



Turners Falls Hydroelectric Project (FERC No. 1889)
Northfield Mountain Pumped Storage Project (FERC No. 2485)
March 2016 Study Report Meeting

March 16, 2016



Purpose of Updated Study Report Meeting [18 CFR 5.15(c)(2)]

Per Regulation.....

Within 15 days following the filing of the Updated Study Report (March 16, 2016), the Applicant shall hold a meeting with licensing participants and Commission staff to discuss the study results and the potential applicant's and/or other participant's proposals, if any, to modify the study plan in light of the progress of the study plan and the data collected.

- ❑ To summarize the 13 reports filed on 3/1/2016.
- ❑ To provide a status update on the mussel report.

Relicensing Process- Next Steps

Study Report Meeting (All Stakeholders and FirstLight)

- March 16, 2016

Study Report Meeting Summary Filed (FirstLight)

- March 31, 2016

Conduct Field Studies (FirstLight)

- Ultrasound Array, 2nd Year of DS Eel

Disagreements/Modifications to Study/Propose New Study (All Stakeholders)

- May 2, 2016

Filing of Final License Application

- April 30, 2016 – falls on a Saturday- defaults to Monday, May 2, 2016

File Responses to Disagreements (All Stakeholders)

- May 30, 2016

Last date for the Director to resolve disagreements and amend the approved study plans (FERC, if necessary)

- June 29, 2016

Study Recap

FERC Filing Date	No. of Studies	Study Name Abbreviations
09/15/2014	2	Full River Reconnaissance, Rec Inventory
12/31/2014	2	Archaeological- Phase 1A only, Historic Structures
09/14/2015	9	Hydraulic Model Study, Aquatic Habitat Mapping, Tributary Access, Canal Drawdown, NFM Land Management, Whitewater, Day/Overnight Rec Facilities, Rec Study of NFM, Traditional Cultural Properties.
03/01/2016	13	Water Quality, US Passage Eel, Shad Spawning, CFD Modeling, River2D model of NFM tailrace, Odonates, Fish Assemblage, Cabot Emergency Gates, Ichthyoplankton, Terrestrial Wildlife & Botanical, RTE, Rec Use/User Survey, Land Use Inventory
10/14/2016	10	Erosion Causation, Sediment Monitoring, IFIM Study, US & DS Adult Shad, DS Juvenile Shad, Entrainment, Littoral Zone, Sea Lamprey Spawning, Mussels Project Ops impact on Rec
03/01/2017	3	DS Eel, Ultrasound Array, Ops Model
Total	39	

Agenda

Times	Study
9:00-9:30 am	Introductions, Review of Meeting Purpose, Meeting Objectives, Schedule
	Fish and Aquatic
9:30 am-Noon	3.3.4- Evaluate Upstream Passage of American Eel at the Turners Falls Project
	3.3.6- Impact of Project Operations on Shad Spawning, Spawning Habitat and Egg Deposition in the Area of the Northfield Mountain and Turners Falls Projects
	3.3.20- Study to Evaluate Entrainment of Ichthyoplankton at the Northfield Mountain Pumped Storage Project
	3.3.11- Fish Assemblage
	3.2.1-Water Quality Monitoring Study
	3.3.12- Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream from Cabot Station
Noon-1:00 pm	Lunch on your own
	Modeling
1:00-5:00 pm	3.3.8-Computational Fluid Dynamics Modeling in the Vicinity of the Fishway Entrances and Powerhouse Forebays
	3.3.9-Two-Dimensional Modeling of the Northfield Mountain Pumped Storage Project Intake/Tailrace Channel and Connecticut River Upstream and Downstream of the Intake/Tailrace.
	Odonates and Mussels
	3.3.10-Assess Operational Impacts on Emergence of State-Listed Odonates in the Connecticut River
	3.3.16-Habitat Assessment, Surveys, and Modeling of Suitable Habitat for State-listed Mussel Species in CT River below Cabot Station
	RTE and Terrestrial
	3.4.1-Baseline Study of Terrestrial Wildlife and Botanical Resources
	3.5.1-Baseline Inventory of Wetland, Riparian and Littoral Habitat in the Turners Falls Impoundment, and Assessment of Operational Impacts on Special-Status Species
	Recreation and Land Use
	3.6.1-Recreation Use/User Contact Survey
	3.6.5-Land Use Inventory

Fish and Aquatic Resources Water Quality Resources

3.3.4-Evaluate Upstream Passage of American Eel at the Turners Falls Project

Background

Between 2003 and 2014 the Holyoke Hydroelectric Project (FERC No. 2004) passed approximately 100-50,000 juvenile American eel annually. There are 35 river miles of eel rearing habitat between the Holyoke and Turners Falls Projects. Although there is evidence of eel passing the Turners Falls Project (the Project) via the fishways, the number of eel attempting to migrate past the dam, and the number successfully passing, are unknown.

Study Objectives

- Identify concentration of eels staging in pools attempting to ascend wetted structures (Phase 1- 2014).
- Assess whether eels can be passed in substantial numbers and whether sites are viable for permanent structures (Phase 2-2015).

Work Completed

Task 1: Systematic Surveys (2014)

Nighttime surveys were conducted to assess eel presence and abundance at the Turners Falls Project. The nighttime surveys were used to site the location of temporary eel ramps which were installed in July 2015.

Task 2: Trap Collection (2015)

Temporary traps were used to determine if eel pass in substantial numbers and whether sites are viable for permanent structures.

3.3.4-Evaluate Upstream Passage of American Eel at the Turners Falls Project

Task 1: Systematic Surveys (2014)

- Identify concentrations of eel staging in pools or attempting to ascend wetted structures



Nighttime Survey

- 11 surveys
 - Every 1-2 weeks beginning on June 11, 2014 and ending October 9, 2014
 - Visual observation of each site, noting eel presence and abundance

3.3.4-Evaluate Upstream Passage of American Eel at the Turners Falls Project

Task 1: Eel Monitoring (2014)

- A total of 6,263 eel were observed during 11 nighttime surveys
- The majority of the eel were collected at the Spillway Fishway (n=5,867) and the Cabot Emergency Spillway (n=332).
- Most eel observed on July 2, 10 and July 17.

Locations where eel were observed at the Cabot Emergency Spillway



Eel congregating and climbing the upper gate at the Turners Falls Spillway Fishway



3.3.4-Evaluate Upstream Passage of American Eel at the Turners Falls Project

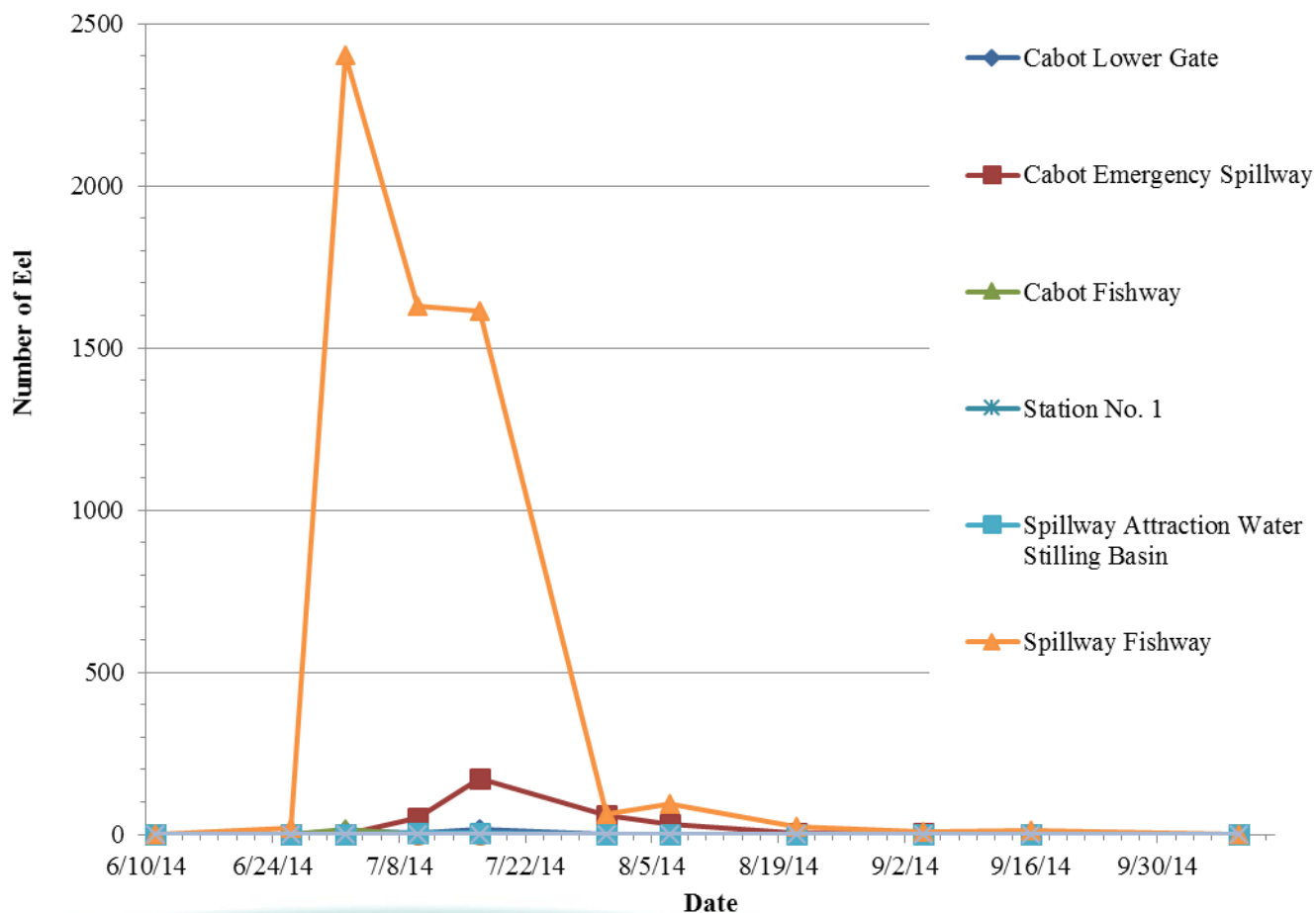
Task 1: Eel Monitoring (2014)

Station	TOTAL
Cabot Lower Gate	33
Cabot Emergency Spillway	332
Cabot Fishway	18
Conte` Discharge	0
Station No. 1	3
Mill Hydro Discharge ^a	0
Outfall 1 ^a	0
Outfall 2 ^a	0
Outfall 3 ^a	0
Paper Mill Discharge ^a	0
Spillway Attraction Water Stilling Basin ^b	10
Spillway Fishway ^b	5,867
Tainter Gates	0
TOTAL	6,263

^aDiscontinued surveying these locations on July 31, 2014 because of a lack of eel and safety concerns.

^bSurveyed on July 21, 2014.

Estimated number of eel observed during the nighttime surveys.



3.3.4-Evaluate Upstream Passage of American Eel at the Turners Falls Project

Task 2: Trap Collection (2015)

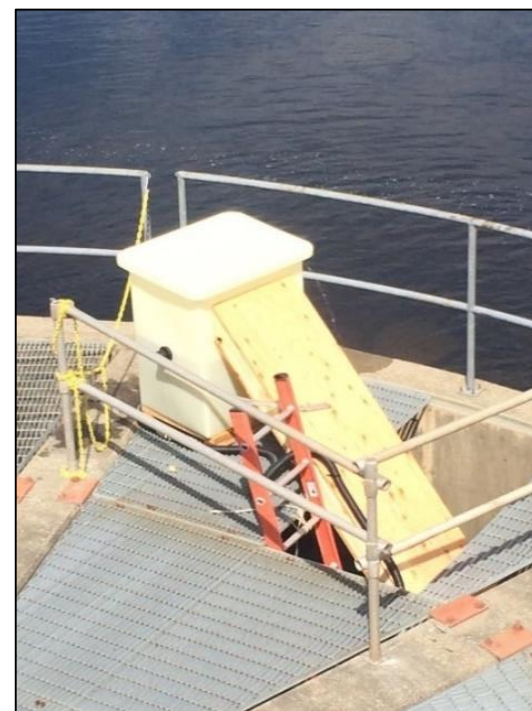
- In July 2015, temporary eel ramp traps were installed at Spillway Fishway, Cabot Fishway, and Cabot Emergency Spillway.
- Medusa traps were deployed at the Station No. 1 discharge.
- Eel were counted, measured and categorized (<10cm, 10-20cm >20cm) and released in the Turners Falls Impoundment.



Spillway Fishway eel trap, located within the second turning pool



Cabot Emergency Spillway Gate No. 10 eel trap, located at the north end of the spillway



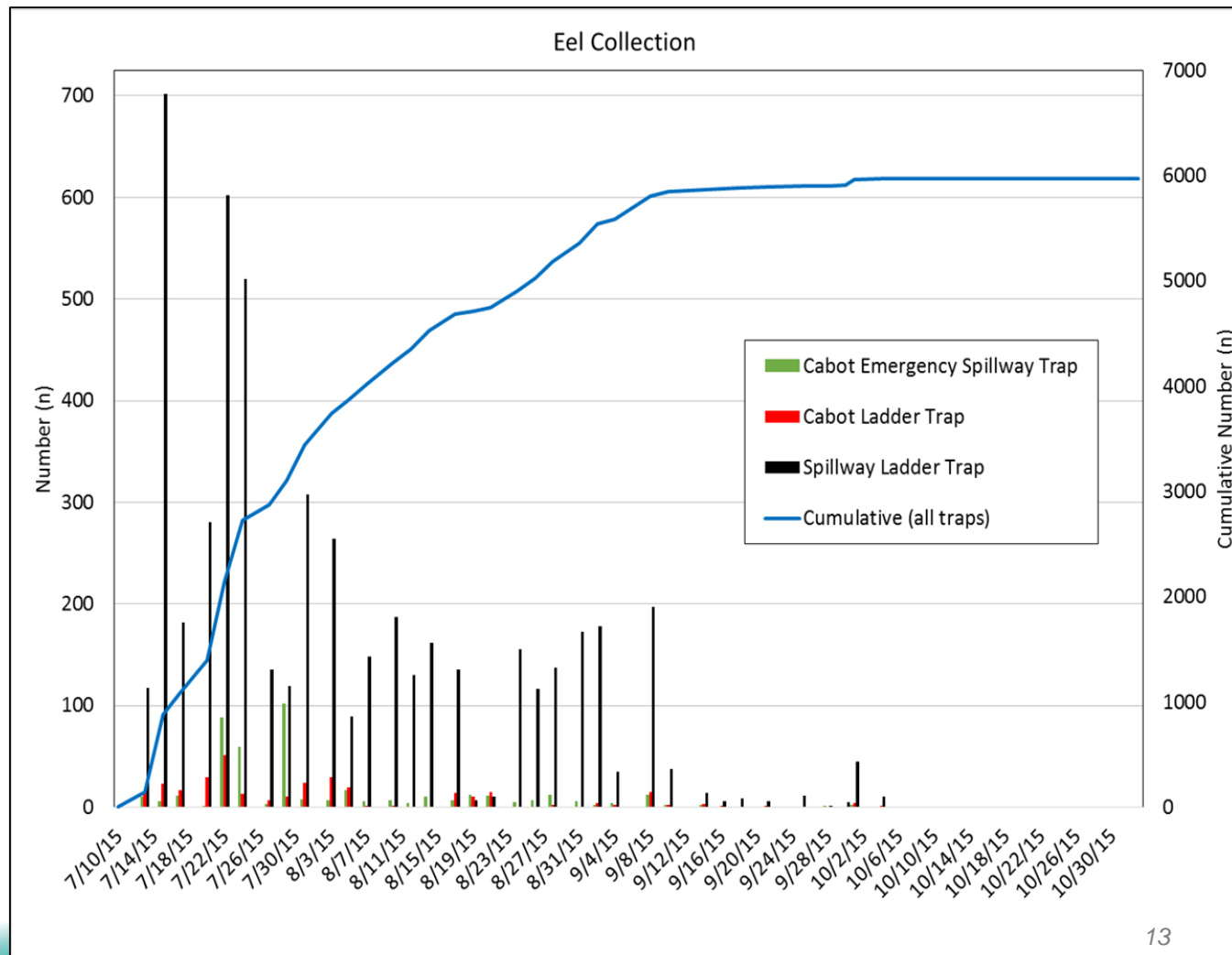
Cabot Fishway eel trap, located in third turning pool

3.3.4-Evaluate Upstream Passage of American Eel at the Turners Falls Project

Task 2 Findings: Eel Collections

- A total of 5,972 eel were collected between July 9 and November 2, 2015.
- Peak migration occurred in July

Eel Trap Location	Number of Eel
Spillway Fishway	5,235 (87.7%)
Cabot Emergency Spillway	424 (7.1%)
Cabot Fishway	313 (5.2%)
Station No. 1 (Medusa traps)	0

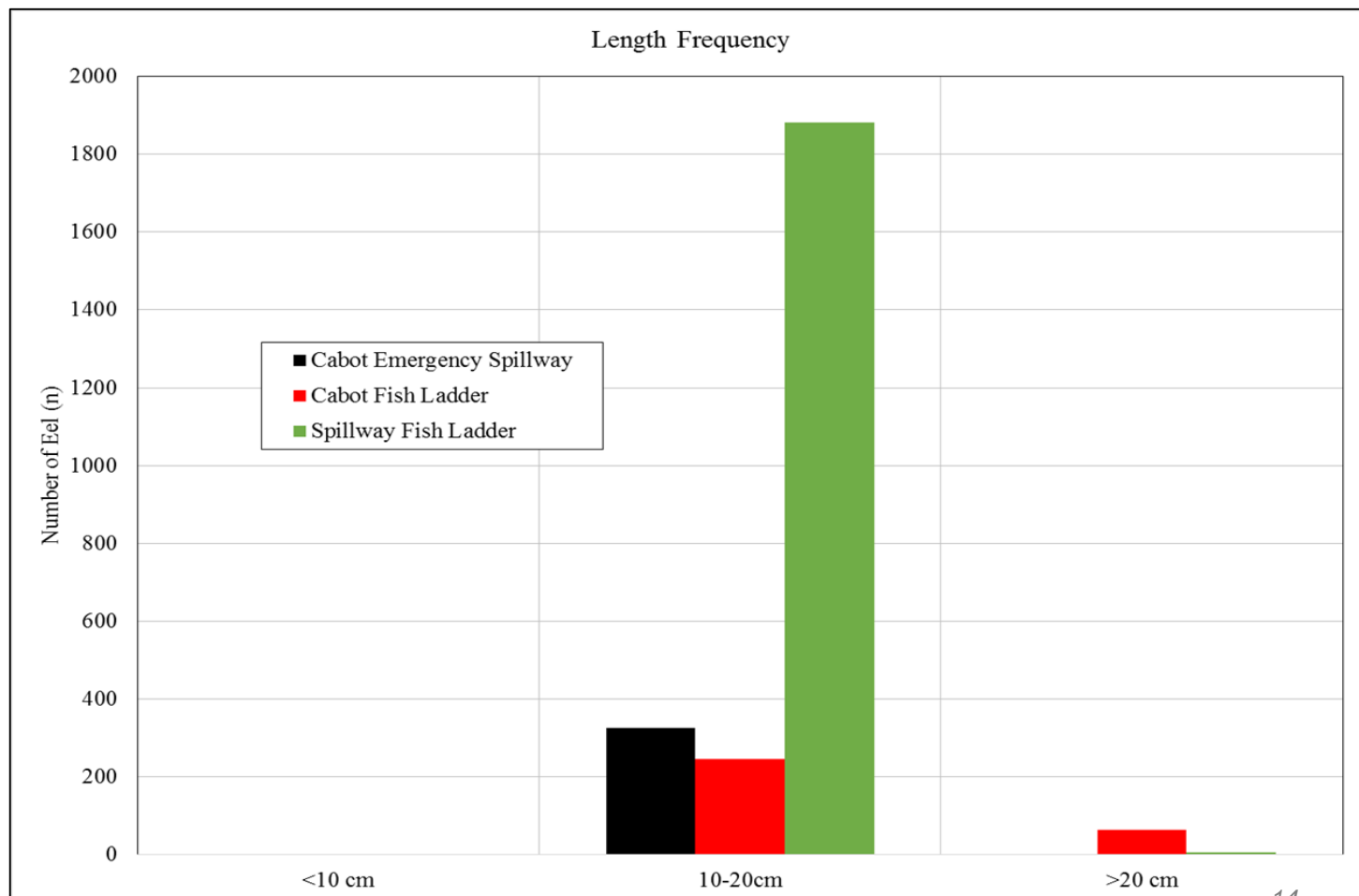


3.3.4-Evaluate Upstream Passage of American Eel at the Turners Falls Project

Task 2: Length Frequencies of Sub-Sampled Eel Collections at the Project

- A total of 2,526 eel were sorted into the three size categories

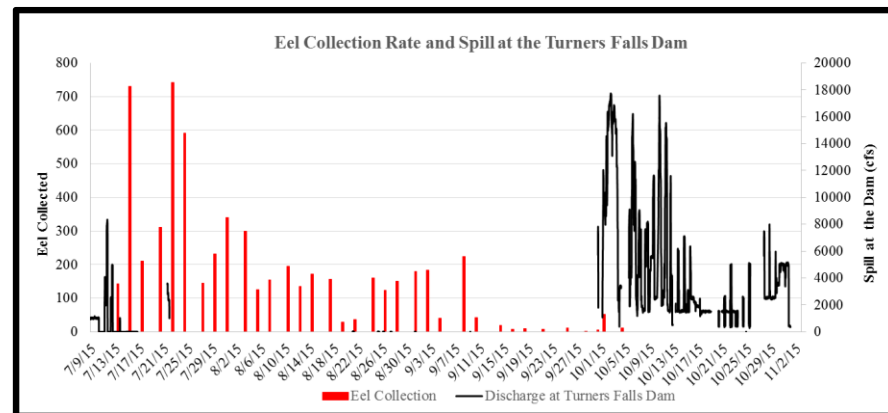
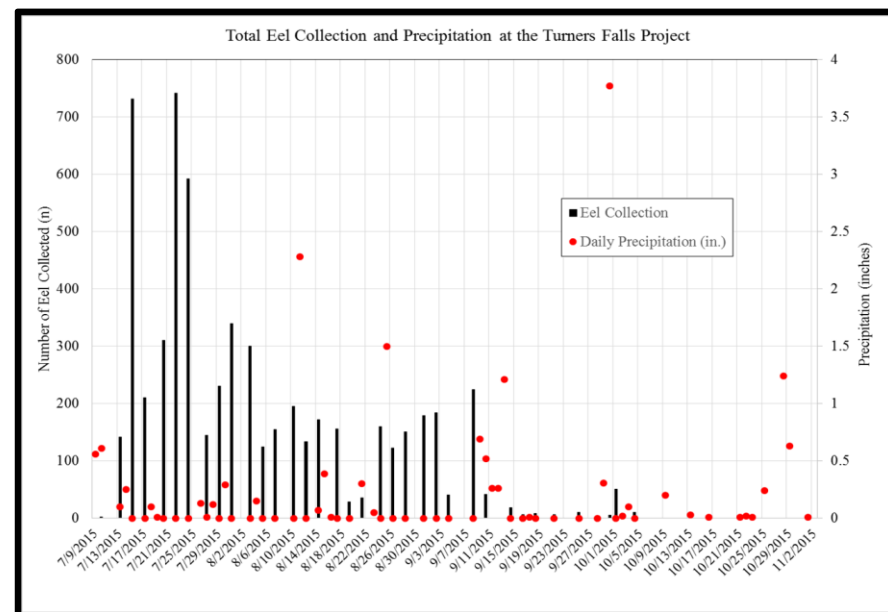
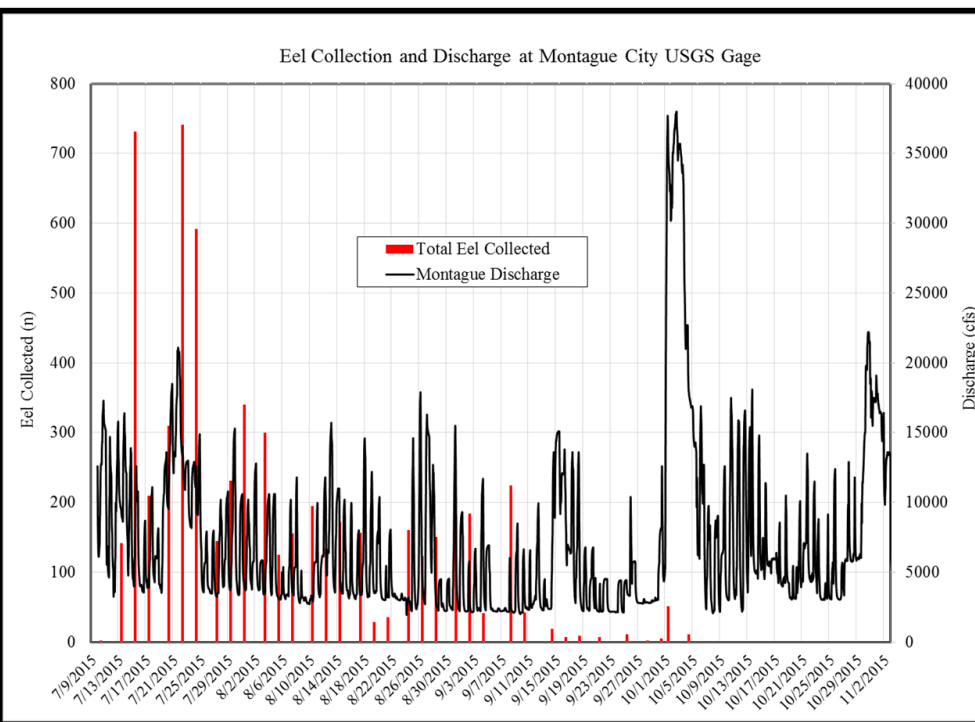
Size Category	Number of Eel
<10 cm	1 (0.04%)
10-20 cm	2,453 (97.1%)
>20 cm	72 (2.85%)



3.3.4-Evaluate Upstream Passage of American Eel at the Turners Falls Project

Task 2: Environmental and Operational Conditions

- No significant correlation was found between eel collection rates and precipitation, river flow or spill.



3.3.4-Evaluate Upstream Passage of American Eel at the Turners Falls Project

Conclusions

- Study results and observations conducted during the study indicate that the Spillway Fishway attracts the greatest number of migrating eel and probably has the most potential as a site for permanent passage facilities.
- The Cabot Emergency Spillway is not an appropriate location for a permanent passage structure. Spillway operation is intended to rapidly draw down the power canal in the event of a Cabot Station load rejection or canal dike breach or to sluice ice and debris downstream.

Variances

- Based on findings from Task 1 and with the concurrence of state and Federal agencies as well as other stakeholders, traps were not installed at the Cabot Fishway attraction flow stilling basin, and Spillway Fishway attraction flow stilling basin during the 2015 upstream eel migration period.
- The ramps of the eel traps were constructed at an angle between 34-43° based on site specific requirements in consultation with the stakeholders rather than < 35° as stipulated in the RSP.

