								
Chain Pickerel								
Channel Catfish								
Brown Bullhead								
Tessellated Darter								
Sea Lamprey								
American Shad								
Common Carp	1	1			0.01	0.01		
Rosyface Shiner								
Banded Killifish								
	1				0.01			

78.2 (V*irtual Seine*)	Number of Individuals				CPUE by Distance (205m)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	1	1			0.0049	0.0049		
Largemouth Bass								
White Sucker								
Yellow Perch								
Spottail Shiner								
Fallfish								
Mimic Shiner								
Golden Shiner								
Common Shiner								
American Eel								
Walleye								
Black Crappie								
Rock Bass								
Bluegill Sunfish								
Pumpkinseed Sunfish								
White Perch								
Northern Pike								
Chain Pickerel								
Channel Catfish								
Brown Bullhead								
Tessellated Darter								
Sea Lamprey								
American Shad								
Common Carp								
Rosyface Shiner								
Banded Killifish								
	1				0.0049			

77.0 Electrofishing	Number of Individuals				CPUE by Distance (500m)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	51	14	21	16	0.102	0.03	0.04	0.03
Largemouth Bass	2		2		0.004	0	0	0
White Sucker	1		1		0.002	0	0	0
Yellow Perch	12	2	5	5	0.024	0	0.01	0.01
Spottail Shiner	164	112	52		0.328	0.22	0.1	0
Fallfish	31	7	15	9	0.062	0.01	0.03	0.02
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	0.014	0	0	0.01
Bluegill Sunfish	5	2		3	0.01	0	0	0.01
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	0.002	0	0	0
Brown Bullhead					0	0	0	0
Tessellated Darter	1			1	0.002	0	0	0
Sea Lamprey					0	0	0	0
American Shad	4			4	0.008	0	0	0.01
Common Carp					0	0	0	0
Rosyface Shiner	1			1	0.002	0	0	0
Banded Killifish	5		5		0.01	0	0.01	0
	285				0.57			

76.1 Electrofishing	Number of Individuals				CPUE by Distance (500m)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	33	11	14	8	0.066	0.02	0.03	0.02
Largemouth Bass	2		2		0.004	0	0	0
White Sucker	6	3	2	1	0.012	0.01	0	0
Yellow Perch	1			1	0.002	0	0	0
Spottail Shiner	18		3	15	0.036	0	0.01	0.03
Fallfish	19	9		10	0.038	0.02	0	0.02
Mimic Shiner					0	0	0	0
Golden Shiner					0	0	0	0
Common Shiner					0	0	0	0
American Eel	1		1		0.002	0	0	0
Walleye					0	0	0	0
Black Crappie					0	0	0	0
Rock Bass	8			8	0.016	0	0	0.02
Bluegill Sunfish					0	0	0	0
Pumpkinseed Sunfish					0	0	0	0
White Perch	1		1		0.002	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	1	1			0.002	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
	90				0.18			

71.2 Electrofishing	Number of Individuals				CPUE by Distance (500m)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	45	20	25		0.09	0.04	0.05	0
Largemouth Bass	10	1	9		0.02	0.002	0.018	0
White Sucker	1	1			0.002	0.002	0	0
Yellow Perch	9	1	3	5	0.018	0.002	0.006	0.01
Spottail Shiner	77	15		62	0.154	0.03	0	0.124
Fallfish	3	1	2		0.006	0.002	0.004	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		0.004	0	0.004	0
Black Crappie					0	0	0	0
Rock Bass	6	2	3	1	0.012	0.004	0.006	0.002
Bluegill Sunfish	14	14			0.028	0.028	0	0
Pumpkinseed Sunfish	1	1			0.002	0.002	0	0
White Perch					0	0	0	0
Northern Pike					0	0	0	0
Chain Pickerel					0	0	0	0
Channel Catfish	1	1			0.002	0.002	0	0
Brown Bullhead					0	0	0	0
Tessellated Darter	1	1			0.002	0.002	0	0
Sea Lamprey					0	0	0	0
American Shad	3			3	0.006	0	0	0.006
Common Carp					0	0	0	0
Rosyface Shiner					0	0	0	0
Banded Killifish	1	1		1	0.002	0.002	0	0.002
	174				0.348			

71.1 (V*irtual Seine*)	Number of Individuals				CPUE by Distance (147m)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass					0	0	0	0
Largemouth Bass	1		1		0.007	0	0.007	0
White Sucker					0	0	0	0
Yellow Perch	8		8		0.054	0	0.054	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			0.014	0.014	0	0
Pumpkinseed Sunfish	2	2			0.014	0.014	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			0.014	0.014	0	0
Rosyface Shiner					0	0	0	0
Banded Killifish	2	2			0.014	0.014	0	0
	17				0.116			