3.3.6- Impact of Project Operations on Shad Spawning, Spawning Habitat and Egg Deposition in the Area of the Northfield Mountain and Turners Falls Projects

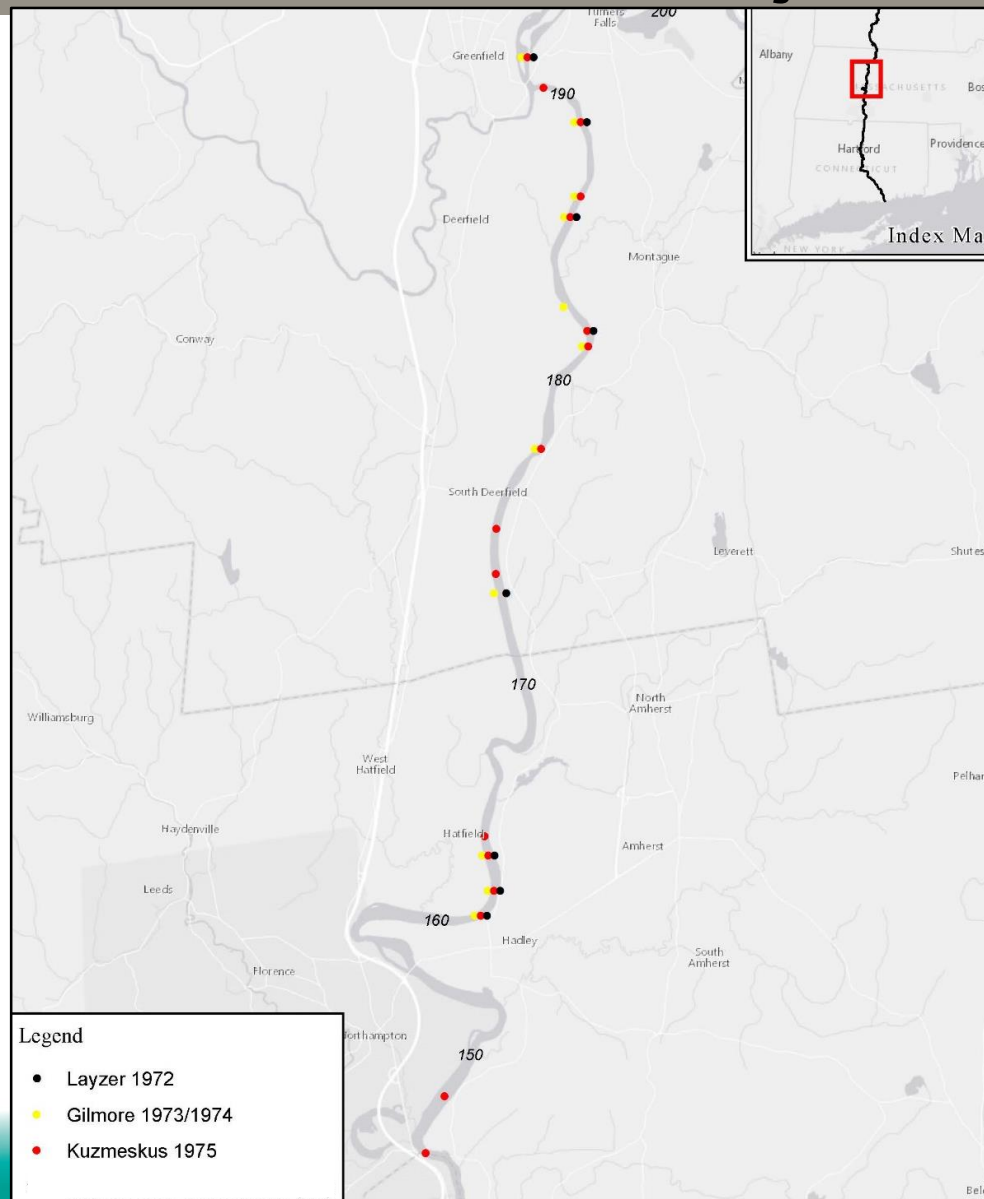
Study Objectives

- Determine areas utilized by shad for spawning by conducting night-time visual and aural observation of spawning activity;
- Identify and define those areas geospatially, and obtain data on physical habitat conditions affected by Project operations (e.g., water depth, velocity, discharge, substrate, exposure and inundation of habitats);
- Collect information to assess Project operation effects on observed spawning activity, under a range of permitted or proposed Project operation conditions;
- Quantify effects (e.g., water velocity, depths, inundation, exposure of habitats) of Project operation on identified spawning areas for a range of conditions, over the complete period of spawning activity and,
- Verify spawning activity as measured by night-time spawning/splash surveys in areas of spawning activity, and downstream of these areas, to gather data to determine project operation effects.

3.3.6- Impact of Project Operations on Shad Spawning, Spawning Habitat and Egg Deposition in the Area of the Northfield Mountain and Turners Falls Projects

Phase 1 Surveys

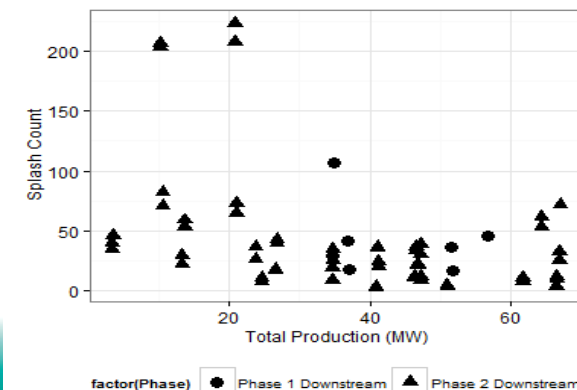
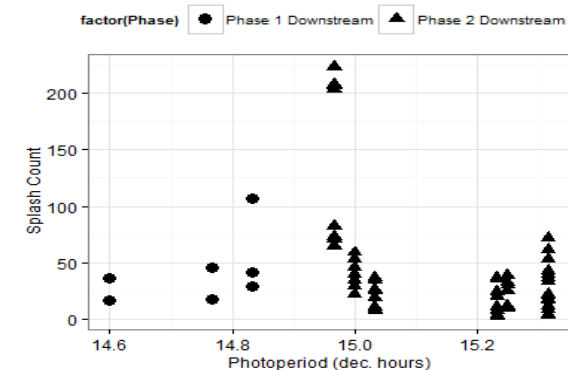
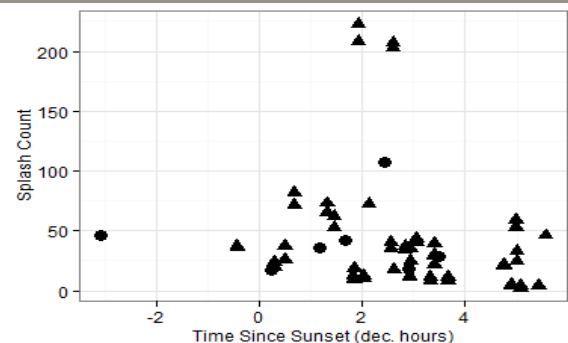
- Surveys in downstream reach were conducted on five nights between sunset and 01:00 from May 13 to May 21, 2015.
- Seven spawning events were observed during Phase 1.
- Almost 4 decades have passed since areas of shad spawning were identified downstream of Cabot Station, some of the same areas remain active spawning grounds for shad.



3.3.6- Impact of Project Operations on Shad Spawning, Spawning Habitat and Egg Deposition in the Area of the Northfield Mountain and Turners Falls Projects

Phase 2 Surveys – Below Cabot Station

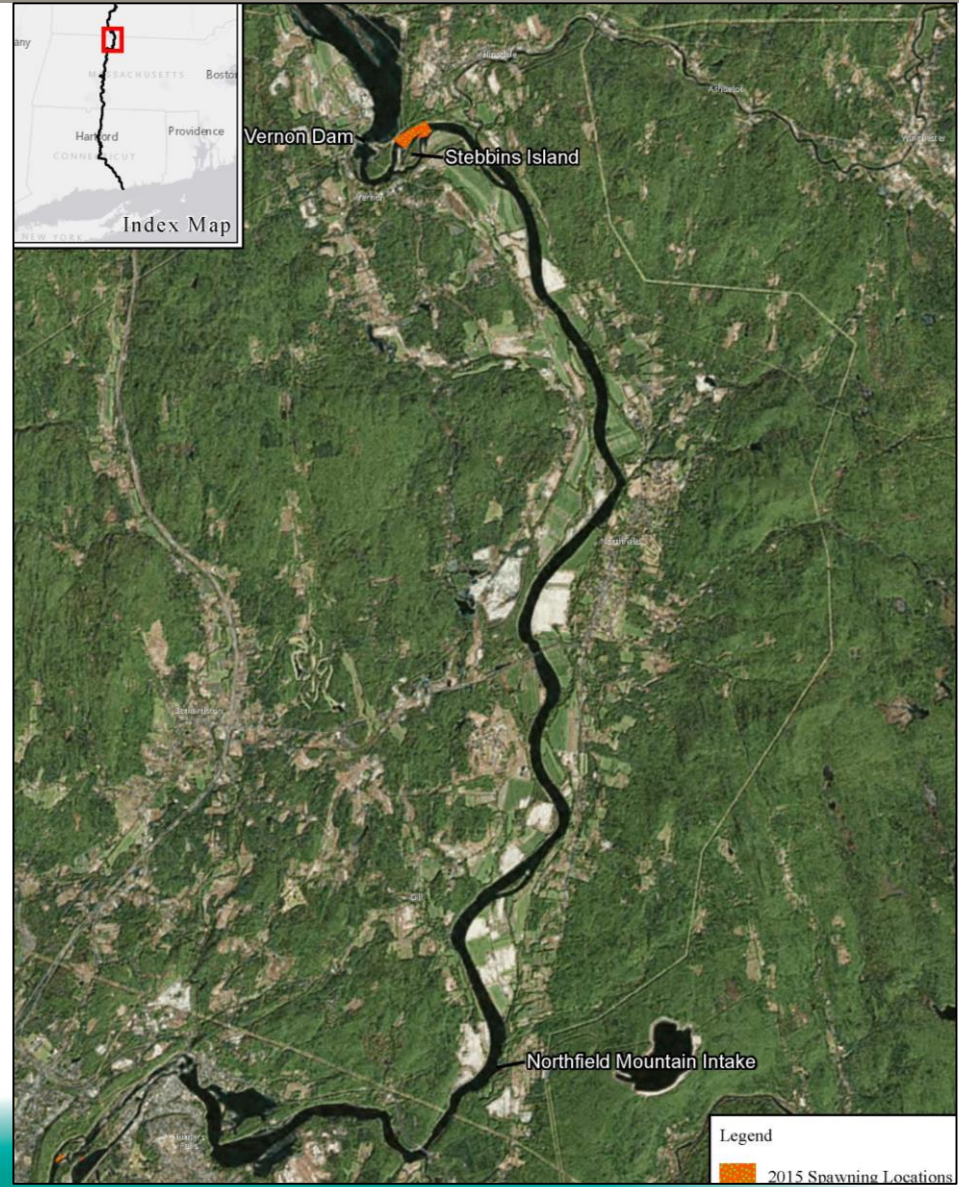
- Conducted from May 26 to June 22, 2015, the effects of changing generation at Cabot Station on shad spawning activity, as indicated by splash counts, was assessed.
- A spawning event was identified, splash counts were initially recorded over a 15-minute interval and physical habitat parameters were measured.
- Cabot Station generation was increased or decreased by one or two units and splash counts were again recorded.
- A multiple regression analysis was performed to identify variables that drive spawning, however the models failed goodness of fit testing and the errors suggested a strong temporal signature, which is exemplified in the photo period figure.
- The negative binomial model found no statistical difference in the mean splash counts before ($x=47.6$) and after ($x=36.6$) changes in generation at Cabot Station ($p=0.302$).



3.3.6- Impact of Project Operations on Shad Spawning, Spawning Habitat and Egg Deposition in the Area of the Northfield Mountain and Turners Falls Projects

Phase 2 Surveys – Impoundment

- Spawning activity was documented in a 39 acre area near the downstream end of Stebbins Island during 7 separate events.
- The Vernon Hydroelectric Project is located less than 2 river kilometers upstream from this spawning area.
- Shad eggs and larvae were collected downstream of the spawning area and densities ranged from 7 to 101 eggs per 100 m³; 2 larvae were also collected.

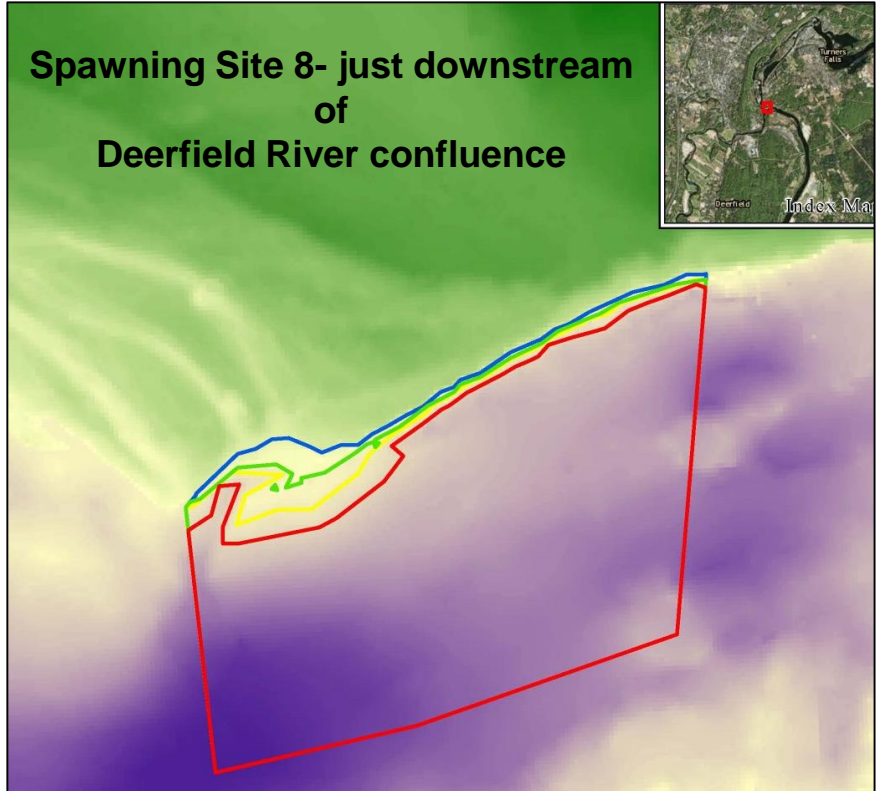


3.3.6- Impact of Project Operations on Shad Spawning, Spawning Habitat and Egg Deposition in the Area of the Northfield Mountain and Turners Falls Projects

Spawning Habitat During Generation Changes

- In general, changes in area due to increasing or decreasing Cabot Station generation by 1 or 2 units were minimal.
- Spawning sites were impacted by a maximum of 2% during generation change.
- The magnitude of area changes at the sites closest to Cabot Station was less than at Fourth Island.

Spawning Site 8- just downstream of Deerfield River confluence



Legend

Elevation NGVD29 ft

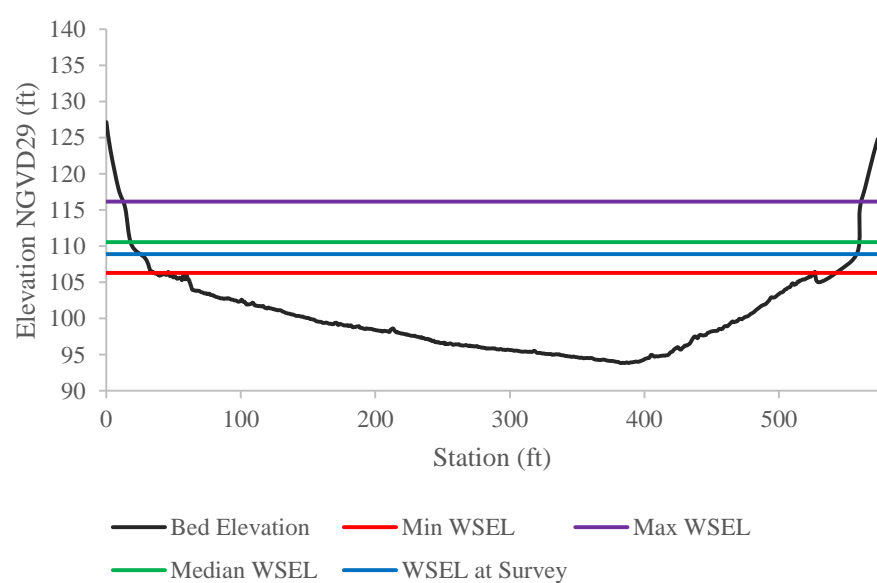
High : 156.575

Low : 71.48

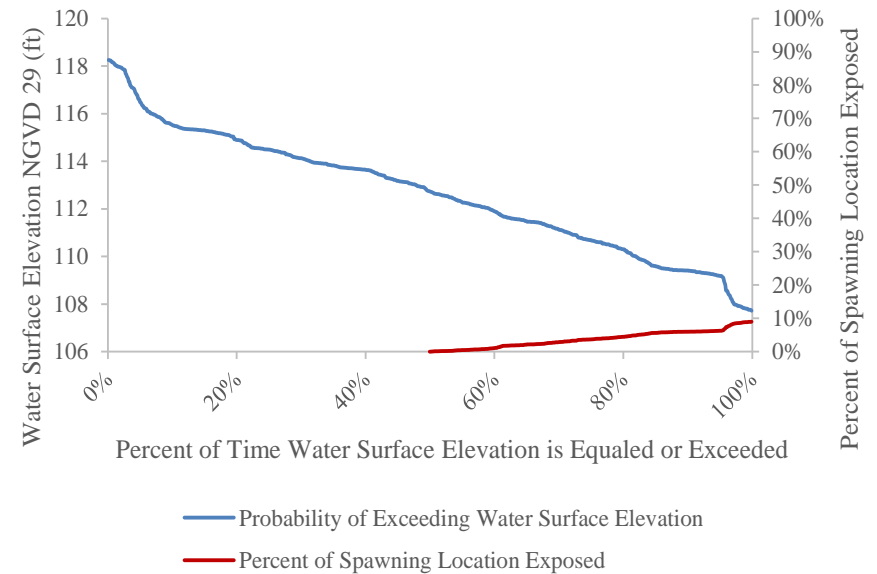
- Wetted Spawning Area At Minimum Observed WSEL During Study Period (WSEL 107.72ft, 3,180cfs @ USGS 01170500)
- Wetted Spawning Area At Median WSEL During Study Period (WSEL 112.74ft, 13,000cfs @ USGS 01170500)
- Wetted Spawning Area at Survey WSEL (WSEL 111ft, 8,310cfs @ USGS 01170500)
- Wetted Spawning Area at Maximum Observed WSEL During Study Period (WSEL 118.37ft, 36,600cfs @ USGS 01170500)

3.3.6- Impact of Project Operations on Shad Spawning, Spawning Habitat and Egg Deposition in the Area of the Northfield Mountain and Turners Falls Projects

Minimum, Maximum, Median, and Survey Time WSEL for Spawning Site 9



Habitat Duration Curve for Spawning Site 8



3.3.20- Study to Evaluate Entrainment of Ichthyoplankton at the Northfield Mountain Pumped Storage Project

Study Objectives

- Calculate the number of American shad eggs and larvae entrained at the Northfield Mountain Project;
- Estimate the loss of adult and juvenile shad equivalents based on shad egg and larvae entrainment at the Northfield Mountain Project;
- Compare entrainment rates with one through four units pumping; and
- Determine the temporal distribution of entrainment within the prevailing pumping period.



3.3.20- Study to Evaluate Entrainment of Ichthyoplankton at the Northfield Mountain Pumped Storage Project

Entrainment Sampling

Sampling system consisted of PVC and rubber piping, a digital flow meter, a 1,000-liter plastic tank, and a 0.333 mm mesh plankton net. 100 m³ (26,500 gallons) of intake water at a rate of 3 and 3 ½ gal/sec was filtered for each sample. Approximately 2 hours to collect each sample.



Offshore Sampling

Samples were collected in the intake/tailrace channel with a weighted 60-cm diameter paired bongo nets with 0.333 mm mesh deployed from a boat. Nets were towed until at least 100 m³ of river water were sampled. General Oceanics flowmeters were suspended in the center of each net to measure the volume of river water filtered during each tow.



Sample Processing

Samples were sorted by biologists trained in ichthyoplankton identification with the aid of a dissecting microscope. American shad larvae and eggs were removed from the samples, identified and enumerated. A QC program designed to ensure that the Average Outgoing Quality Limit for sorting and identification is greater than 90% was followed.



3.3.20- Study to Evaluate Entrainment of Ichthyoplankton at the Northfield Mountain Pumped Storage Project

Findings

- 23 entrainment samples and 12 verification samples were collected from May 28 to June 26, 2015.
- The entrainment sample densities are the sample count divided by the sample volume.
- No larvae were counted in entrainment samples.
- Offshore sampling was conducted adjacent to Northfield Mountain intake on evenings corresponding with the special unit scenarios (6/9/2015- 4 units, 6/10/2015- 3 units, 6/18/2015- 2 units and 6/19/2015- 1 unit).
- Overall shad egg densities collected at the intake were lower than those collected in the entrainment samples.
- The only area shad were detected spawning in the impoundment was 22 RKM upstream, at the downstream end of Stebbins Island. Here, egg densities from May 19 to June 18, 2015 ranged from 7 to 101 per 100 m³.

3.3.20- Study to Evaluate Entrainment of Ichthyoplankton at the Northfield Mountain Pumped Storage Project

Findings

- Shad densities in entrainment samples were low. When extrapolated by the volume of water pumped during the spawning season just over 3 million shad eggs and 500,000 shad larvae were estimated to be entrained at the Northfield Mountain Project in 2015.
- Based on the entrainment estimate the number of equivalent juvenile and adult American shad lost to entrainment was estimated to be 696 juveniles and 94 adult American shad.
- American shad spawning strategy includes broadcasting large numbers of eggs which experience high natural mortality.
- Female American shad spawn between 150,000-500,000 eggs, with fecundity increasing with age, length, and weight.
- Only about 1 out of every 100,000 eggs survives to become a spawning adult.
- High fecundity is critical for continuing the stock.



3.3.11- Fish Assemblage

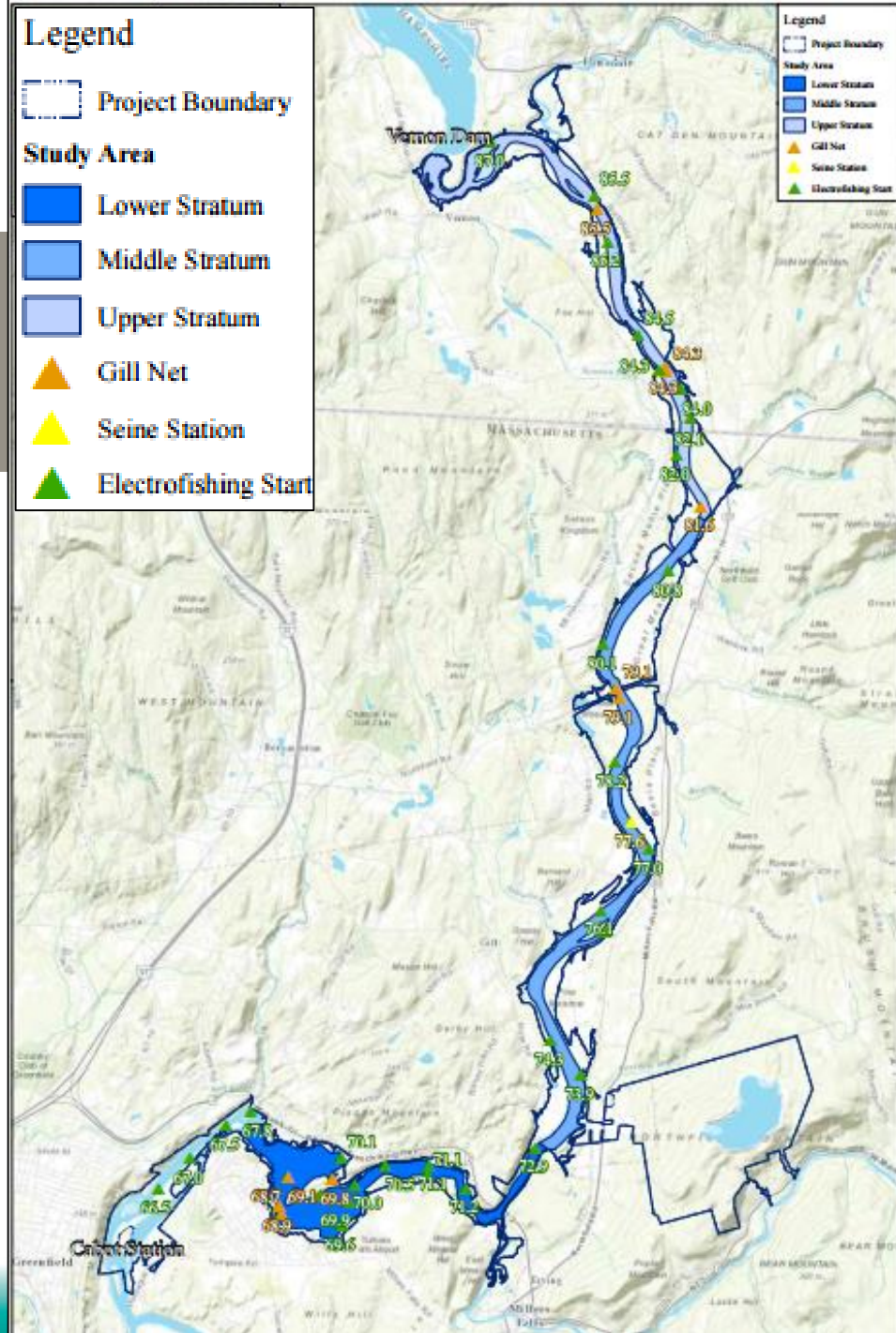
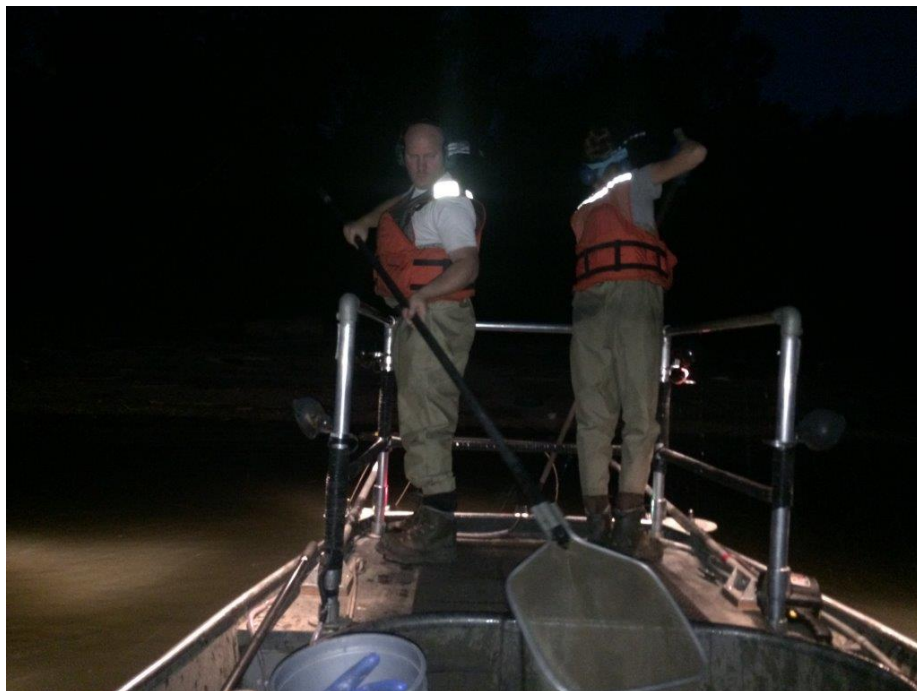
Study Objectives

- Document species occurrence, distribution, and relative abundance of resident and diadromous fish within the project 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.

Sampling Periods

- Turners Falls Impoundment- Early and Late Summer
 - Stratified Sampling Design
- Bypass Reach- Late Summer
 - All mesohabitats sampled

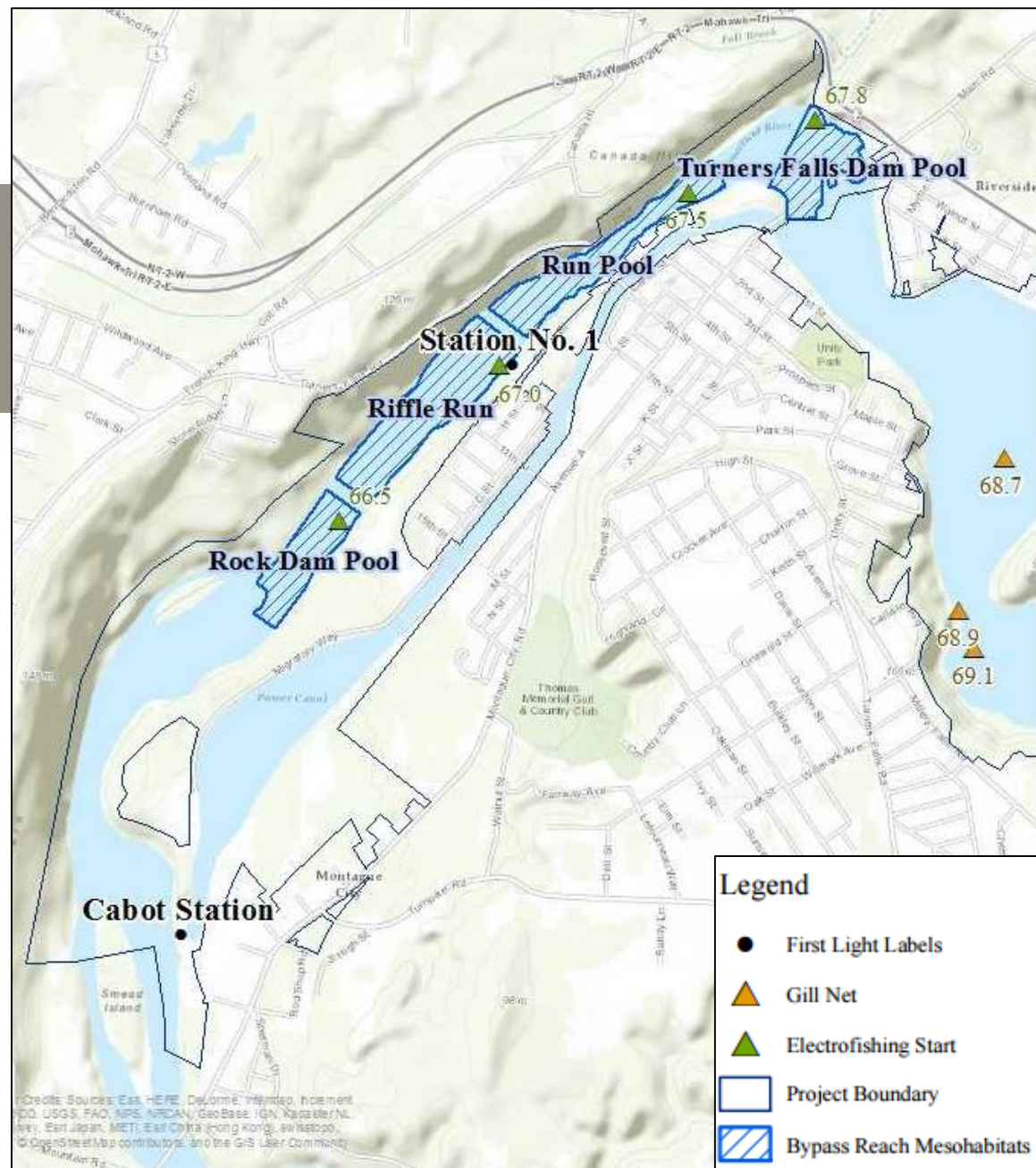
- 24 boat electrofishing samples
- 11 gill net samples
- 6 seine/electrofishing stations



3.3.11- Fish Assemblage

Bypass Reach

- 4 raft electrofishing samples



3.3.11- Fish Assemblage

Species Occurrence, Distribution & Relative Abundance

- 5,908 individuals of 28 species

Impoundment

- Early Summer: Spottail shiner (44%), smallmouth bass (16%) & yellow perch (14%) accounted for 74% of the catch.
- Late Summer: Spottail shiner (48%), smallmouth bass (15%), yellow perch (14%) and fallfish (7%) accounted for 76% of the catch.
- Smallmouth bass, fallfish, rock bass, tessellated darter and American eel abundance was greater in the upstream stratum.
- Bluegill, pumpkinseed, largemouth bass, banded killifish, white sucker, & yellow perch tended toward greater abundance in the downstream stratum.

Bypass Reach

- Smallmouth bass (62.5%), American eel (9.7%), & bluegill (8.2%), collectively accounted for 80.4% of the overall catch.

3.3.11- Fish Assemblage

Distribution Relative to River Reaches

- The highest community diversity was associated with rich habitat and the upper TFI stratum.
- In rich habitat, SW scores ranged from 1.36 (lower TFI) to 1.83 (upper TFI).
- In poor habitat, SW scores range from 1.29 to 1.77.
- The highest mean CPUE per stratum was consistently in the lower TFI stratum.
- Habitat complexity (QHEI) correlated positively with diversity; however, diversity was only slightly different between the two categories: 1.57 (rich habitat) vs 1.43 (poor habitat).
- Sites with a QHEI score greater than 60 exhibit relatively high SW index scores of 1.8 or more.

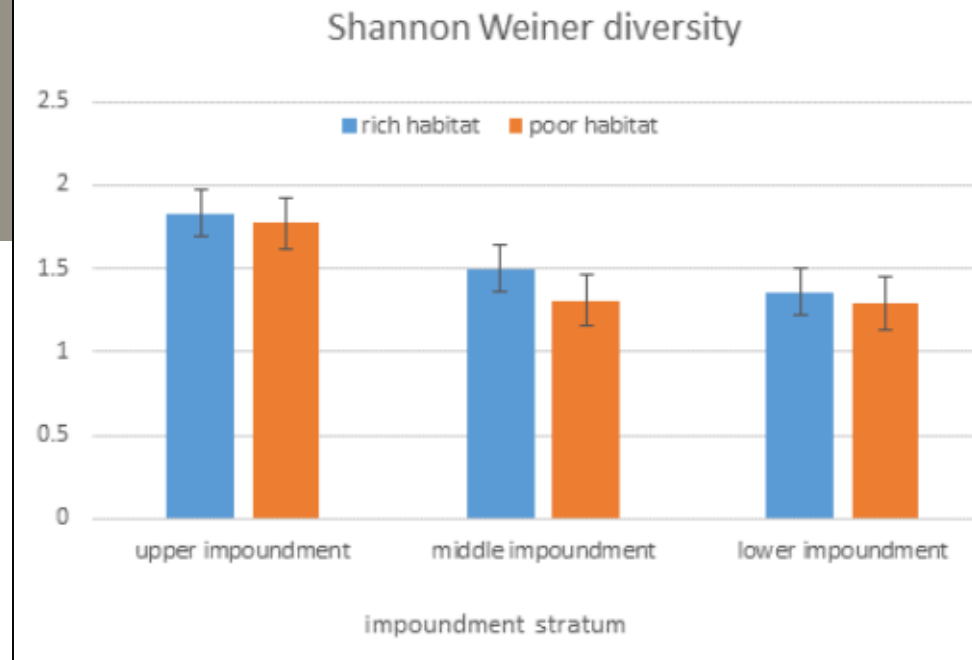


Table 4.2.2.2-5: Turners Falls Project CPUE for 24 Impoundment Boat Electrofishing Samples during Early and Late Summer 2015

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.

3.3.11- Fish Assemblage

Comparison to Historical Data

- Resident fish assemblage remained relatively stable within comparable habitats between 2008 and 2015.
- The present study found 28 species; past surveys detected 19-22 species.

Impoundment

- 4 of the 6 most dominant species remained the same between 2008 and 2015.
- YOY of anadromous species were among the 6 most dominant species in both surveys.
- 4 of the 6 most dominant species remained the same between 1970's and 2015.
- Diadromous (YOY) were dominant in 2015, but absent in the 1970's.

Bypass Reach

- 3 of the 6 most dominant species 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 not common.

Species listed in declining order of rank score dominant

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

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

3.2.1-Water Quality Monitoring Study

Study Objectives

- Characterize water temperature and DO within the TFI, bypass channel, power canal, and below Cabot Station.
- Determine potential impacts of the Turners Falls Project and Northfield Mountain Project on water temperature and DO.
- Compare collected data with applicable state water quality standards.
- Describe water temperature and temperature rate of change in the Connecticut River between Cabot Station and the Holyoke Dam.

3.2.1-Water Quality Monitoring Study

Water Quality Field Methods:

Water Temperature: April – mid-November

Dissolved Oxygen: June - September

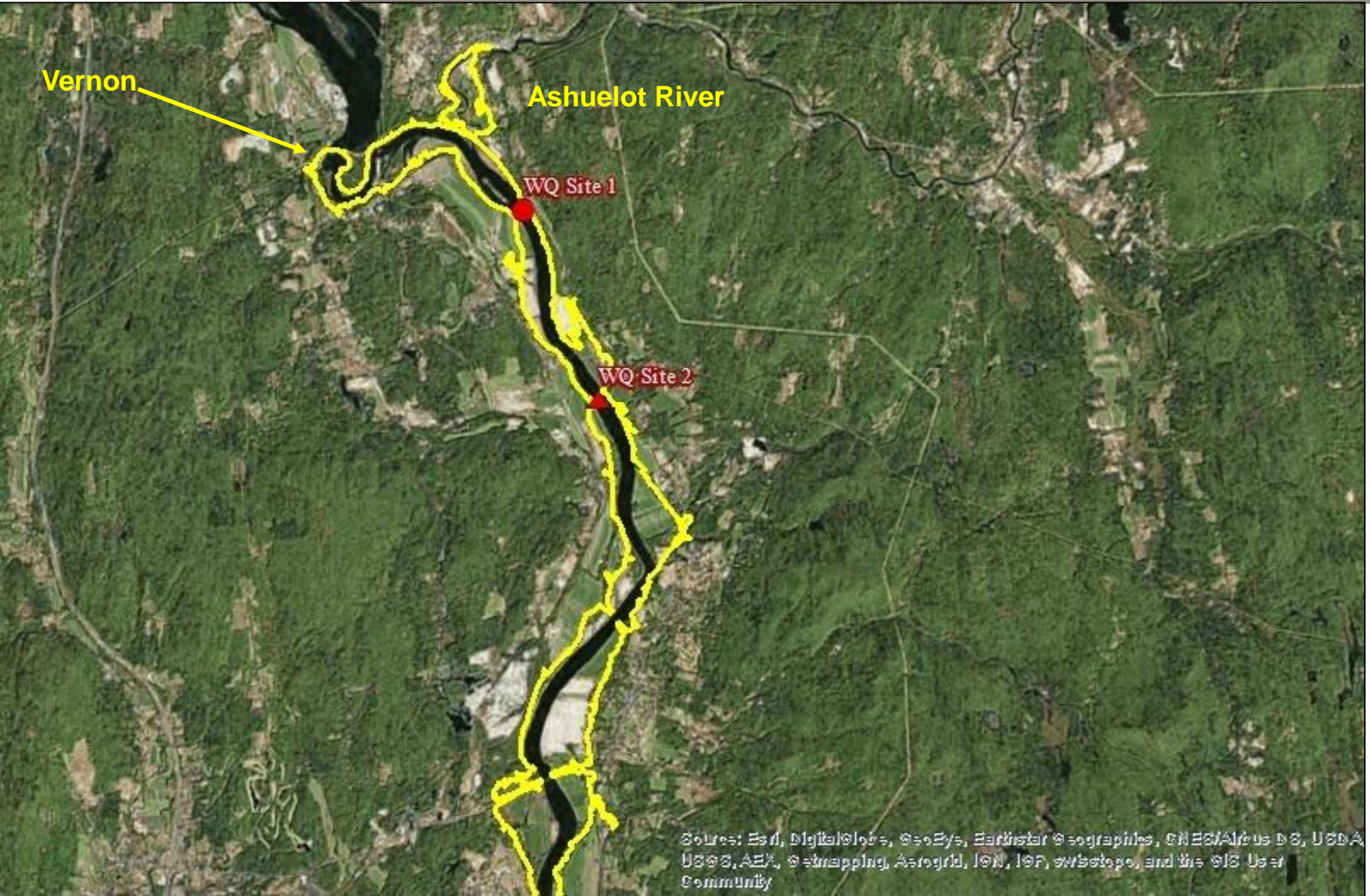
Impoundment Vertical Profiles:

- 3 locations
- Biweekly field visits
- Data in 1 m increments

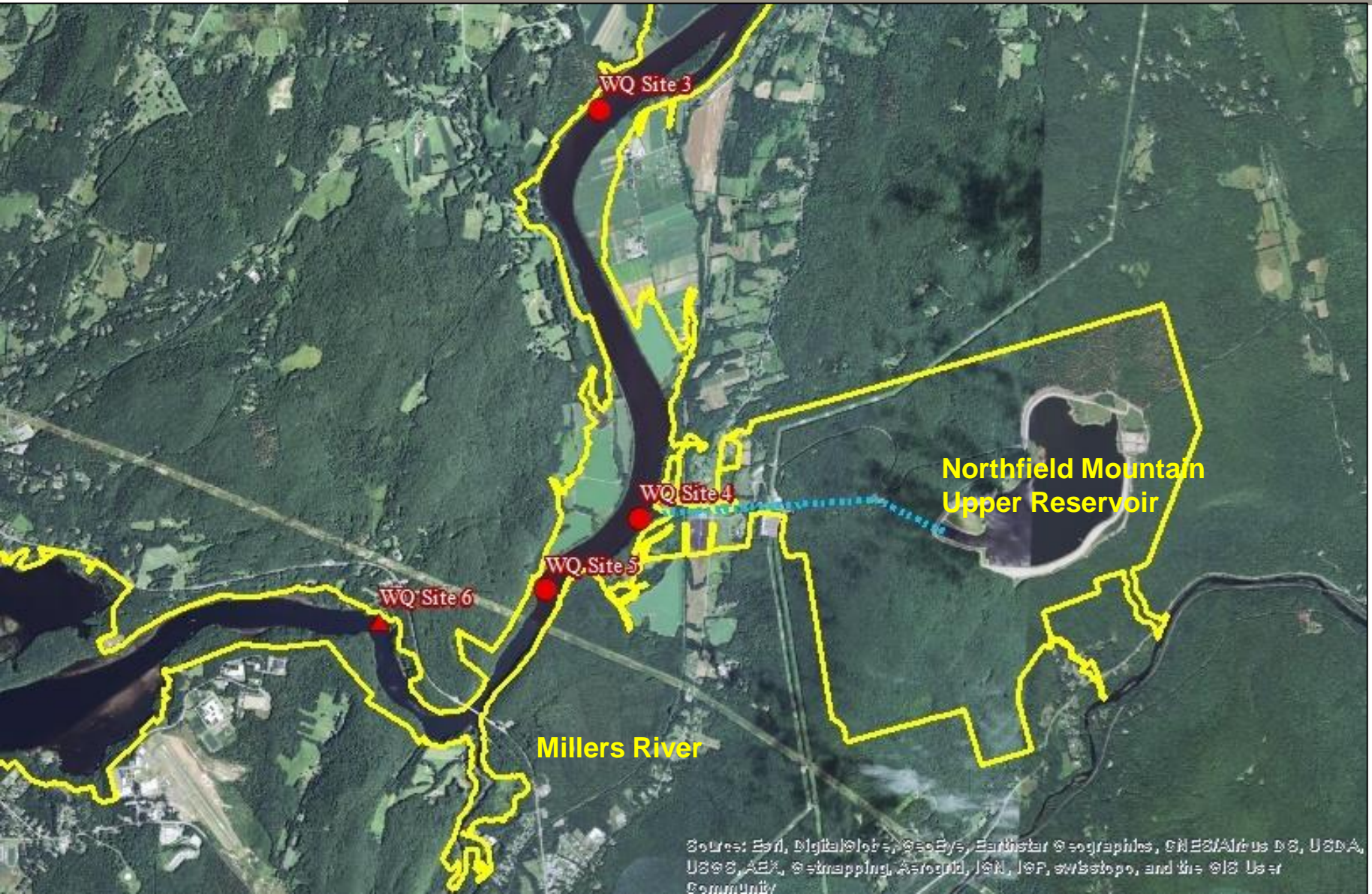
Continuous Data Monitoring:

- 18 locations
- Biweekly field visits
- Data in 15 min intervals
- DO & temperature loggers
 - 11 locations
- Temperature (only) loggers:
 - 7 locations