70.5 Electrofishing	Number of Individuals				CPUE by Distance (500m)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	12	7	5		0.024	0.014	0.01	0
Largemouth Bass	13		9	4	0.026	0	0.018	0.008
White Sucker	5	4	1		0.01	0.008	0.002	0
Yellow Perch	68	16	27	25	0.136	0.032	0.054	0.05
Spottail Shiner	320				0.64	0	0	0
Fallfish					0	0	0	0
Mimic Shiner	2		2		0.004	0	0.004	0
Golden Shiner	2			2	0.004	0	0	0.004
Common Shiner					0	0	0	0
American Eel					0	0	0	0
Walleye					0	0	0	0
Black Crappie	1	1			0.002	0.002	0	0
Rock Bass	5	3	1	1	0.01	0.006	0.002	0.002
Bluegill Sunfish	44	38	4	2	0.088	0.076	0.008	0.004
Pumpkinseed Sunfish	18	15	3		0.036	0.03	0.006	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	0.02	0	0	0.02
Common Carp					0	0	0	0
Rosyface Shiner					0	0	0	0
Banded Killifish					0	0	0	0
	500				1			

70.0 Electrofishing	Number of Individuals				CPUE by Distance (500m)			
Species	Total	ADULT	JUV.	YOY	Total	ADULT	JUV.	YOY
Smallmouth Bass	3	1	2		0.006	0.002	0.004	0
Largemouth Bass	12	3	6	3	0.024	0.006	0.012	0.006
White Sucker	4		4		0.008	0	0.008	0
Yellow Perch	44	12	10	23	0.088	0.024	0.02	0.046
Spottail Shiner	211	70		141	0.422	0.14	0	0.282
Fallfish					0	0	0	0
Mimic Shiner	3			3	0.006	0	0	0.006
Golden Shiner	6	6			0.012	0.012	0	0
Common Shiner					0	0	0	0
American Eel					0	0	0	0
Walleye					0	0	0	0
Black Crappie	2	1	1		0.004	0.002	0.002	0
Rock Bass	3	2	1		0.006	0.004	0.002	0
Bluegill Sunfish	17	14	2	1	0.034	0.028	0.004	0.002
Pumpkinseed Sunfish	7	6	1		0.014	0.012	0.002	0
White Perch					0	0	0	0
Northern Pike	1	1			0.002	0.002	0	0
Chain Pickerel	1	1			0.002	0.002	0	0
Channel Catfish	1	1			0.002	0.002	0	0
Brown Bullhead					0	0	0	0
Tessellated Darter					0	0	0	0
Sea Lamprey					0	0	0	0
American Shad	1			1	0.002	0	0	0.002
Common Carp					0	0	0	0
Rosyface Shiner					0	0	0	0
Banded Killifish	12	8		4	0.024	0.016	0	0.008
	328				0.656			

69.5 Electrofishing	Number of Individuals				CPUE by Distance (500m)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	4	2		2	0.008	0.004	0	0.004
Largemouth Bass	8		5	3	0.016	0	0.01	0.006
White Sucker	13	1	12		0.026	0.002	0.024	0
Yellow Perch	58	11	6	41	0.116	0.022	0.012	0.082
Spottail Shiner	271	64	207		0.542	0.128	0.414	0
Fallfish					0	0	0	0
Mimic Shiner	1		1		0.002	0	0.002	0
Golden Shiner	1			1	0.002	0	0	0.002
Common Shiner					0	0	0	0
American Eel					0	0	0	0
Walleye	1	1			0.002	0.002	0	0
Black Crappie	2	2			0.004	0.004	0	0
Rock Bass	2	2			0.004	0.004	0	0
Bluegill Sunfish	24	20	1	3	0.048	0.04	0.002	0.006
Pumpkinseed Sunfish	14	5	9		0.028	0.01	0.018	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			0.002	0.002	0	0
Tessellated Darter	2			1	0.004	0	0	0.002
Sea Lamprey					0	0	0	0
American Shad	20			20	0.04	0	0	0.04
Common Carp	1	1			0.002	0.002	0	0
Rosyface Shiner					0	0	0	0
Banded Killifish	4	2		2	0.008	0.004	0	0.004
	427				0.854			

68.9 Gill Net	Number of Individuals				CPUE by Distance (100 ft)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass								
Largemouth Bass								
White Sucker								
Yellow Perch								
Spottail Shiner								
Fallfish								
Mimic Shiner								
Golden Shiner								
Common Shiner								
American Eel								
Walleye								
Black Crappie								
Rock Bass								
Bluegill Sunfish								
Pumpkinseed Sunfish								
White Perch								
Northern Pike								
Chain Pickerel								
Channel Catfish	1	1			0.01	0.01		
Brown Bullhead								
Tessellated Darter								
Sea Lamprey								
American Shad								
Common Carp								
Rosyface Shiner								
Banded Killifish								
	1				0.01			

68.7 Gill Net	Number of Individuals				CPUE by Distance (100 ft)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass								
Largemouth Bass								
White Sucker	4	4			0.04	0.04		
Yellow Perch								
Spottail Shiner								
Fallfish								
Mimic Shiner								
Golden Shiner								
Common Shiner								
American Eel								
Walleye	1	1			0.01	0.01		
Black Crappie								
Rock Bass								
Bluegill Sunfish								
Pumpkinseed Sunfish	2	2			0.02	0.02		
White Perch								
Northern Pike								
Chain Pickerel								
Channel Catfish	2	2			0.02	0.02		
Brown Bullhead								
Tessellated Darter								
Sea Lamprey								
American Shad								
Common Carp								
Rosyface Shiner								
Banded Killifish								
	9				0.09			