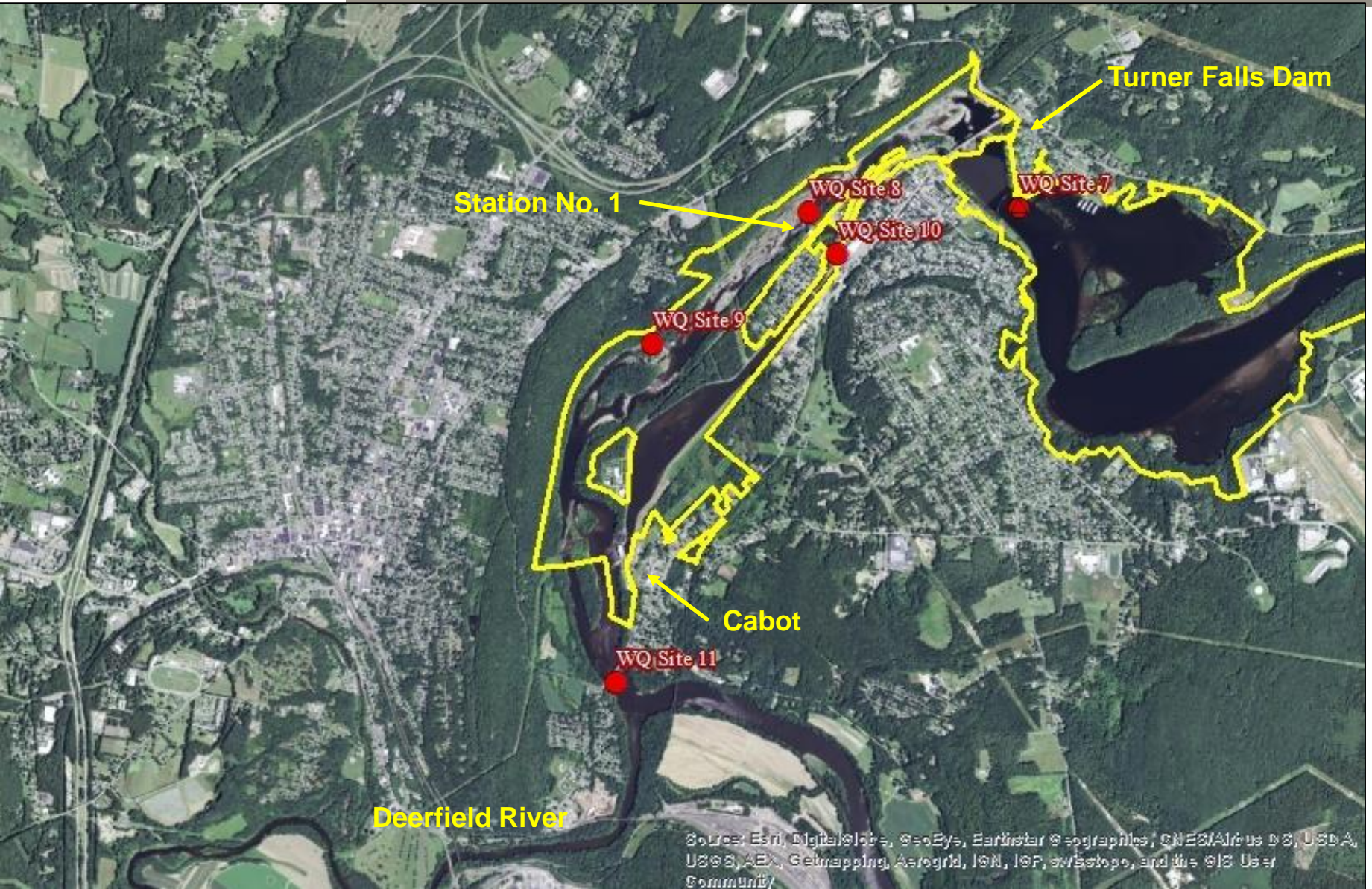
3.2.1-Water Quality Monitoring Study



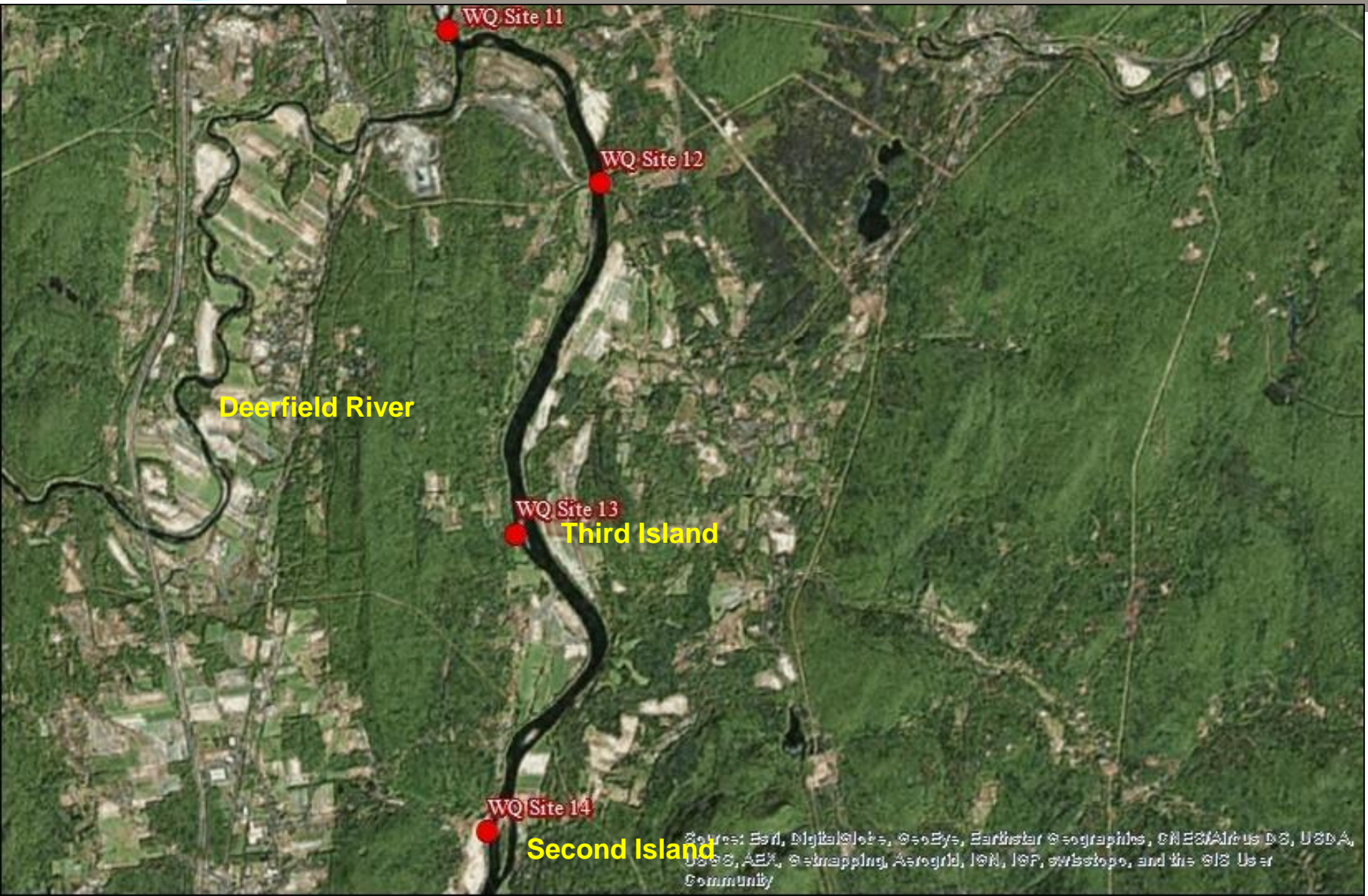
3.2.1-Water Quality Monitoring Study



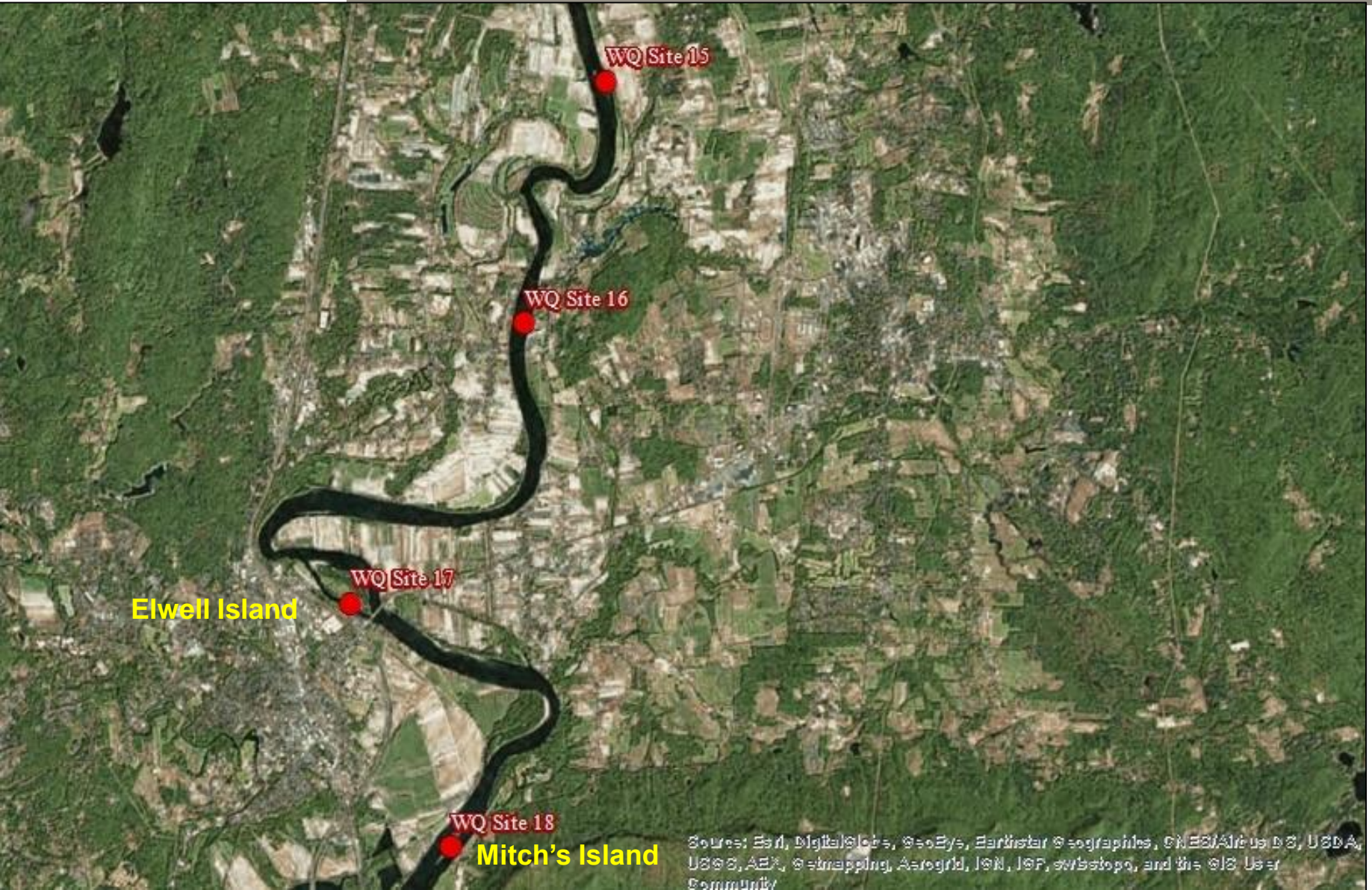
3.2.1-Water Quality Monitoring Study



3.2.1-Water Quality Monitoring Study



3.2.1-Water Quality Monitoring Study

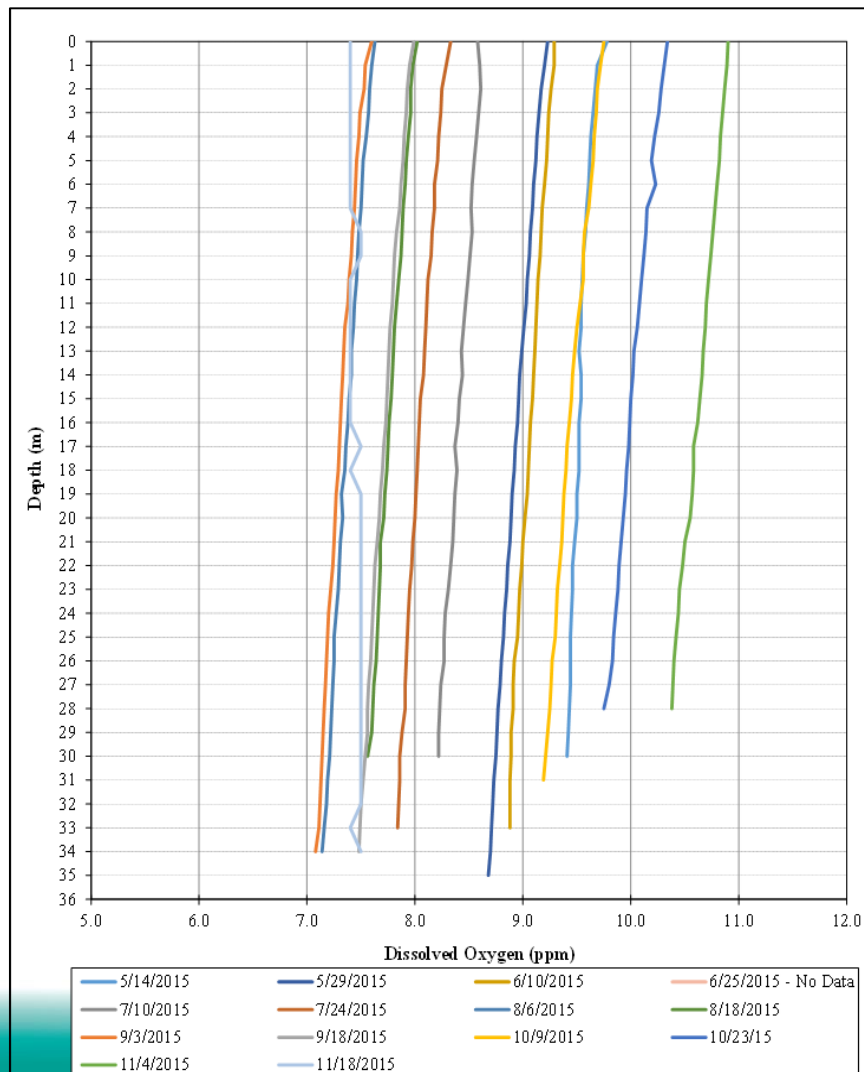
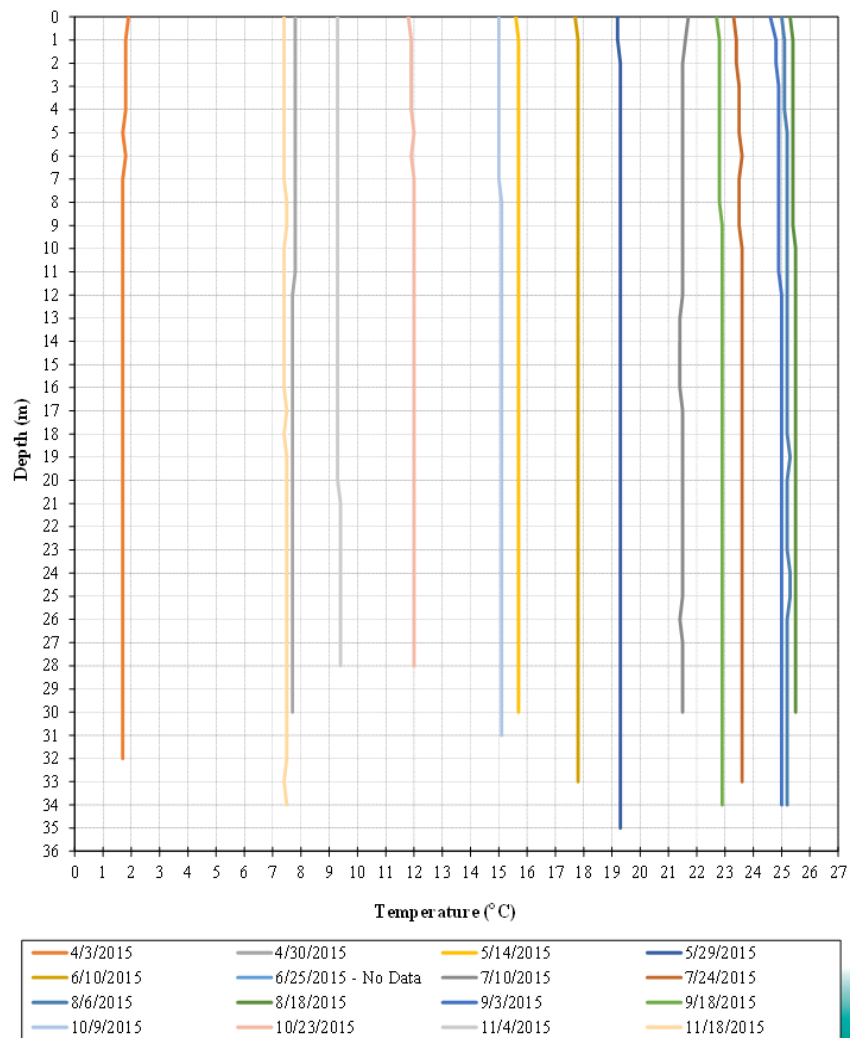


3.2.1-Water Quality Monitoring Study

Site 6 – Deepest area of TFI (up to 35 m)

2015 Temperature Results (°C)

2015 Dissolved Oxygen Results (mg/L)



3.2.1-Water Quality Monitoring Study

All Class B MA Water Quality Standards were met

State	DO Standard	Temperature Standard
MA	No less than 5.0 mg/L. "Natural variations to be maintained. Where natural background conditions are lower, DO shall not be less than natural background conditions."	Shall not exceed 83° F (28.3° C). Rise in temperature due to discharge shall not exceed 5° F (2.8° C) based on minimum expected flow for the month.
NH	75% DO saturation based on daily average, and an instantaneous minimum dissolved oxygen concentration of at least 5 mg/L.	Related temperature increases shall not interfere appreciably with the uses of this class.
VT	No less than 5 mg/L and 60% DO saturation at all times.	Shall ensure full support of aquatic flora, fauna and habitat uses.

Instantaneous Temperature

Max: 28.1°C at Site 16 (below Cabot Station)

Instantaneous Dissolved Oxygen

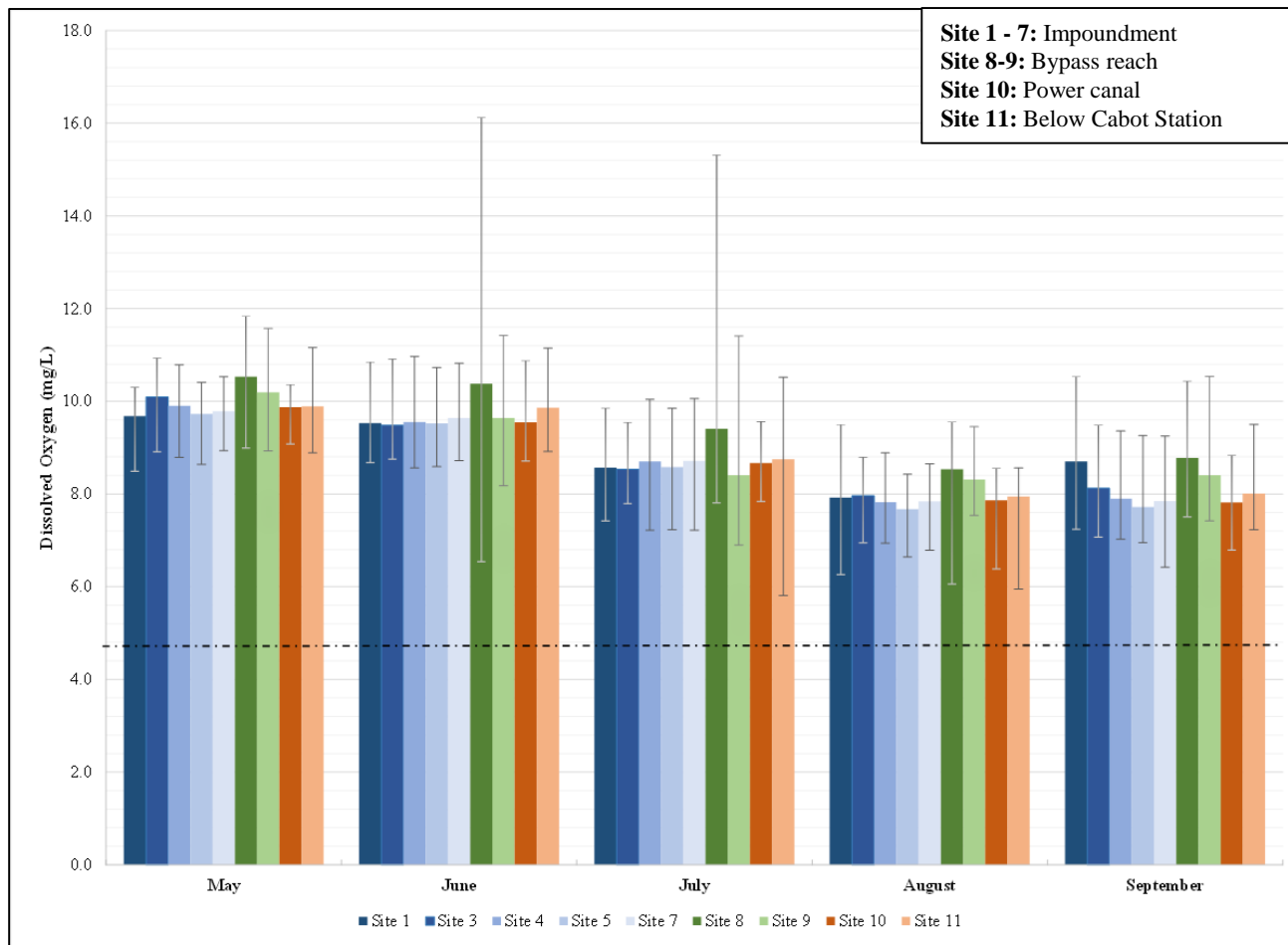
Min: 5.8 mg/L (71.1% saturation) at Site 11 (below Cabot Station)

Max: 16.1 mg/L (181% saturation) at Site 8 (upstream of Station No. 1)

3.2.1-Water Quality Monitoring Study

Water Quality Characterization: DO (Sites 1 – 11)

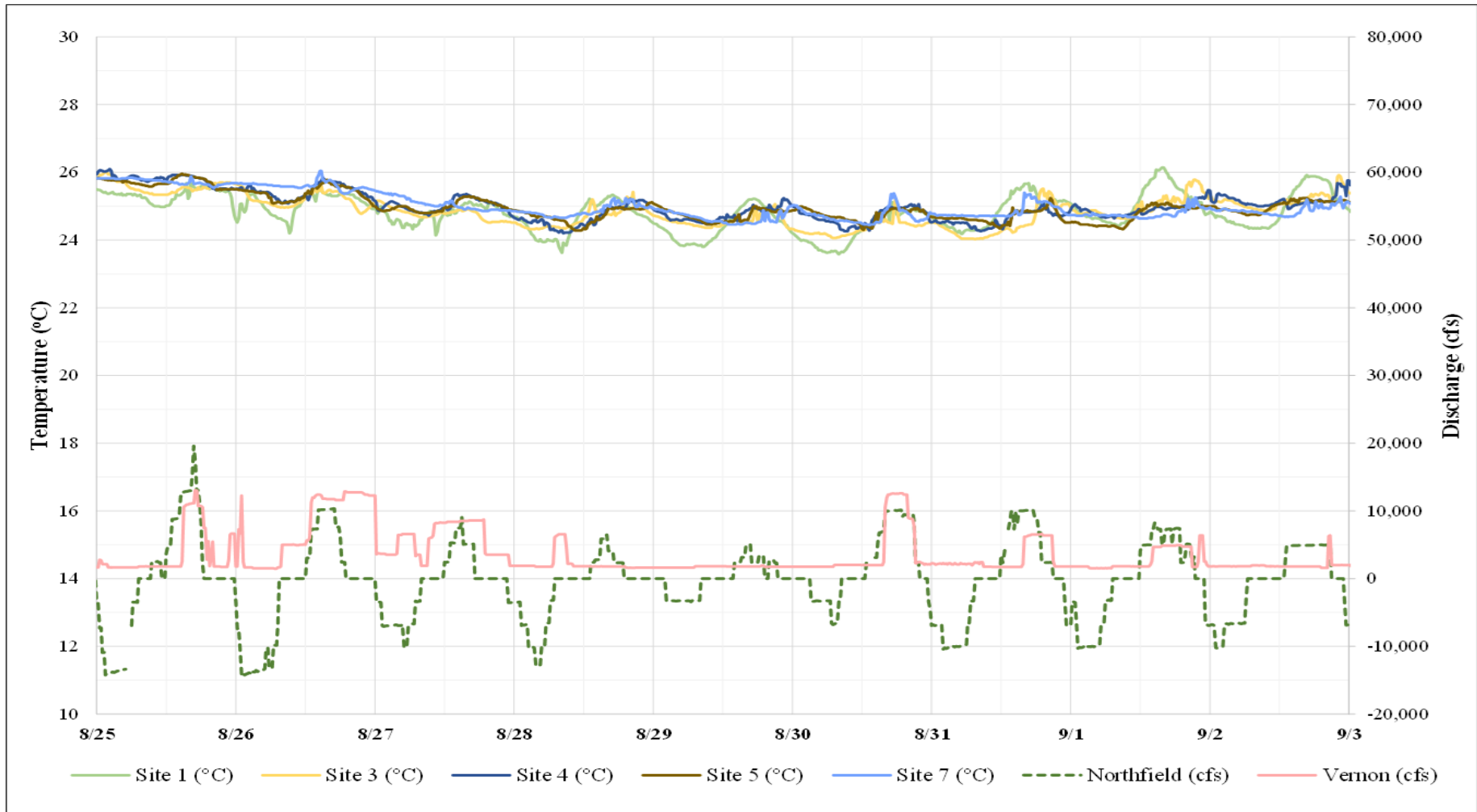
Monthly Average, Minimum and Maximum DO Concentrations (Mid-May – September, 2015)



3.2.1-Water Quality Monitoring Study

Water Quality Characterization: TFI (Sites 1 – 7)

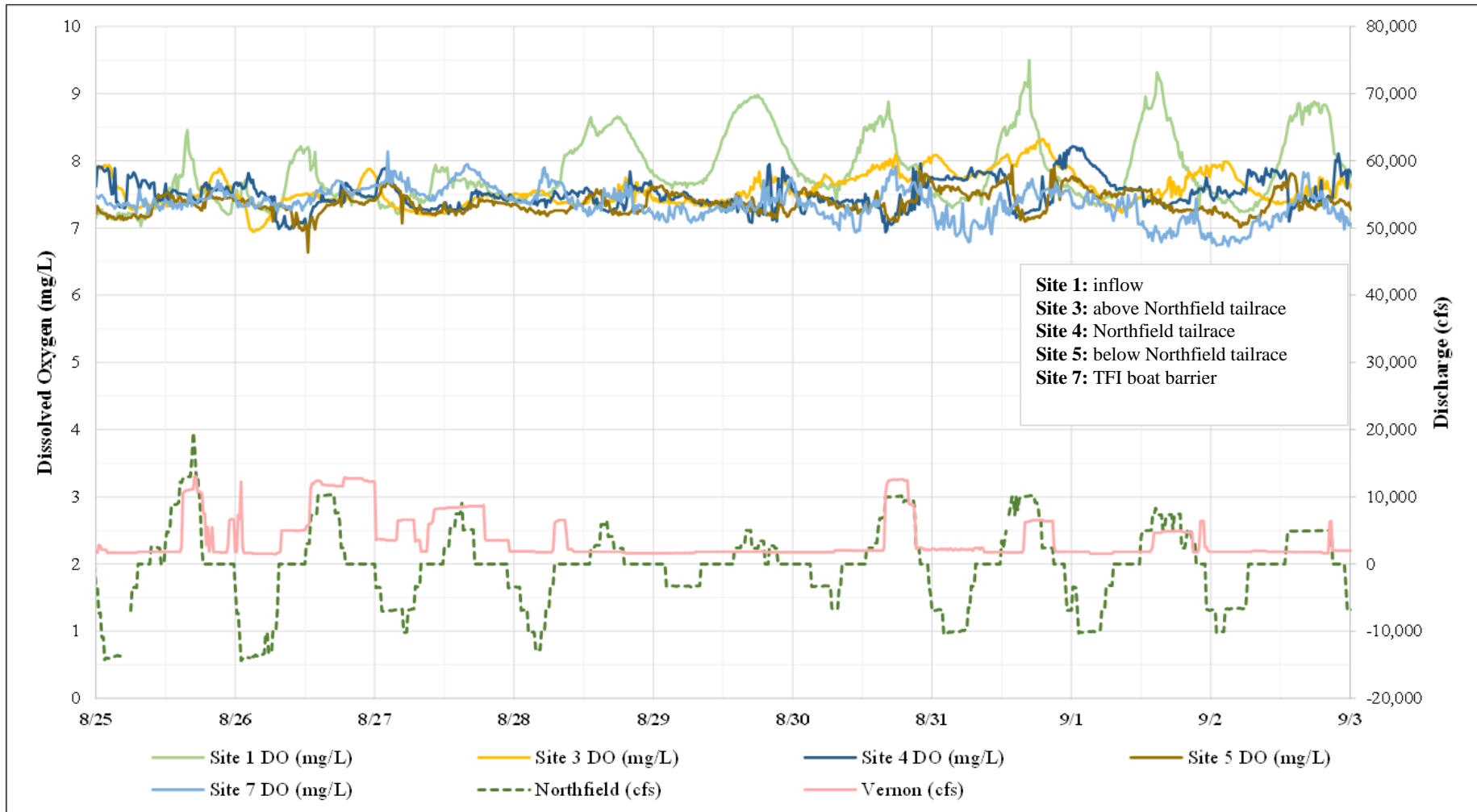
Temperature in TFI in Comparison to Vernon and Northfield Mountain Operations (Aug 25 – Sep 2, 2015)



3.2.1-Water Quality Monitoring Study

Water Quality Characterization: TFI (Sites 1 – 7)

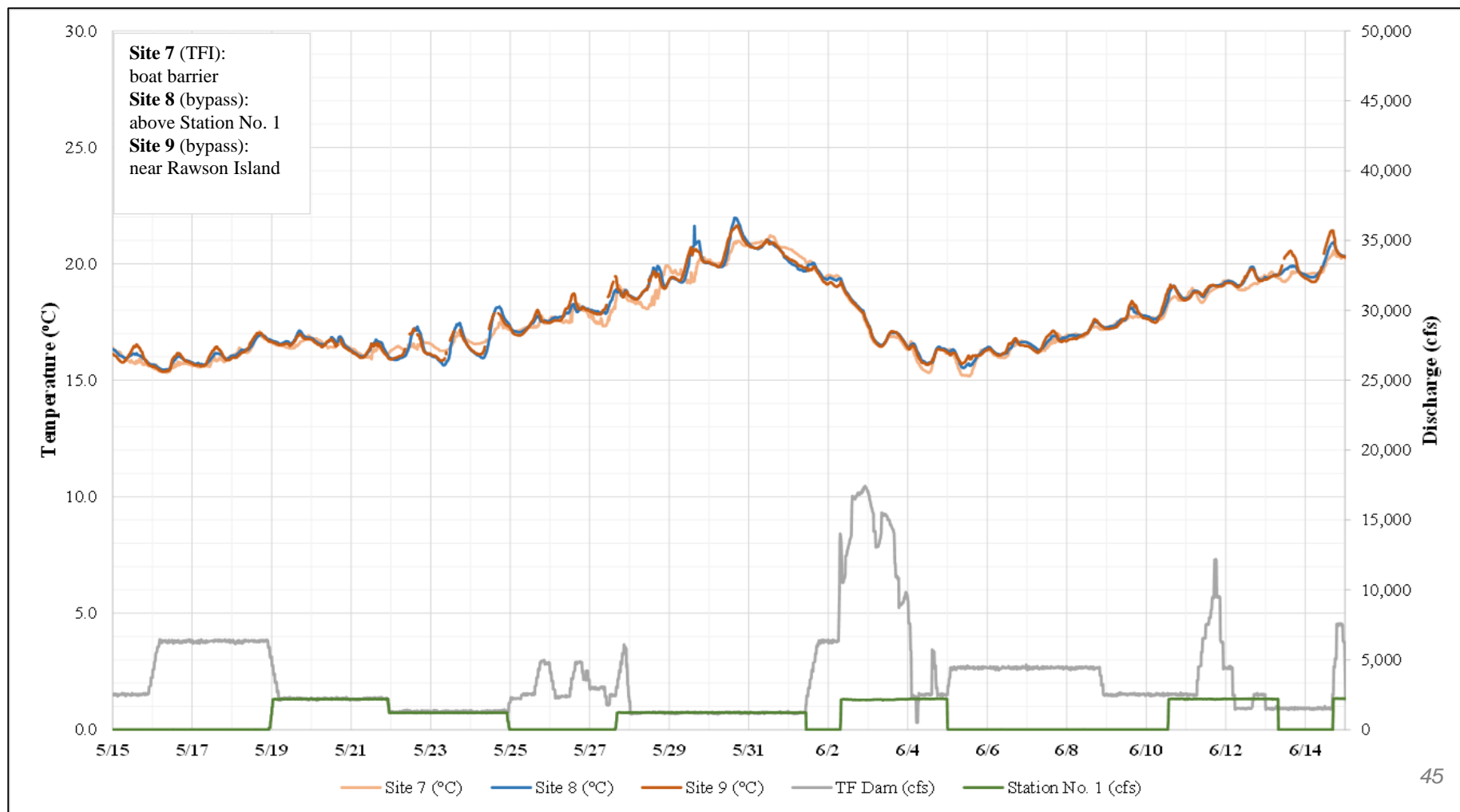
DO Concentration in TFI in Comparison to Vernon and Northfield Mountain Operations (Aug 25– Sep 2, 2015)



3.2.1-Water Quality Monitoring Study

Water Quality Characterization: Bypass Reach (Sites 8 & 9)

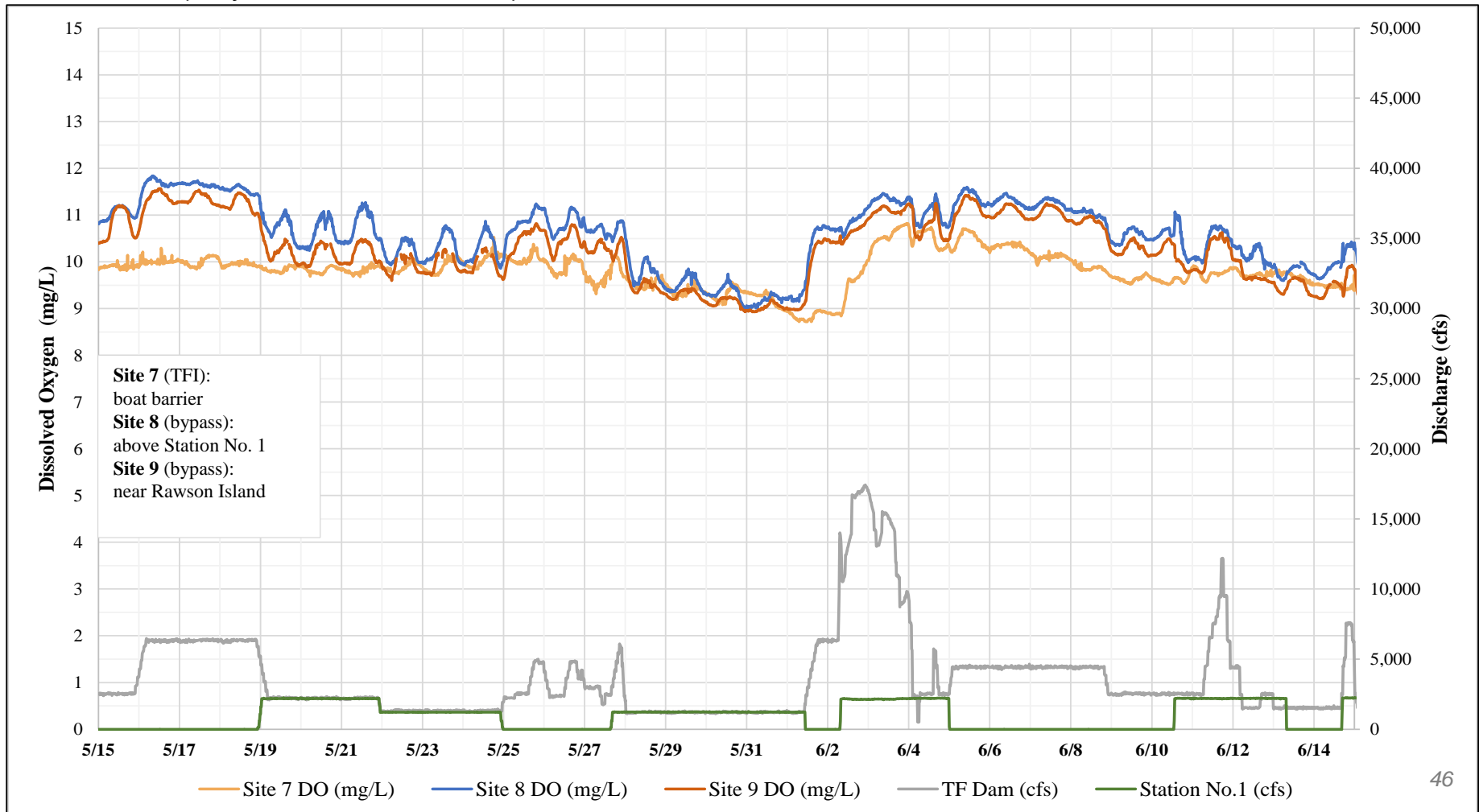
Bypass Reach Temperature compared against Turners Falls Dam Spillage and Station No. 1 Generation
(May 15 – June 14, 2015)



3.2.1-Water Quality Monitoring Study

Water Quality Characterization: Bypass Reach (Sites 8 & 9)

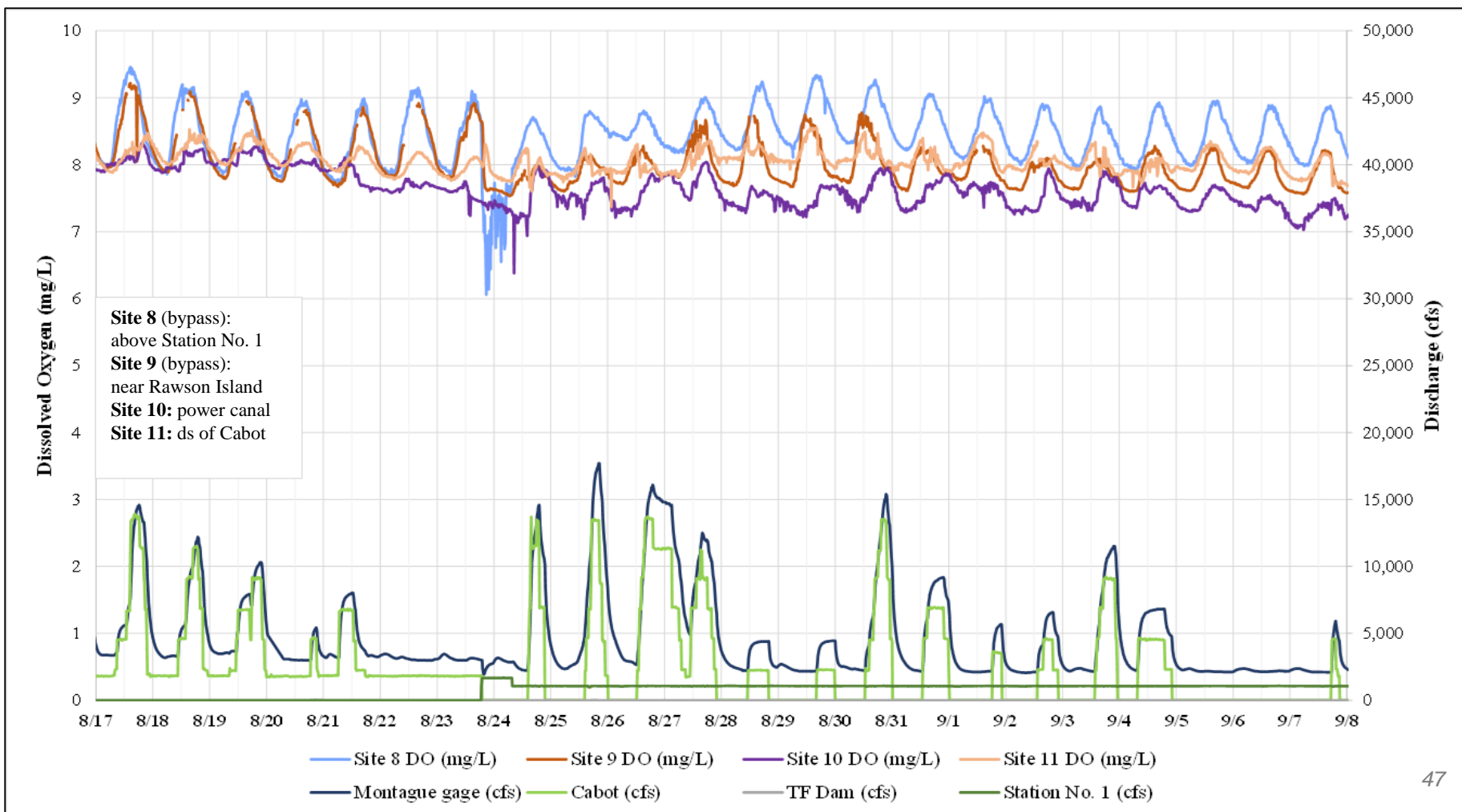
Bypass Reach DO Concentration compared Against Turners Falls Dam Spillage and Station No. 1 Generation (May 15 – June 14, 2015)



3.2.1-Water Quality Monitoring Study

Water Quality Characterization: Bypass reach, power canal and ds of Cabot (Sites 8-11)

DO Concentration at Site 11 Downstream of Cabot Station (August 17 – September 7, 2015)

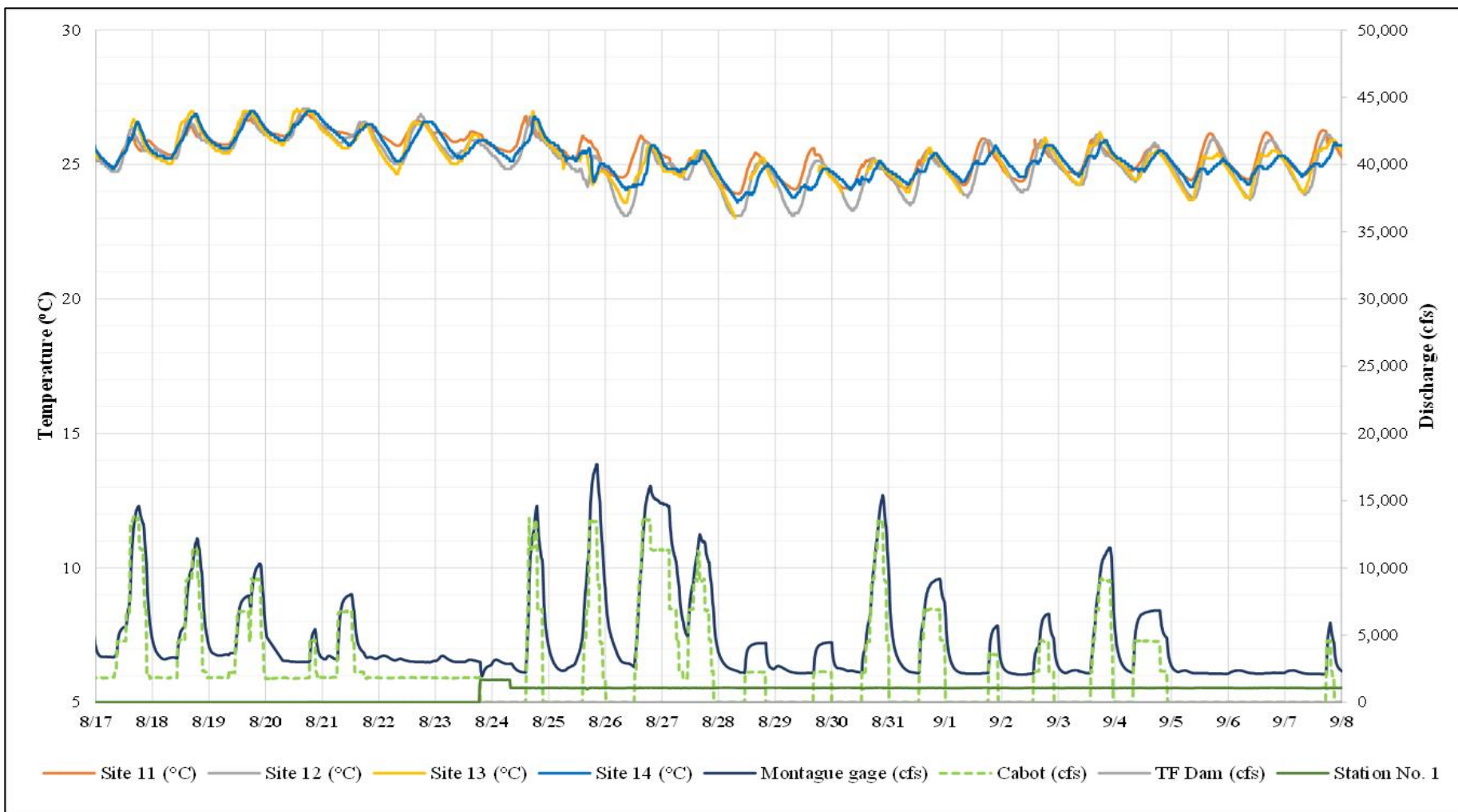


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3.2.1-Water Quality Monitoring Study

Water Quality Characterization: Downstream of Cabot Station (Sites 11-14)

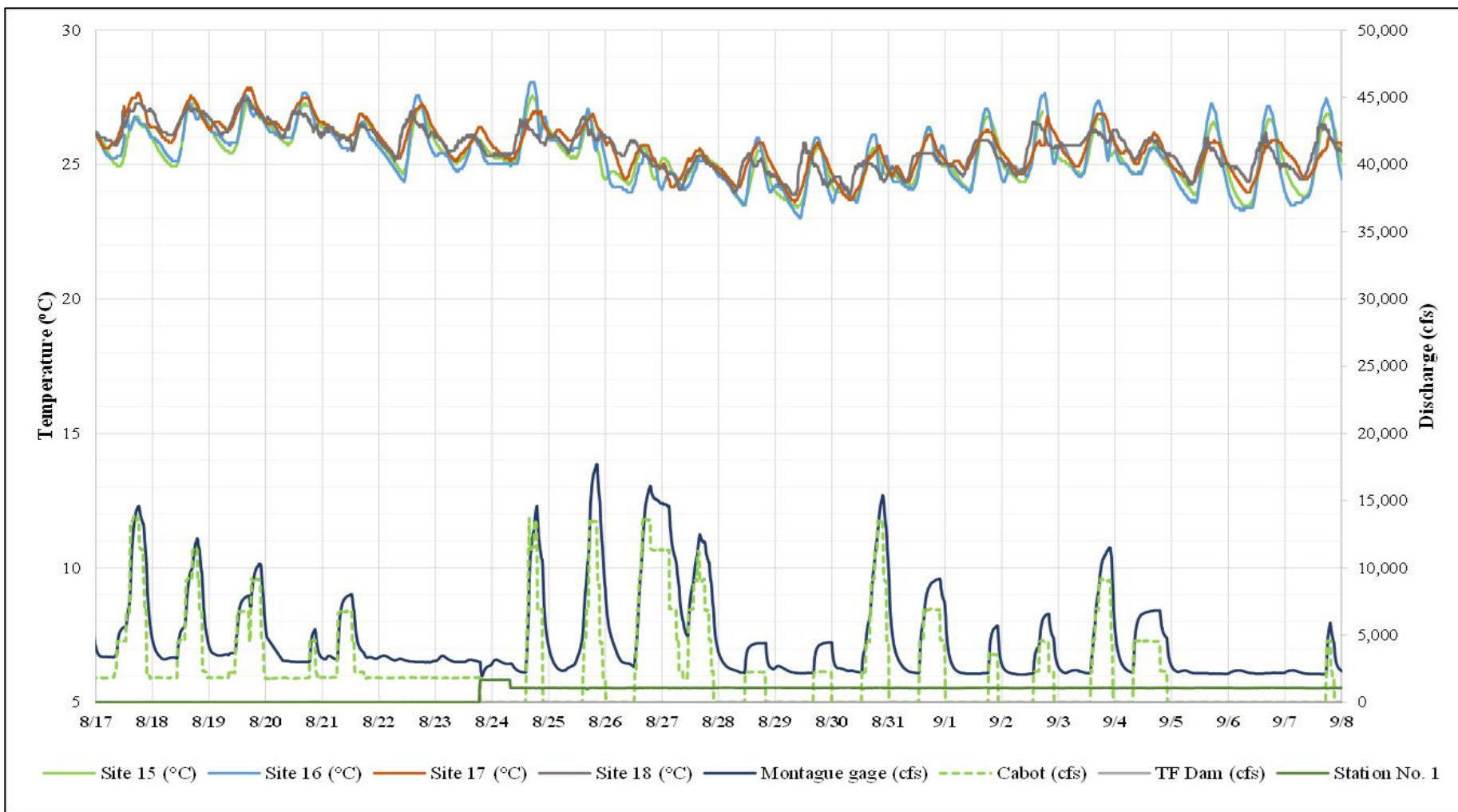
Temperature at downstream locations (August 17 – September 7, 2015)



3.2.1-Water Quality Monitoring Study

Water Quality Characterization: Downstream of Cabot Station (Sites 15-18)

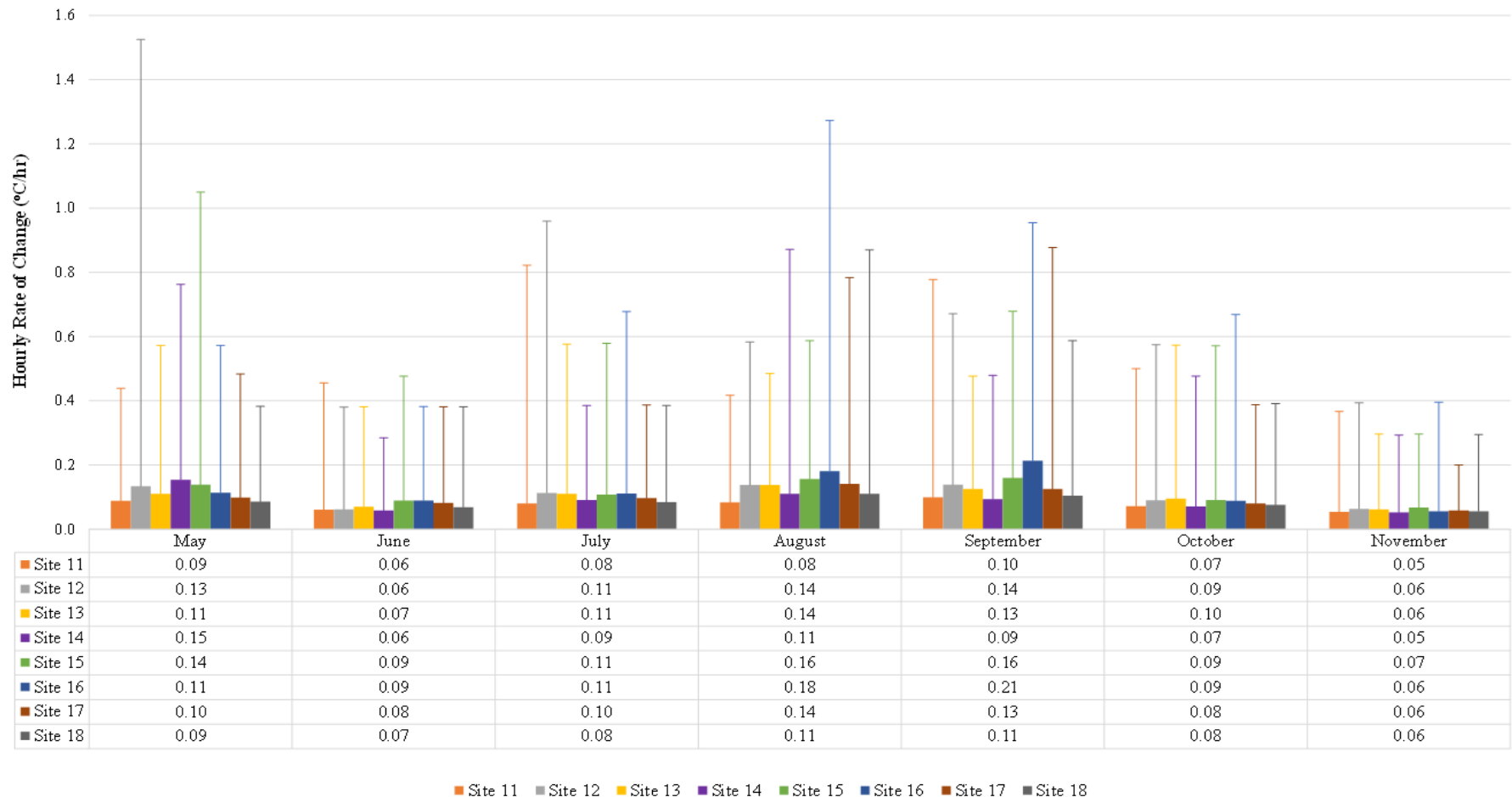
Temperature at downstream locations (August 17 – September 7, 2015)



3.2.1-Water Quality Monitoring Study

Water Quality Characterization: Bypass reach, power canal and d/s of Cabot (Sites 8-11)

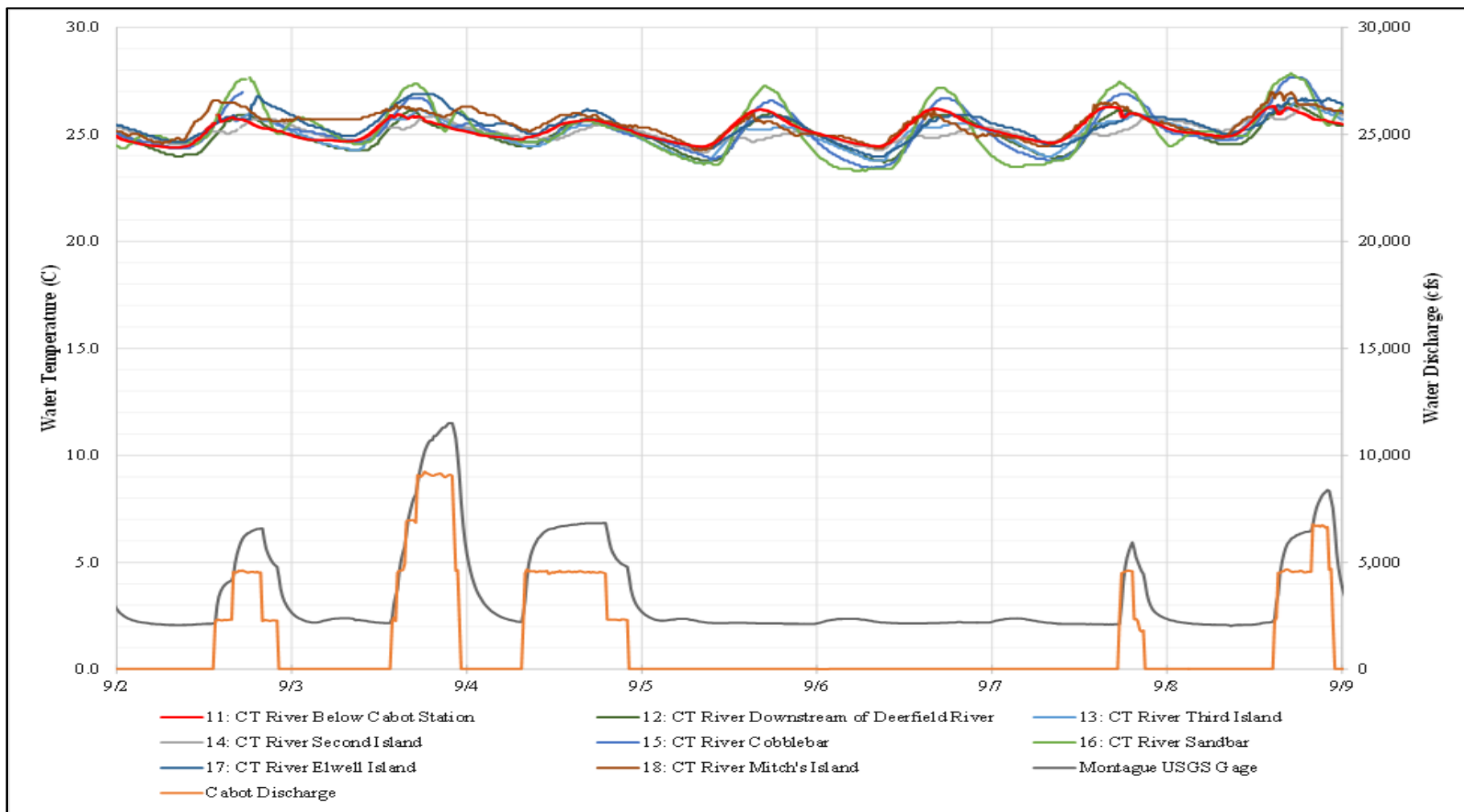
Monthly Average and Maximum Temperature Rate of Change (RoC)



3.2.1-Water Quality Monitoring Study

Water Quality Characterization: Bypass reach, power canal and ds of Cabot (Sites 8-11)

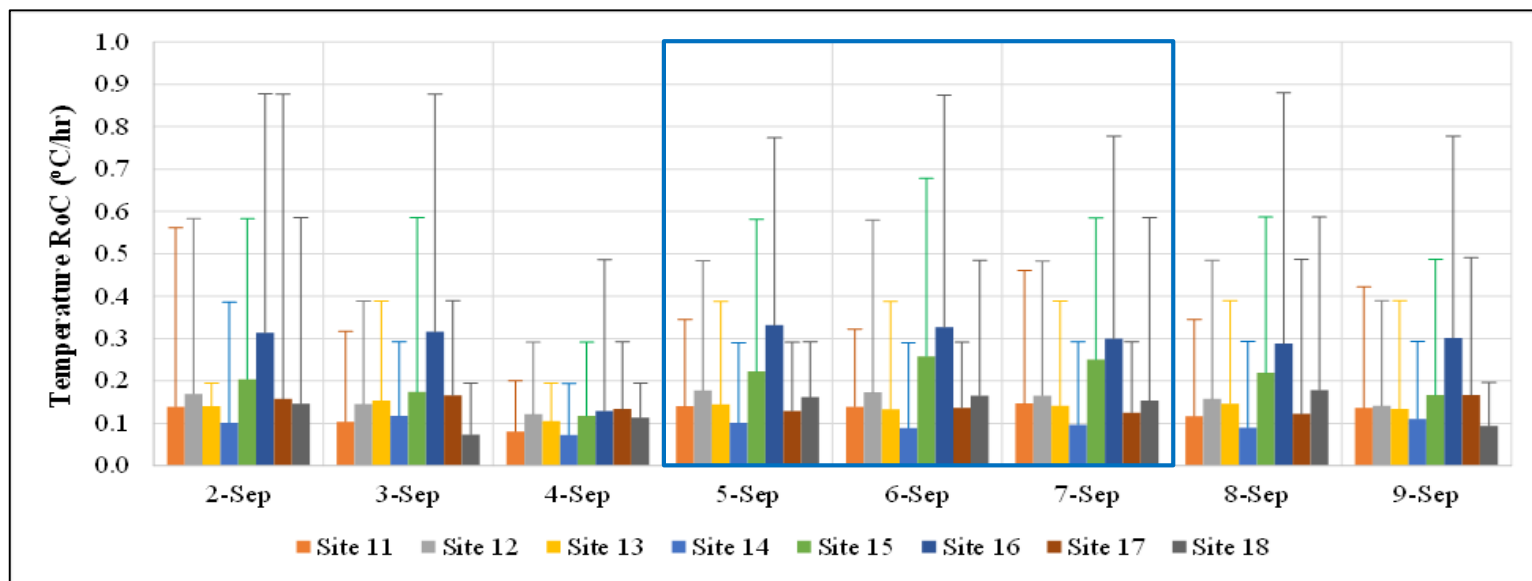
Water temperature RoC at locations below Cabot Station versus Cabot Operation status (Sep 2–8, 2015)



3.2.1-Water Quality Monitoring Study

Water Quality Characterization: Bypass reach, power canal and ds of Cabot (Sites 8-11)

Hourly average and maximum Temperature RoC (September 2 – September 9, 2015)



□ = No Cabot Station discharge. Stable flow at Montague

3.2.1-Water Quality Monitoring Study

Conclusions

1. Study area weather and flow reflect typical conditions in 2015.
2. Turners Falls Impoundment did not stratify.
3. All MA water quality standards were met.
4. Water quality characterization:
 - Turners Falls Impoundment (1-7): short-term effects from Northfield Mountain
 - Bypass reach (8 & 9): both sites similar at low flow; DO effects from spillage
 - Downstream of Cabot Station (11-18): water temperatures and rate of change were similar site to site

3.3.12- Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream from Cabot Station



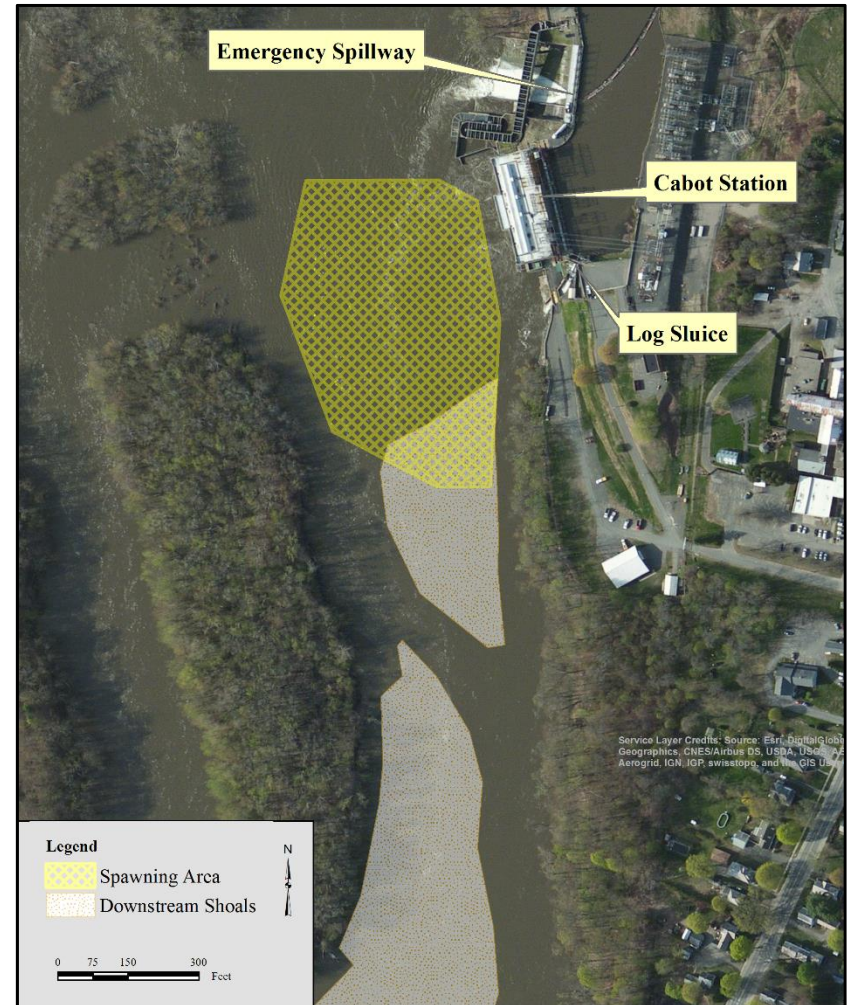
3.3.12- Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream from Cabot Station

Study Objectives:

- Determine the frequency with which the Emergency Spillway gates are operated to discharge large quantities of water.
- Describe the operation of the Log Sluice gate that results in bypass flume spill events.
- Evaluate the impact of these events on sediment transport and bottom velocities within known Shortnose Sturgeon spawning and rearing habitat below Cabot Station

Some data were reported previously (i.e. initial reports; meetings). However, data reported previously have been superseded by data in this report.