All Stations Combined	Length Range (TL mm)			Weight Range (g)		
Species	**ADULT**	**JUV.**	**YOY**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	160-458	85-159	58-90	50-1200	10-50	5-8
Largemouth Bass	173-349	80-155	65-83	60-620	10-55	6-9
White Sucker	386-502	74-315	72	720-1370	10-390	4
Yellow Perch	136-267	89-130	57-90	30-250	10-20	5-8
Spottail Shiner	97-165	58-72	55-57	10-40	3-5	1-2
Fallfish	128-406	65-126	56-81	20-550	6-15	2-5
Mimic Shiner	57-65		55-56	3-6		1-2
Golden Shiner	93-212		57-81	10-110		2-7
Common Shiner						
American Eel	700	250-550		720	80-410	
Walleye	302-530	146-259		220-1440	25-120	
Black Crappie	175-273	87		60-310	10	
Rock Bass	130-257	80-108	32-57	50-360	10-40	1-5
Bluegill Sunfish	110-225	93-95	30-63	20-260	10-12	1-6
Pumpkinseed Sunfish	106-205	77-105		30-140	13-20	
White Perch		109			20	
Northern Pike	467-780	199-231		560-2650	40-80	
Chain Pickerel	197-477			45-477		
Channel Catfish	288-622	173	76	220-1900	60	8
Brown Bullhead	330			550		
Tessellated Darter	51-63		33-49	2-3		1
Sea Lamprey		126	120		10	5
American Shad			67-110			5-12
Common Carp	585-865			3000-10200		
Rosyface Shiner						
Banded Killifish	48-67		30-43	2		1

Bypass reach September 2015

Plunge Pool Below Dam	Number of Individuals				CPUE by Distance (1000m)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	48	19	22	7	0.048	0.019	0.022	0.007
Largemouth Bass	1		1		0.001	0	0.001	0
White Sucker	10	10			0.01	0.01	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	0.016	0	0.008	0.008
Walleye	1		1		0.001	0	0.001	0
Black Crappie					0	0	0	0
Rock Bass					0	0	0	0
Bluegill Sunfish	12	9		3	0.012	0.009	0	0.003
Pumpkinseed Sunfish	8	4	4		0.008	0.004	0.004	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			0.004	0.004	0	0
Sea Lamprey	1			1	0.001	0	0	0.001
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	0.101	0.046	0.036	0.019

Pool-Run Above Station No. 1	Number of Individuals				CPUE by Distance (775m)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	67	5	39	23	0.0865	0.0065	0.0503	0.03
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			0.0013	0.0013	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	0.0116	0.0013	0.0013	0.009
Pumpkinseed Sunfish	8	1	3	4	0.0103	0.0013	0.0039	0.005
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	0.0026	0.0013	0	0.001
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				0.0013	0	0	0
Longnose Dace					0	0	0	0
	88	9	43	35	0.1135	0.0116	0.0555	0.045

Riffle-Run Below Station No.1	Number of Individuals				CPUE by Distance (660m)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	30	10	15	5	0.045	0.015	0.023	0.008
Largemouth Bass					0	0	0	0
White Sucker	2	2			0.003	0.003	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	0.011	0	0.006	0.005
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			0.003	0.003	0	0
Sea Lamprey	1		1		0.002	0	0.002	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			0.002	0.002	0	0
	43	15	20	8	0.065	0.023	0.03	0.012

Rock Dam Pool	Number of Individuals				CPUE by Distance (520m)			
Species	**Total**	**ADULT**	**JUV.**	**YOY**	**Total**	**ADULT**	**JUV.**	**YOY**
Smallmouth Bass	23	6	9	8	0.044	0.012	0.017	0.015
Largemouth Bass					0	0	0	0
White Sucker	1		1		0.002	0	0.002	0
Yellow Perch	1			1	0.002	0	0	0.002
Spottail Shiner	1		1		0.002	0	0.002	0
Fallfish					0	0	0	0
Mimic Shiner	1		1		0.002	0	0.002	0
Golden Shiner					0	0	0	0
Common Shiner					0	0	0	0
American Eel	2		2		0.004	0	0.004	0
Walleye					0	0	0	0
Black Crappie					0	0	0	0
Rock Bass					0	0	0	0
Bluegill Sunfish	1	1			0.002	0.002	0	0
Pumpkinseed Sunfish					0	0	0	0
White Perch					0	0	0	0
Northern Pike	1	1			0.002	0.002	0	0
Chain Pickerel					0	0	0	0
Channel Catfish					0	0	0	0
Brown Bullhead	1			1	0.002	0	0	0.002
Tessellated Darter	4	3		1	0.008	0.006	0	0.002
Sea Lamprey	1			1	0.002	0	0	0.002
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	0.071	0.021	0.027	0.023