3.3.12- Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream from Cabot Station



3.3.12- Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream from Cabot Station

Emergency Spillway

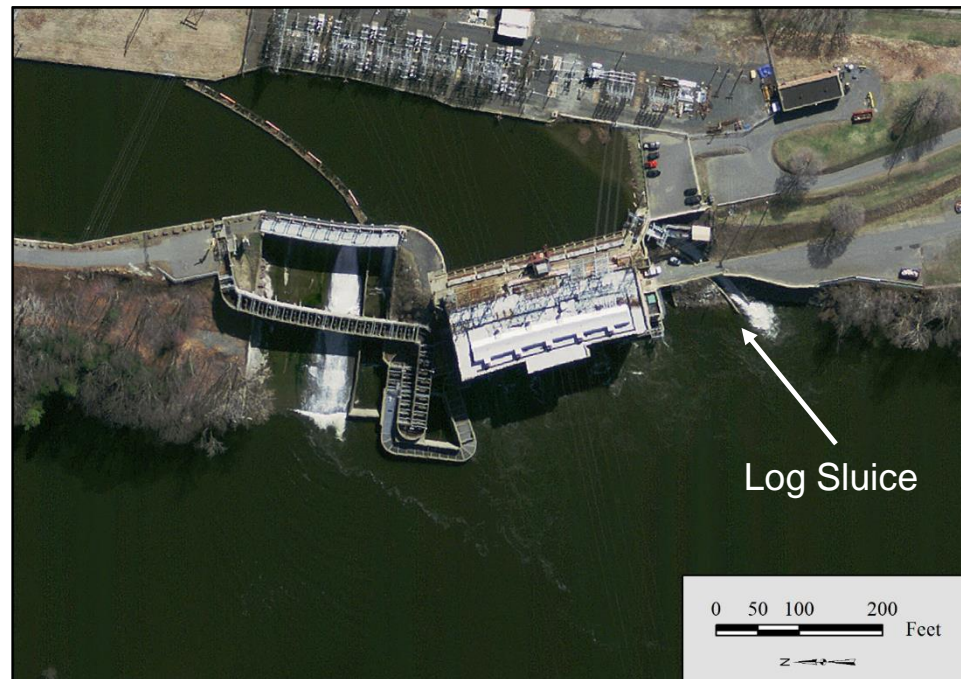
- 10 gates – 12 feet wide by 12 feet high
 - 2 gates supply water to the Cabot Fish Ladder
 - 8 gates discharge water directly to the CT River – **“Spill Gates”**
- Downward opening
- Discharge capacity for spill gates of ~12,000 cfs
- Used in emergencies and to sluice debris/ice



3.3.12- Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream from Cabot Station

Log Sluice (a.k.a. Bypass Flume)

- One gate – “**Sluice Gate**”
- Downward opening, 16 feet wide
- Weir inserted for downstream fish passage (restricts to 8 feet wide when in place)



Operation

- Downstream Fish Passage
- Sluice Debris/Logs
- Sluice Ice

3.3.12- Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream from Cabot Station

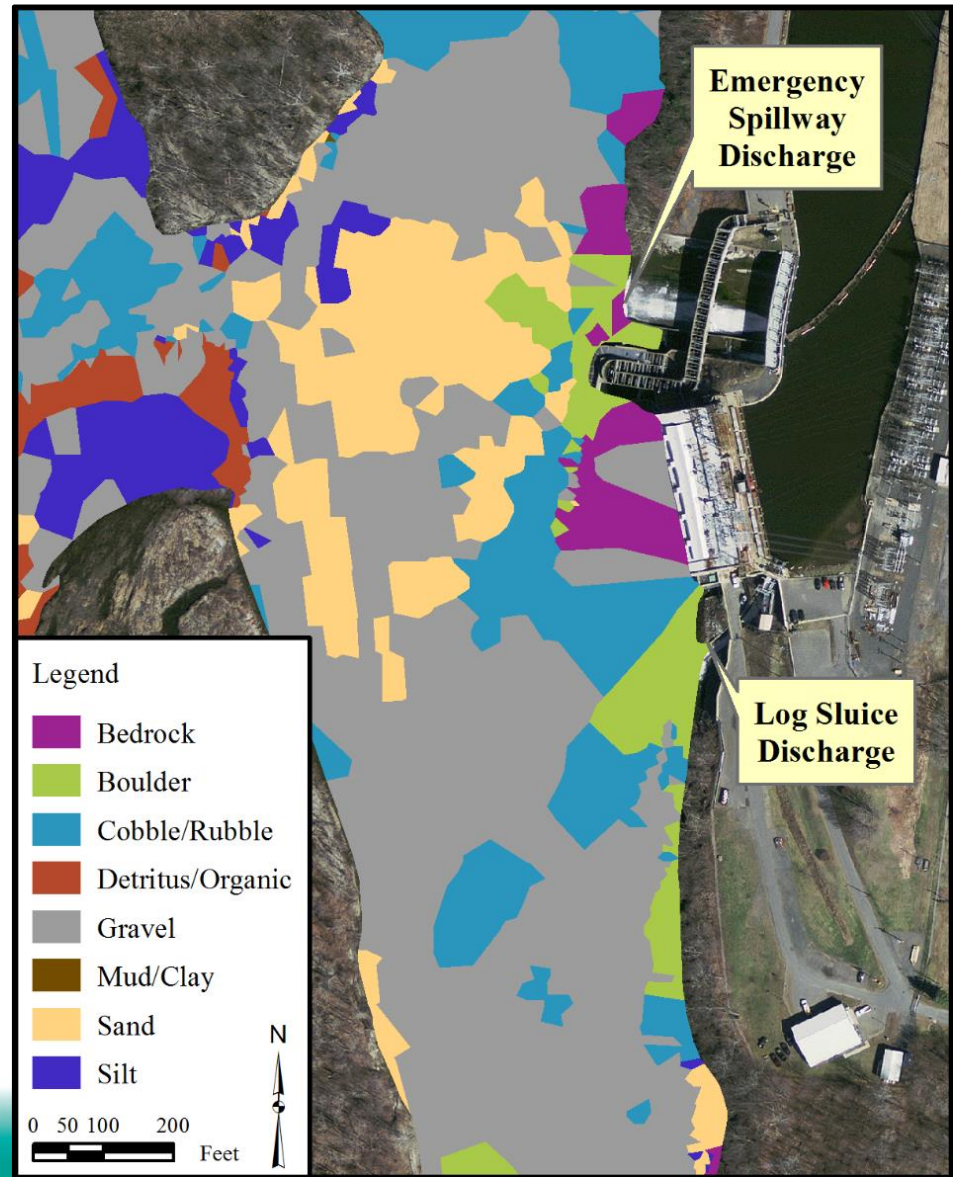
Substrate

Emergency Spillway Discharge

- Hard substrates near entrance
- Sand and gravel further out

Log Sluice Discharge

- Boulder and Cobble/Rubble
- Closed during high flow periods



3.3.12- Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream from Cabot Station

Methods: Flow and Frequency

- Analyzed 10-minute dataset (April 1 – June 30, 2005-2012)
 - Calculated flow at each gate $Q = C * L * H^{1.5}$
 - Frequency Analyses – which flows are most common through the gates, and what other conditions are present during different spill flows through the gates?
- Also used 1-minute dataset to examine high discharge events in more detail

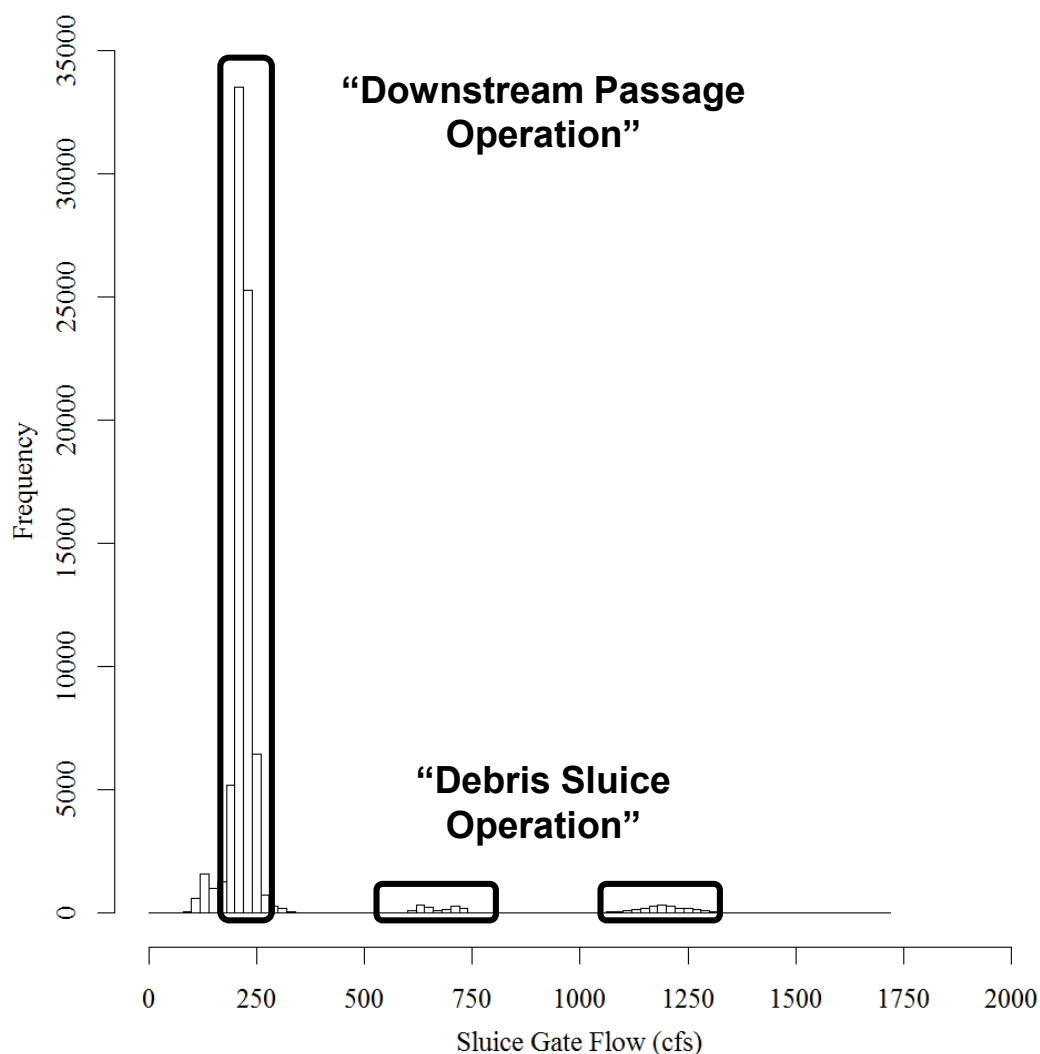
Methods: Velocity and Sediment Mobilization

- River 2D Model from Study No. 3.3.1– Developed Baseline and Scenario Models
 - Velocity
 - Shear Stress
- Potential for Sediment Mobilization
 - Relative Shear Stress (RSS)

$$RSS = \frac{\textit{Shear Stress (Modeled)}}{\textit{Critical Shear Stress (Value based on Substrate)}}$$

RSS = 1 = 50% chance of particle mobilization

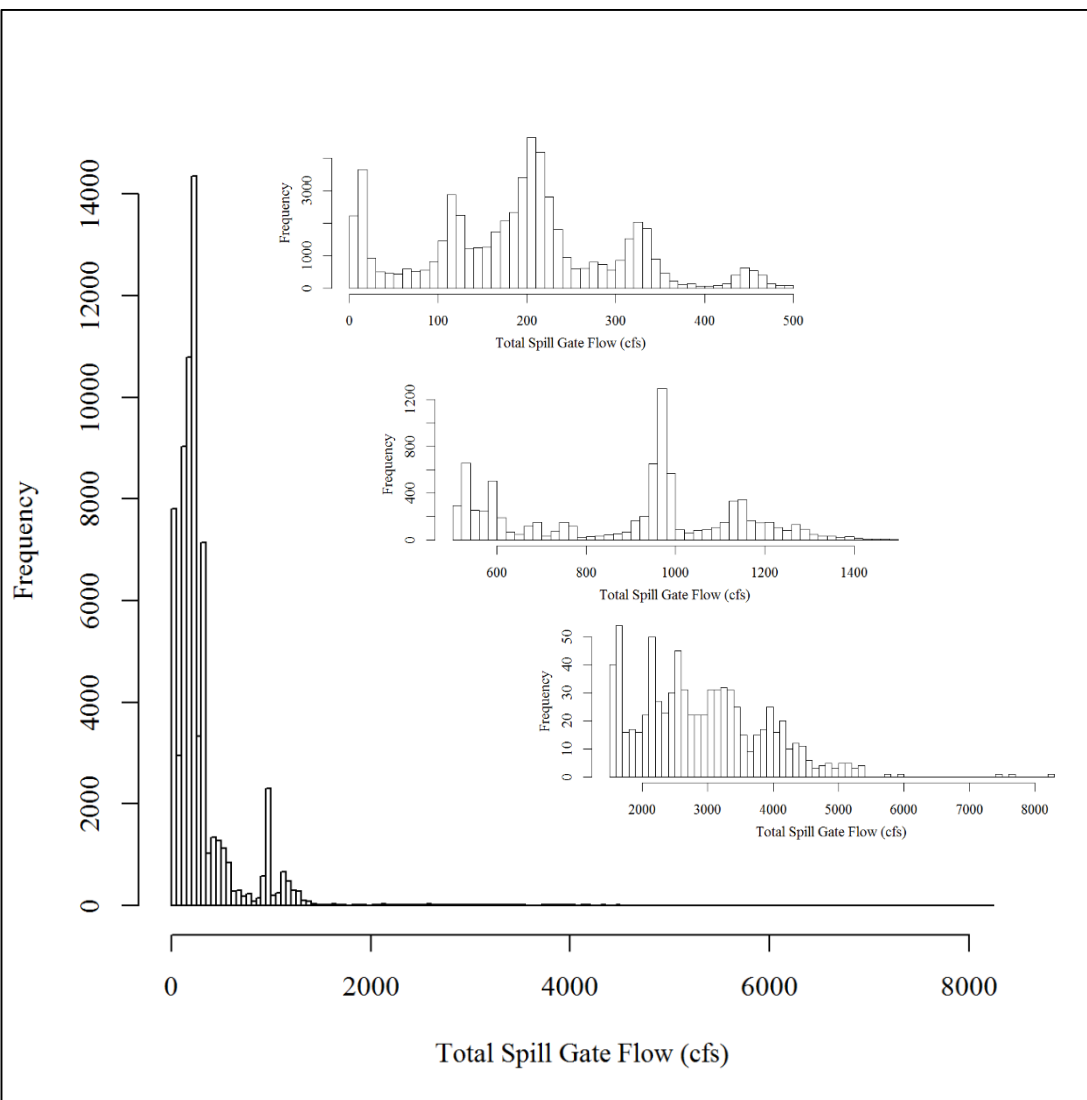
3.3.12- Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream from Cabot Station



Log Sluice

- Operates for downstream fish passage during most of the dataset (~219 cfs)
- May operate at higher gate openings to sluice logs/debris, but these periods are brief
- Gate settings are often held constant for long periods of time
- Flow enters river in areas of primarily hard substrate (i.e. rubble/cobble/boulder)

3.3.12- Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream from Cabot Station

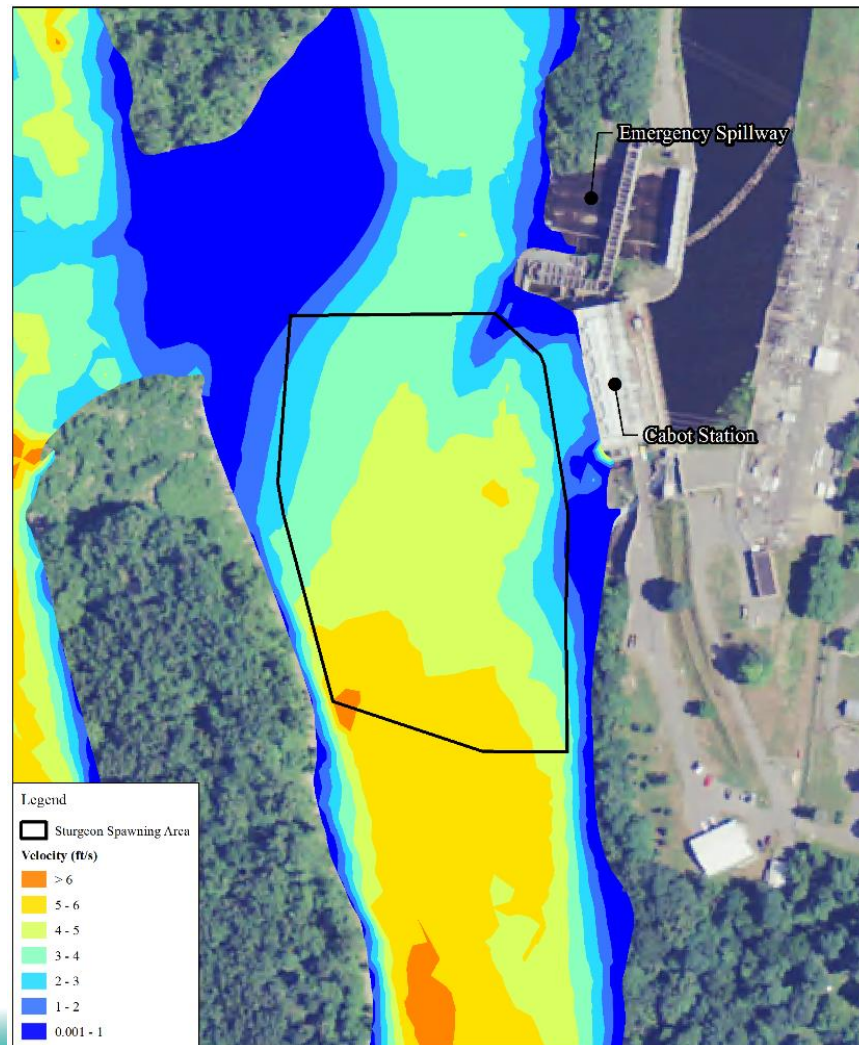
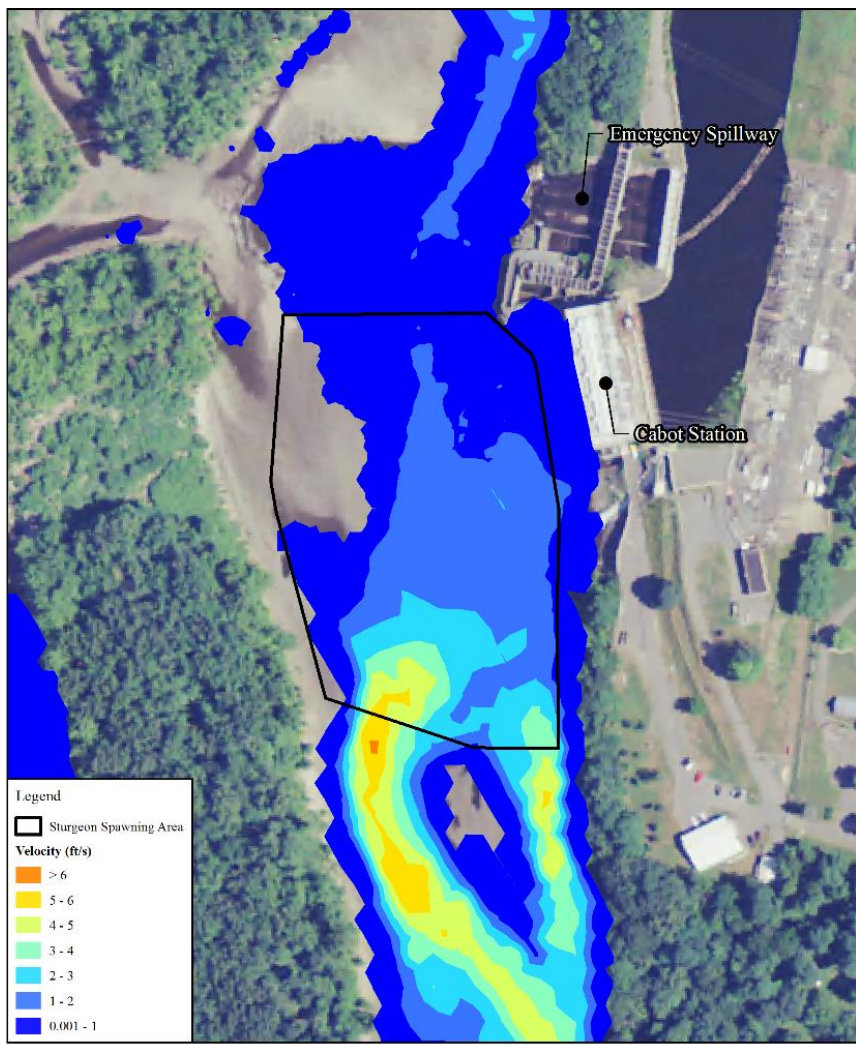


Emergency Spillway

- High frequency of low flows, likely due to keeping a gate open for sluicing ice/debris
- Low frequency of flows > 1,500 cfs
- “Events” with flow > 1,500 cfs occurred during a range of bypass reach flows, and primarily during moderate to high generation at Cabot Station
- Events with spill flow > 1,500 cfs were brief (median = 0.92 hours)
- Emergency spill discharge was only greater than 5,000 cfs when more than four gates were open

3.3.12- Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream from Cabot Station

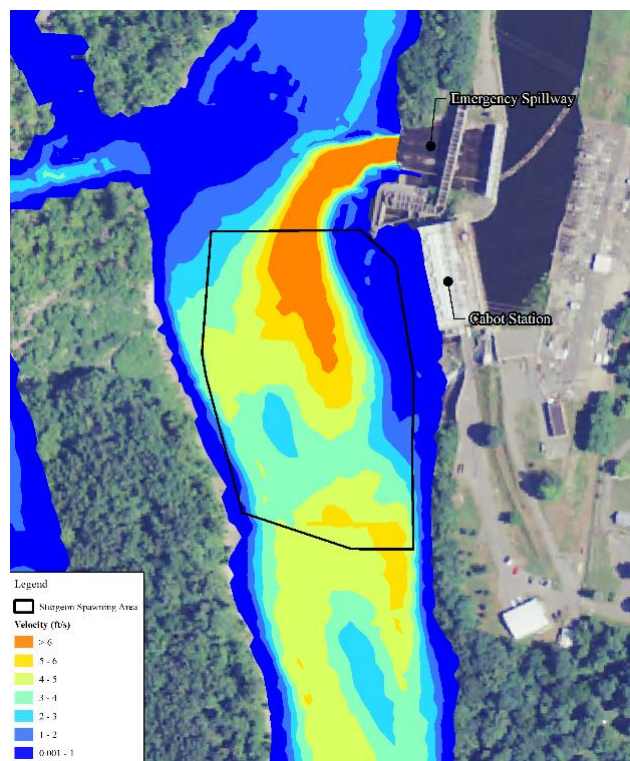
Baseline Velocity Model Examples



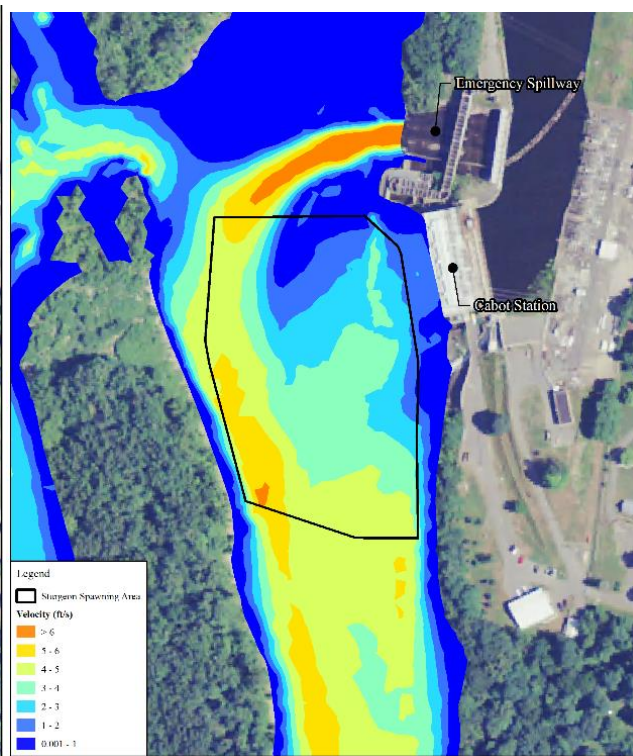
3.3.12- Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream from Cabot Station

How do operational conditions affect flow from the Emergency Spillway?

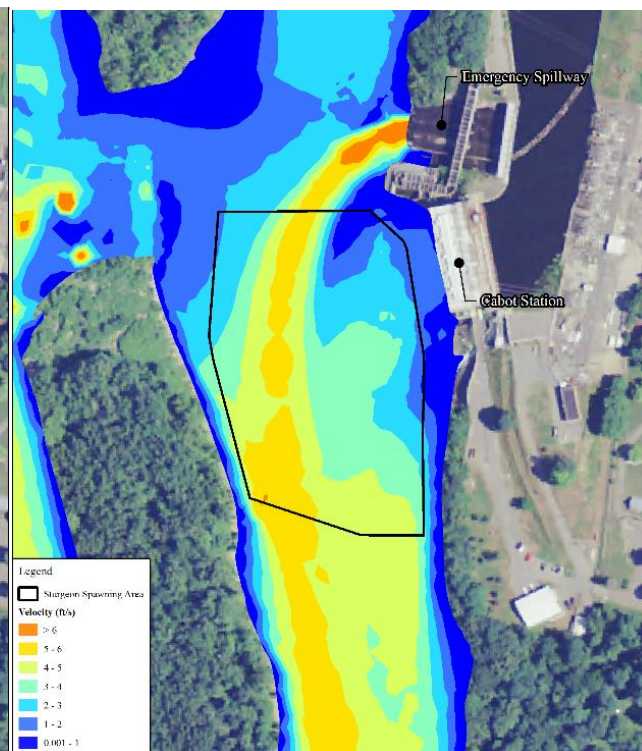
Cabot Off



Cabot On



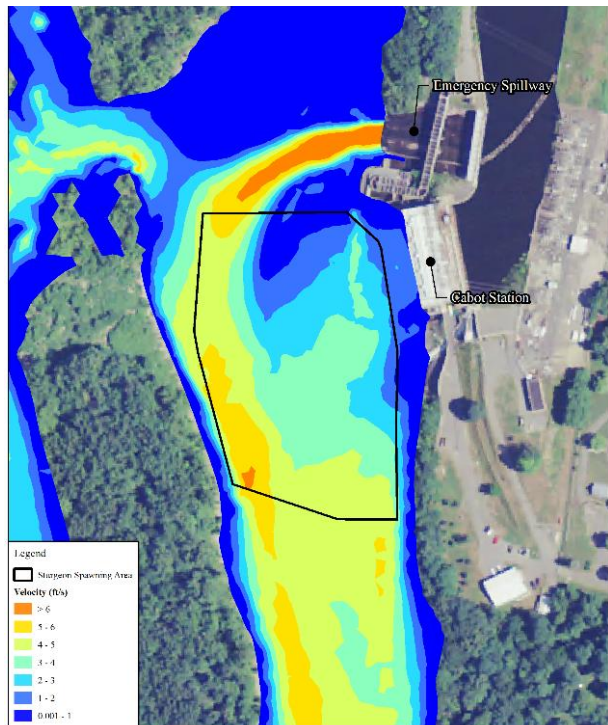
Higher Bypass Flow



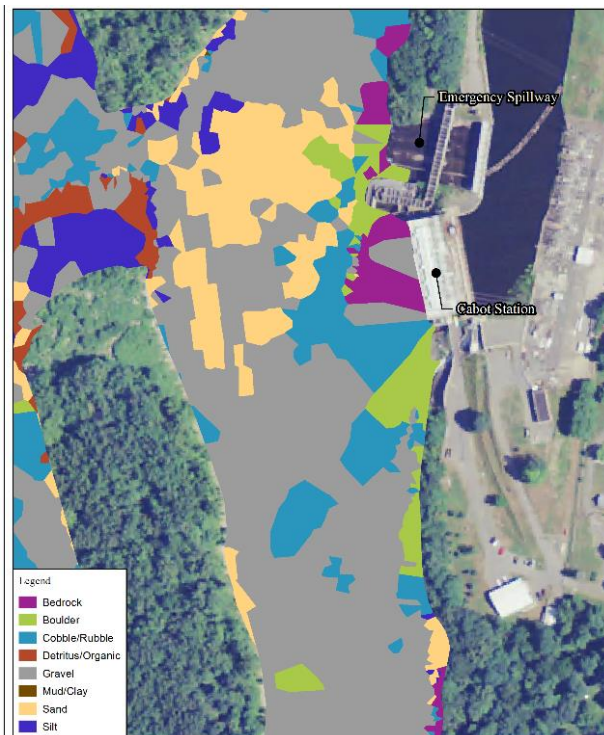
3.3.12- Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream from Cabot Station

Effects on Relative Shear Stress: Velocity and Substrate

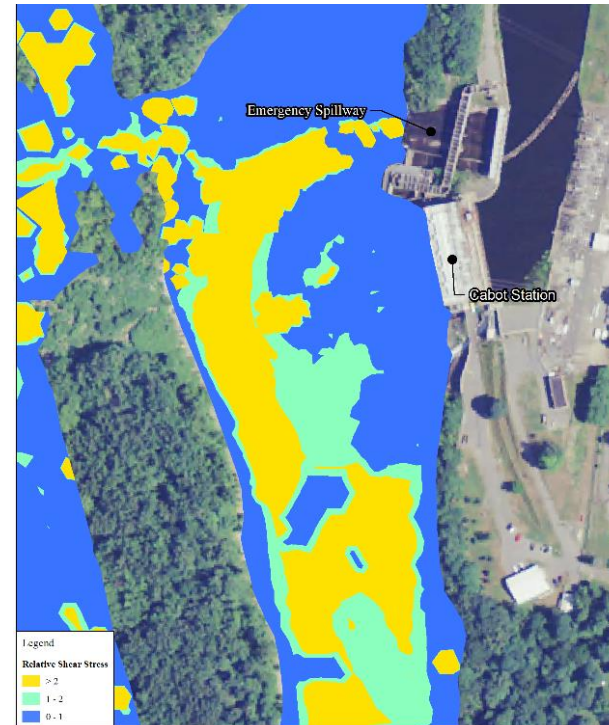
Velocity



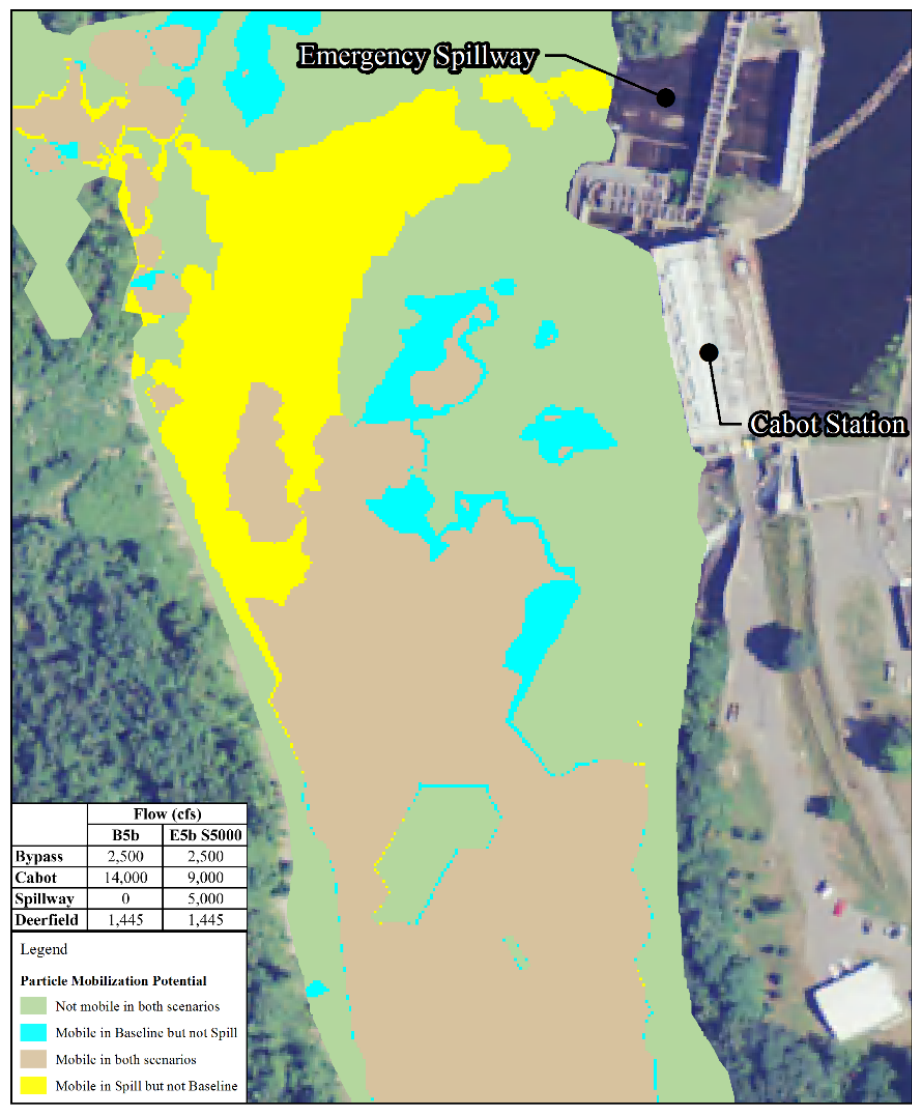
Substrate



RSS



3.3.12- Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream from Cabot Station



Comparison to the Baseline

- There are many areas where substrate could be mobilized for baseline and scenario models
- Increased potential for mobilization in some areas during discharge from the emergency spillway
- Decreased potential for mobilization in some areas during discharge from the emergency spillway

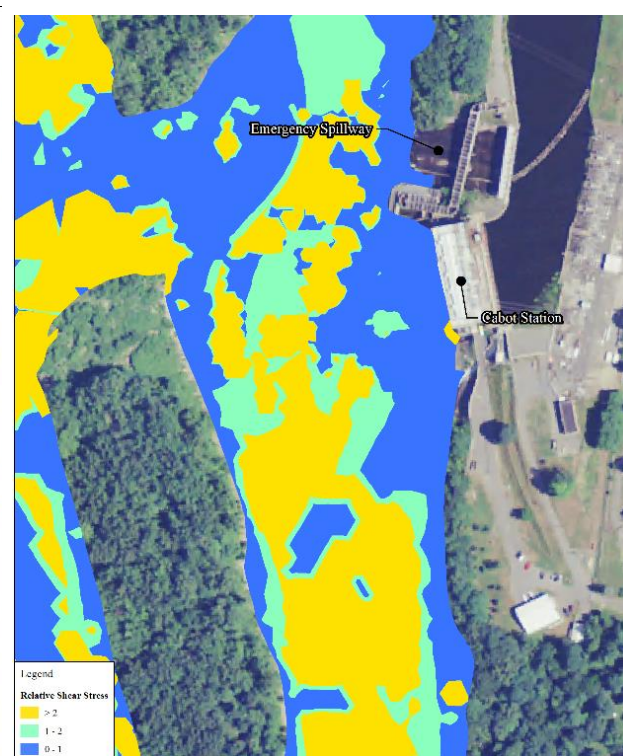
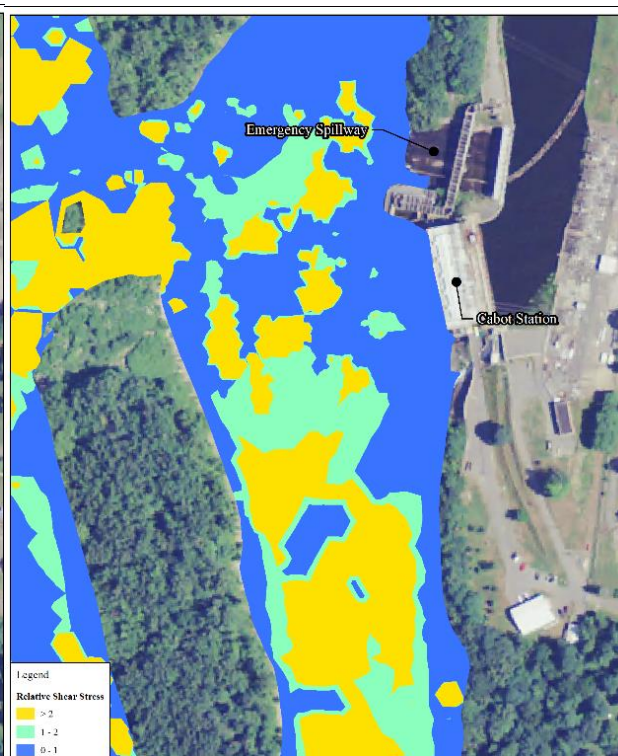
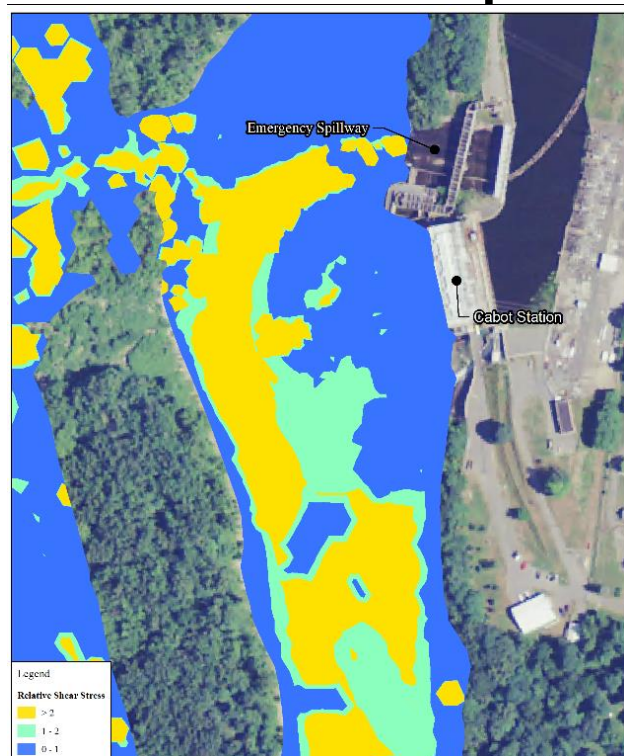
3.3.12- Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream from Cabot Station

Comparison to different baselines

**2,500 cfs Bypass +
5000 cfs Em. Spill**

**10,000 cfs Bypass
+ Cabot**

**20,000 cfs Bypass
+ Cabot**

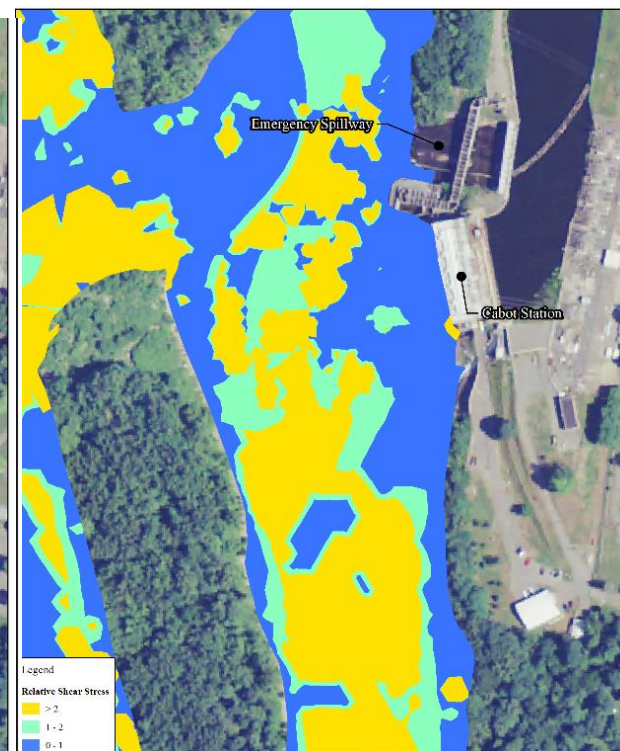
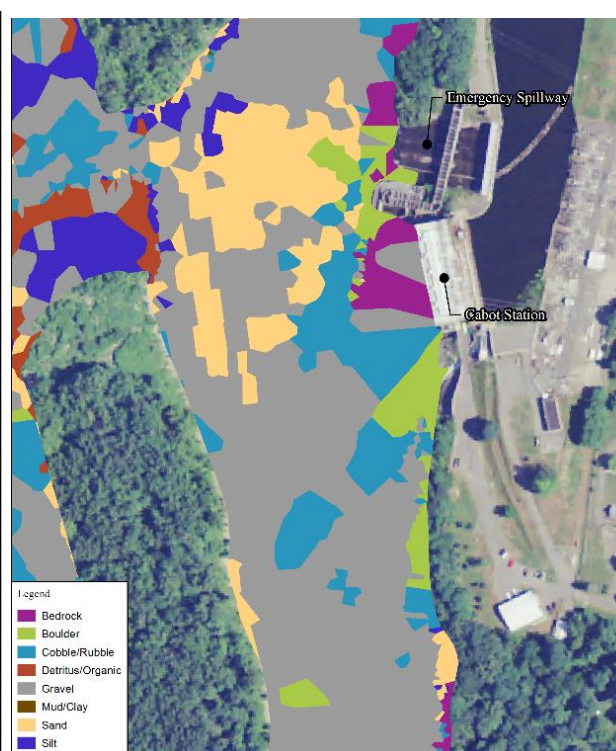
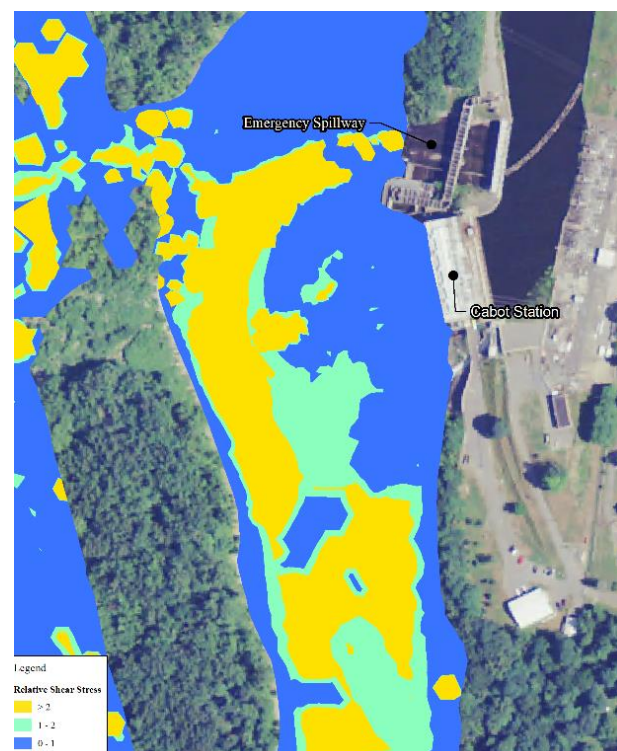


3.3.12- Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream from Cabot Station

Comparison to other
baselines: Location of sandy
substrate is important

E5b S5000

B7



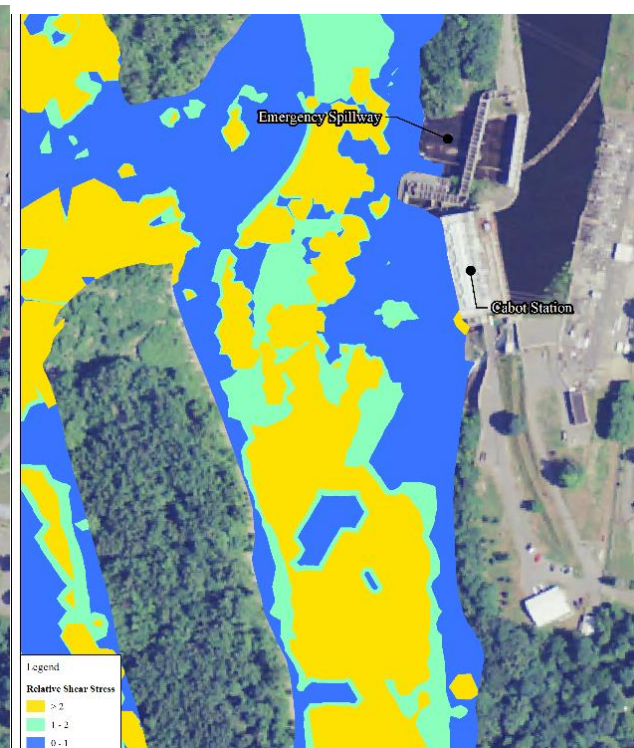
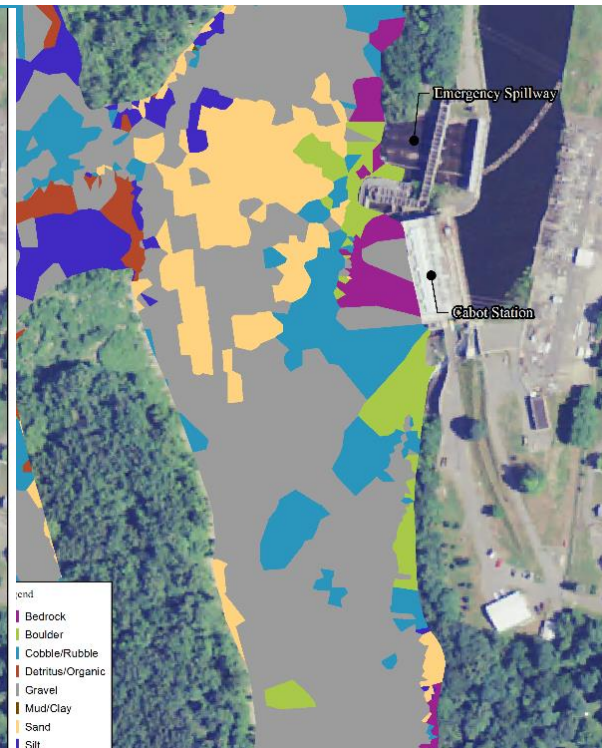
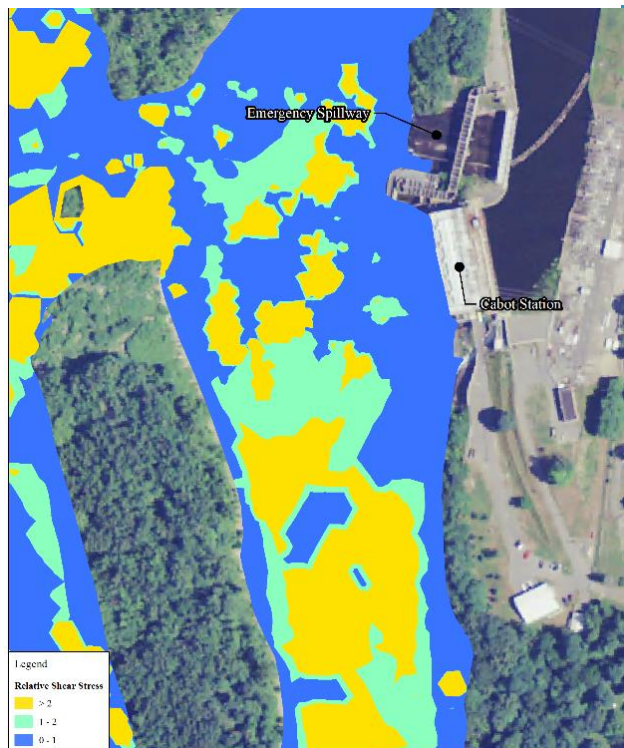
3.3.12- Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream from Cabot Station

Comparison among baselines

- B6 (10,000 cfs Bypass) and B7 (20,000 cfs Bypass) similar for sand

B6

B7



3.3.12- Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream from Cabot Station

General Findings

Velocity

- Discharge from the Emergency Spillway can increase velocities within the sturgeon spawning area.
- The exact location of high velocity areas depends on multiple conditions (i.e. bypass flow, Cabot generation).
- Many areas within the sturgeon spawning area could still be considered suitable for spawning.

Potential for Sediment Mobilization

- Discharge from the Emergency Spillway has the potential to mobilize sand in the vicinity of Cabot Station under a variety of operational conditions.
- 1,500 cfs may or may not have much of an effect, depending on operational conditions (i.e. bypass flow or water levels).
- Substrate mobilization potential of gate flow releases appear similar to common springtime bypass reach flows (i.e., 10,000-20,000 cfs).

Potential for Sediment Deposition

- Velocities at ELS shoals are relatively swift with high shear stress, likely preventing deposition.

3.3.12- Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream from Cabot Station

Caveats

- Study and modeling assumes that the distribution of sand will be consistent through time, and that sand is in unlimited supply for mobilization
- Effects on Shortnose Sturgeon can be theorized, but are speculative

Things to Keep in Mind

- Large discharges from the Emergency Spillway are uncommon and brief and necessary for public safety
- Bypass reach flows with similar sand mobilization potential, are common and much longer in duration
- Existing gate operations include:
 - Low flow, continuous operation for debris/ice sluicing at the log boom
 - High flows (more than four gates open) would result from emergency usage– Necessary for station integrity and public safety

Next Steps

- Biological Assessment for NMFS
- Additional information on Shortnose Sturgeon in IFIM Study

Modeling

3.3.8-Computational Fluid Dynamics Modeling in the Vicinity of the Fishway Entrances and Powerhouse Forebays

Study Objectives

- Characterize the hydraulics of current (existing) conditions and any changes to:
 - Fishway attraction flows;
 - Turbine operations; and
 - Log sluice gates
- Develop a series of velocity maps at select discharges showing approach velocities and flow fields that may create a response in fish;
- Characterize the flow field in front of the Cabot Station and Station No. 1 intakes using velocity maps and cross-sectional plots;
- Assess whether fish are directed to the surface bypass weir near Cabot Station;
- Characterize the near-rack “sweeping” velocities at the Cabot Station and Station No. 1 intakes.

Variances

- The RSP called for developing high-resolution sub-models at the face of the Cabot and Station No. 1 intake racks.
- Due to computational limitations, not practical to create/build these models.
- In lieu of separate model, added 1-foot mesh in front of intake racks to calculate approach and sweeping velocities.

Preface

- The CFD study evaluated hydraulics at the Cabot/Station No. 1 intakes and at the Spillway and Cabot fishway entrances.
- 4 other studies are using empirical radio telemetry data to evaluate the effects of Project operations on migratory fish movement including:
 - Study No. 3.2.2 Evaluate U/S and D/S Passage of Adult American Shad
 - Study No. 3.3.3 Evaluate D/S Passage of Juvenile American Shad
 - Study No. 3.3.5 Evaluate D/S Passage of American Eel
 - Study No. 3.3.15 Assessment of Adult Sea Lamprey Spawning within the TF Project and NFM Project Area.
- The telemetry studies, coupled with CFD model results, will be used to determine the impact of Project operations on upstream and downstream fish passage.

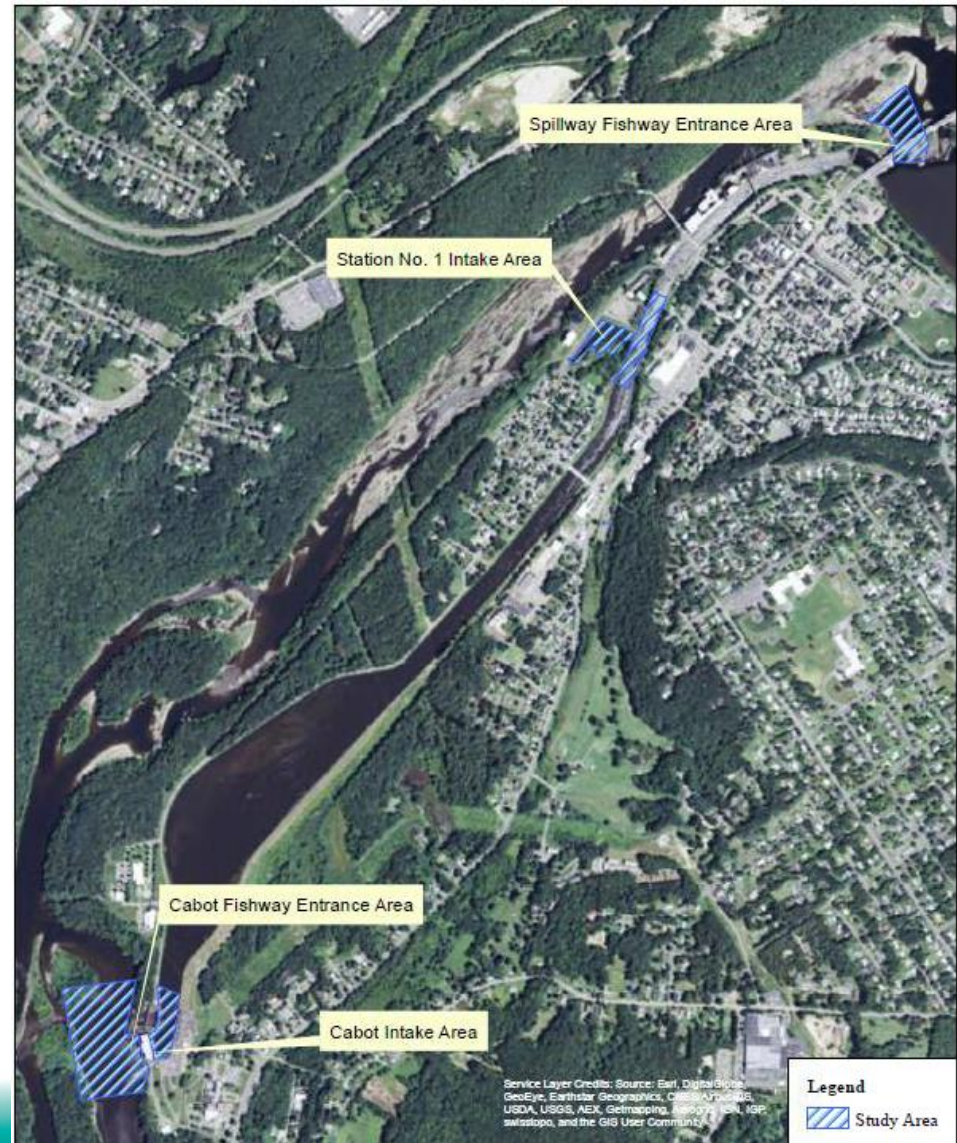
3.3.8-Computational Fluid Dynamics Modeling in the Vicinity of the Fishway Entrances and Powerhouse Forebays

CFD Models

- Spillway Fishway
- Cabot Fishway
- Station No. 1 Intake Area
- Cabot Intake Area

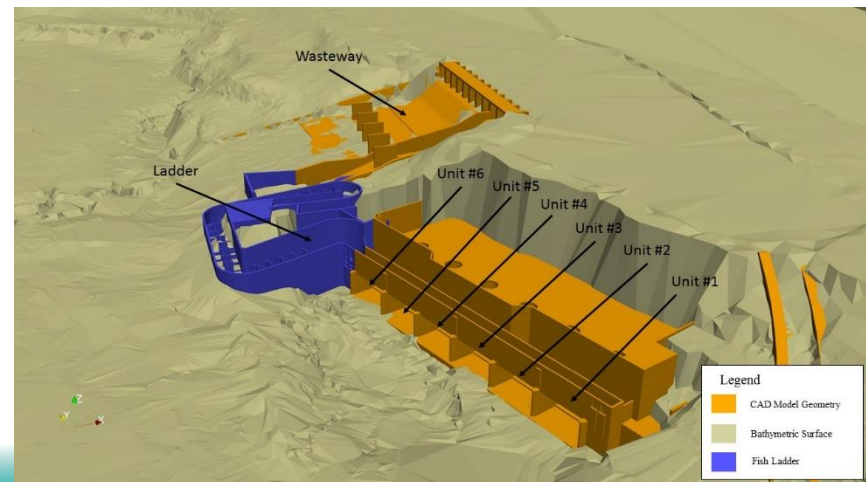
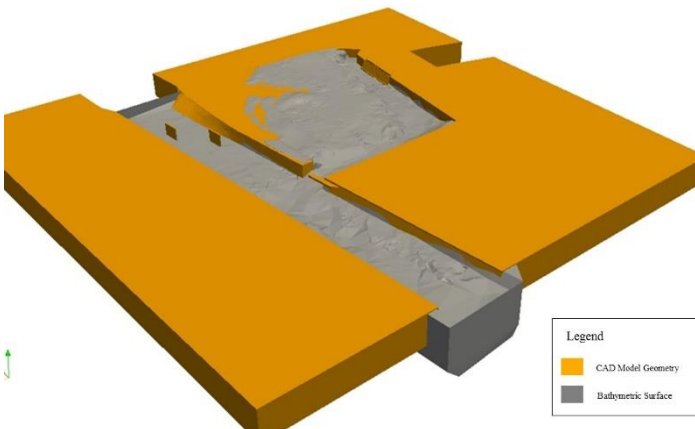
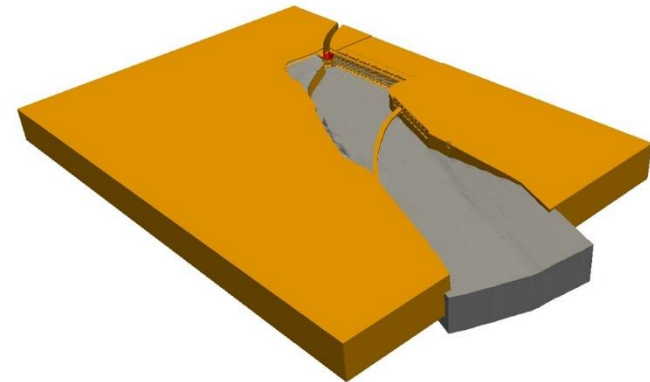
CFD Model Development and Execution

- Field Data Collection and Processing
 - Acoustic Doppler Channel Profiler
 - Topographic and Structure Survey
 - LiDAR Topographic Data
 - Water Level Loggers
- Model Geometry Development
 - CAD Model Development
 - Bathymetric Surface Development
- CFD Model Development
 - Mesh Cell Size
 - Boundary Conditions
- Verification Runs
- Production Runs
- Results

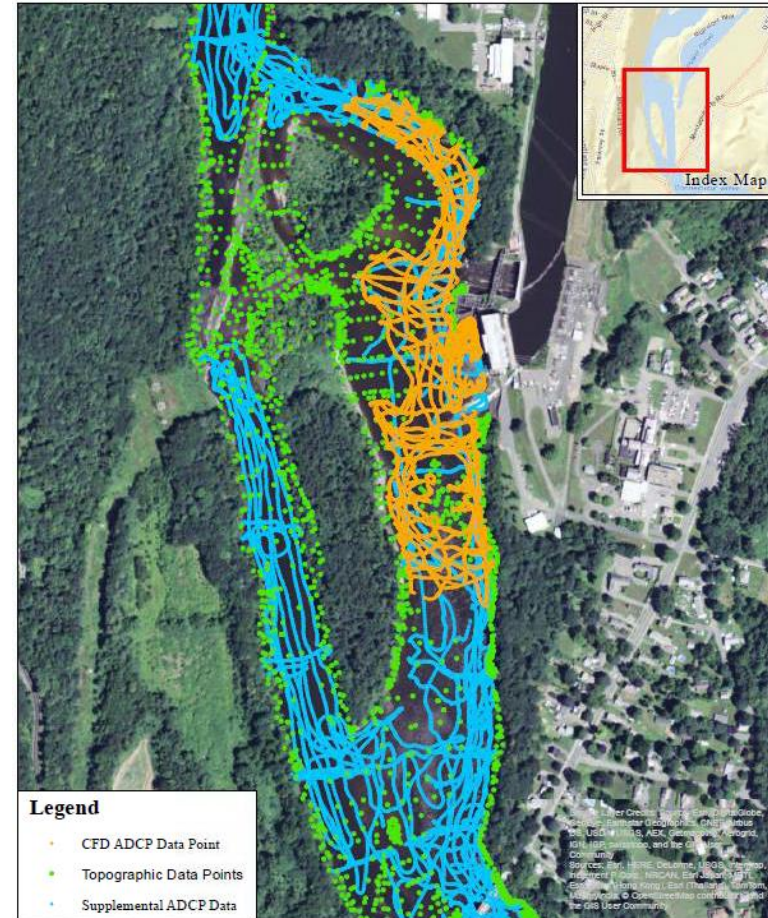


3.3.8-Computational Fluid Dynamics Modeling in the Vicinity of the Fishway Entrances and Powerhouse Forebays

CAD Geometry Development

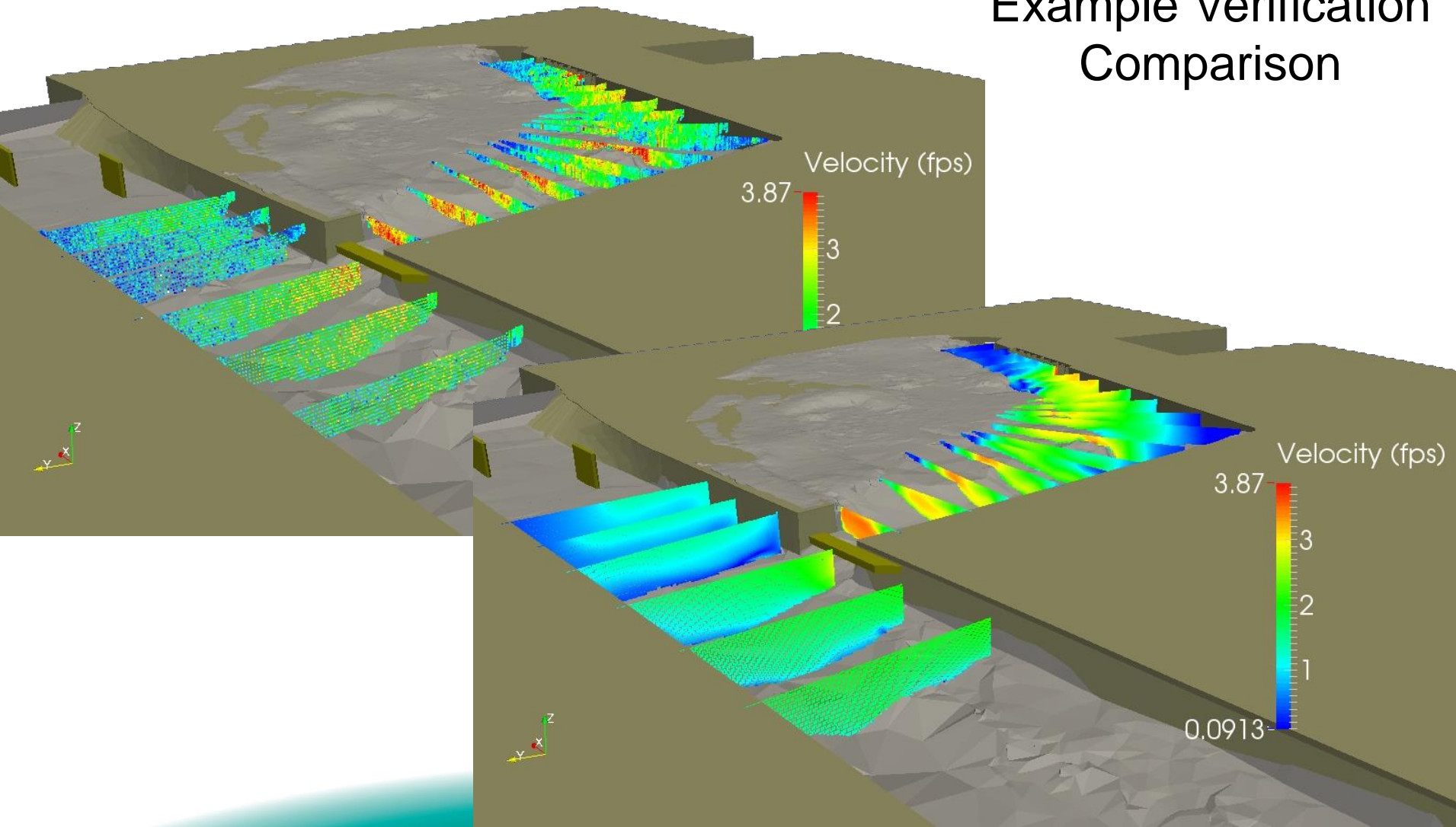


Field Data Collection



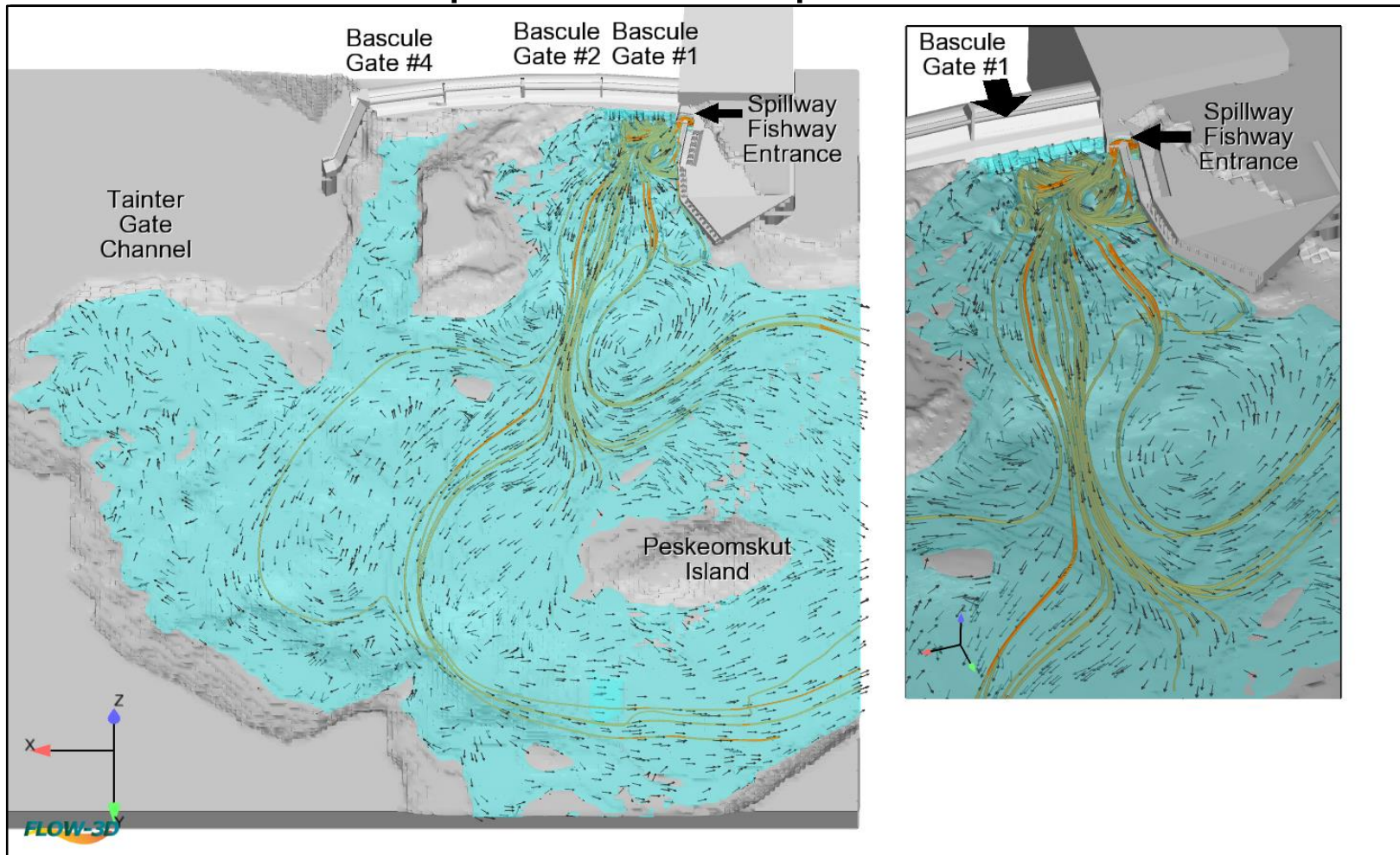
3.3.8-Computational Fluid Dynamics Modeling in the Vicinity of the Fishway Entrances and Powerhouse Forebays

Example Verification Comparison



3.3.8-Computational Fluid Dynamics Modeling in the Vicinity of the Fishway Entrances and Powerhouse Forebays

Example Model Outputs



3.3.9-Two-Dimensional Modeling of the Northfield Mountain Pumped Storage Project Intake/Tailrace Channel and Connecticut River Upstream and Downstream of the Intake/Tailrace

Study Objectives:

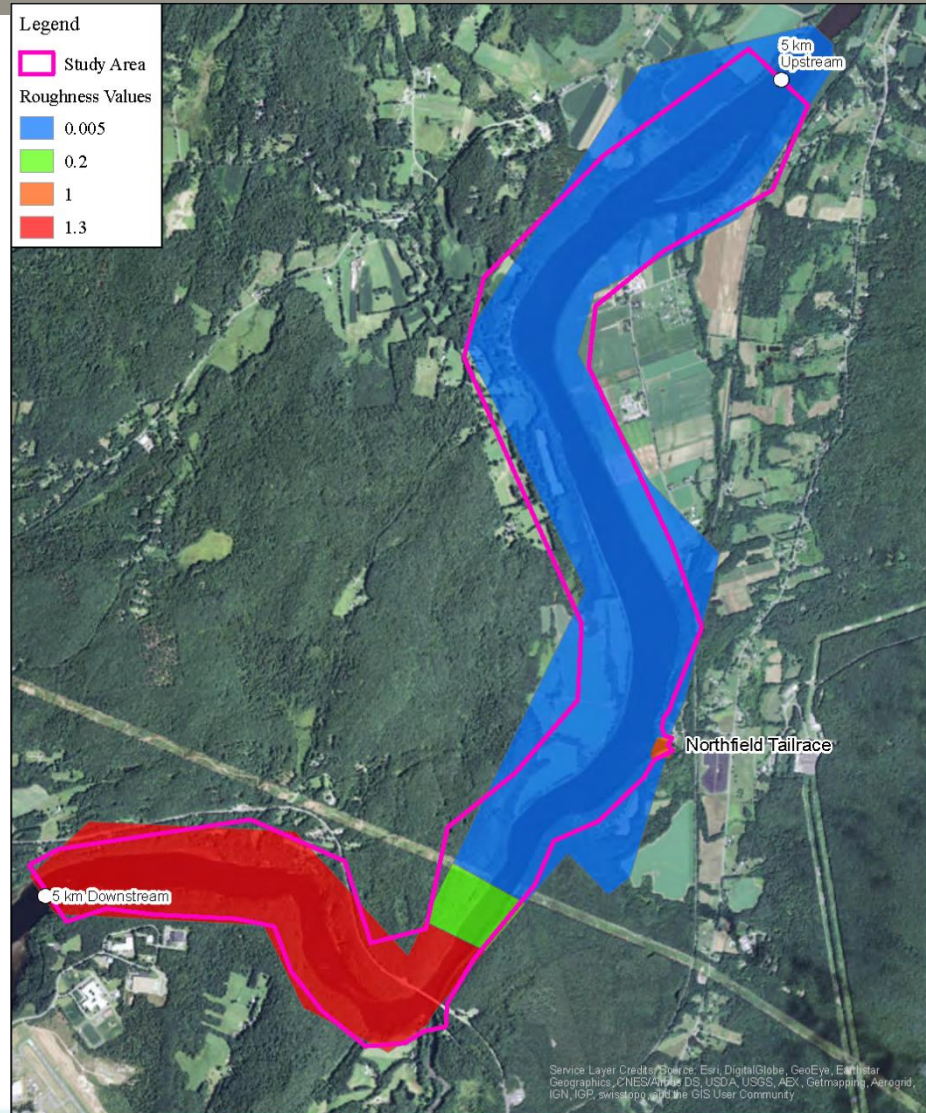
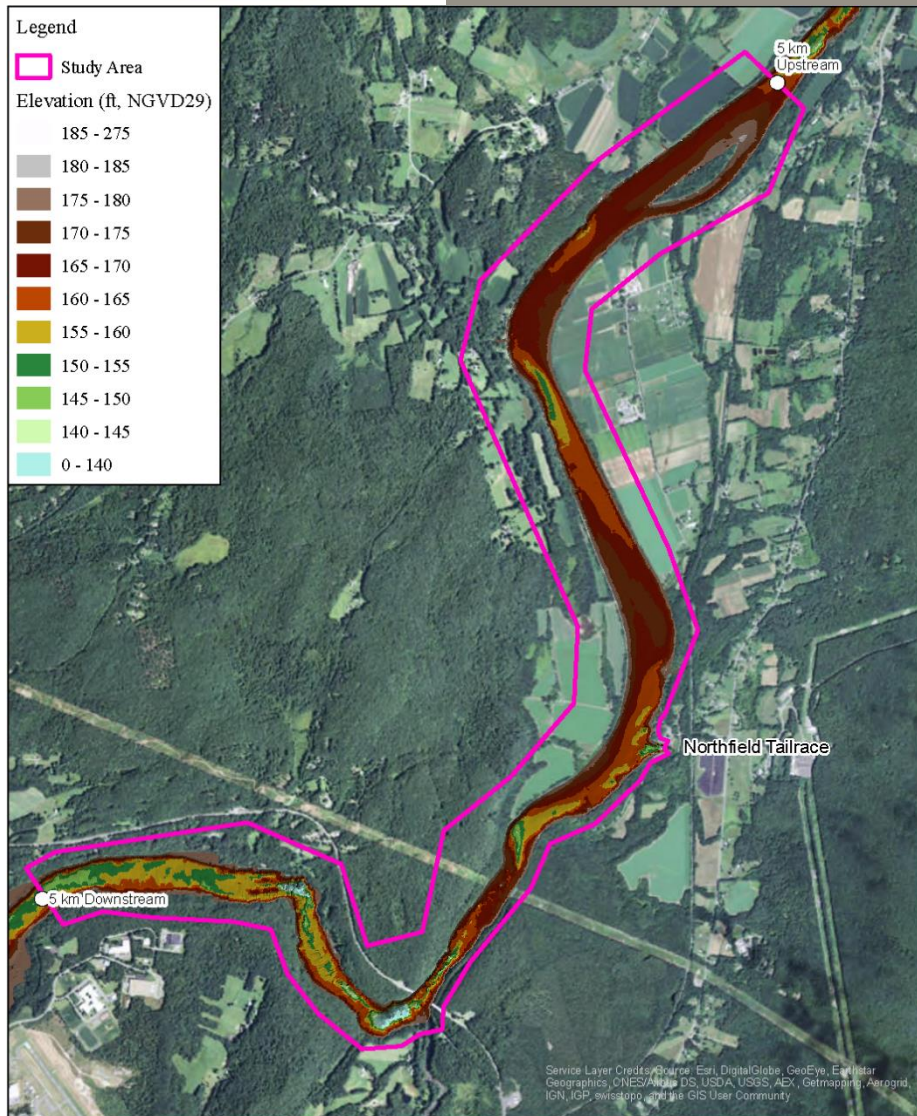
- Assess velocities and flow fields at, and in proximity to, the Northfield Mountain Project intake/discharge structure, when pumping or generating, and their potential to interfere with fish migration.
- Assess the potential for velocity barriers in the mainstem river to develop from pumping and generation flows at the Northfield Mountain Project, alone or in combination with generation flows from the upstream Vernon Project and downstream Turners Falls Project.
- Characterize water column velocity profiles in the immediate vicinity of the Northfield tailrace (i.e. inside the boat barrier).
- Assess the potential for Northfield Mountain Project operations to create undesirable attraction flows to the intake/discharge area that may result in entrainment or delay of migratory fish.
- Assess potential migratory fish impacts due to flow reversals under:
 - Pumping conditions, such that the river flows from the Turners Falls Dam toward the Northfield tailrace; and;
 - Generating conditions, such that the river flows from the Northfield tailrace toward Vernon Dam.

3.3.9-Two-Dimensional Modeling of the Northfield Mountain Pumped Storage Project Intake/Tailrace Channel and Connecticut River Upstream and Downstream of the Intake/Tailrace

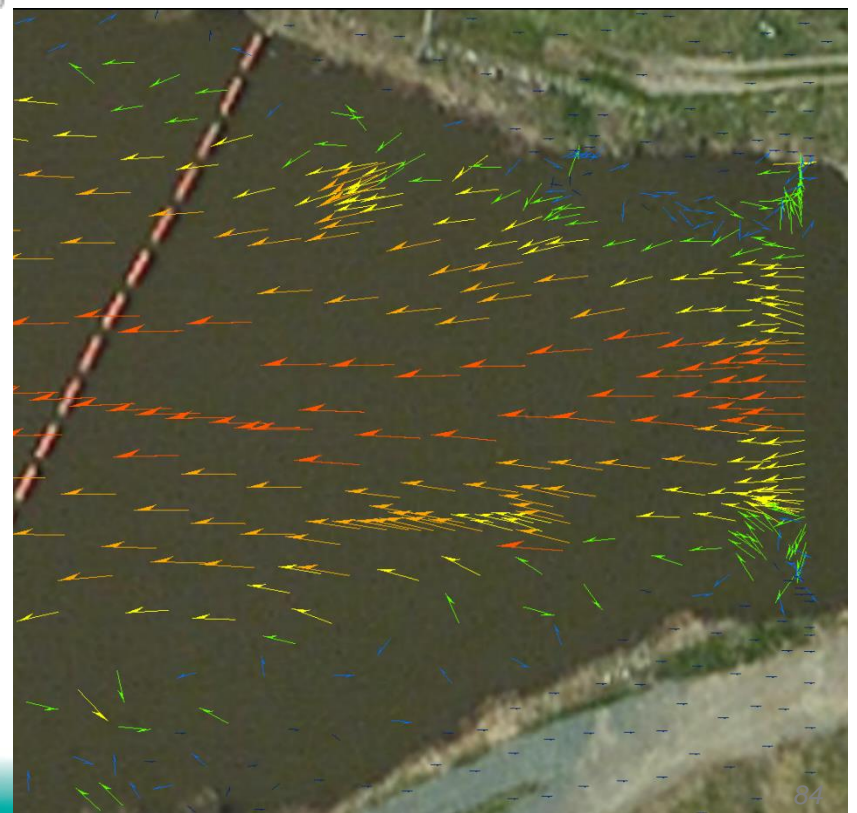
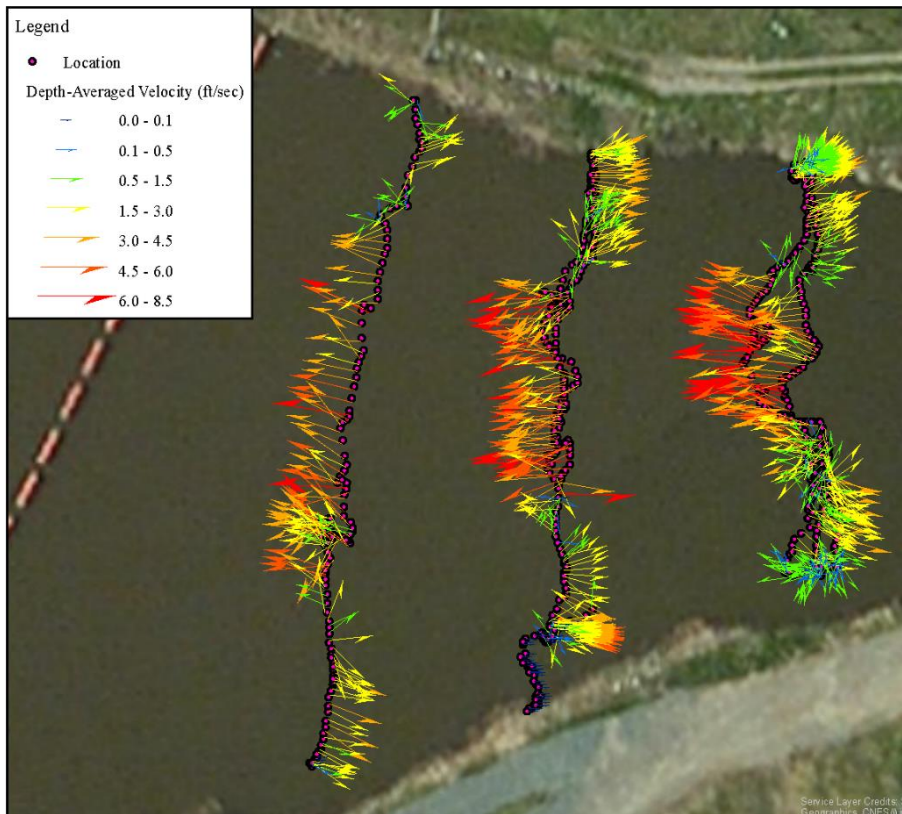
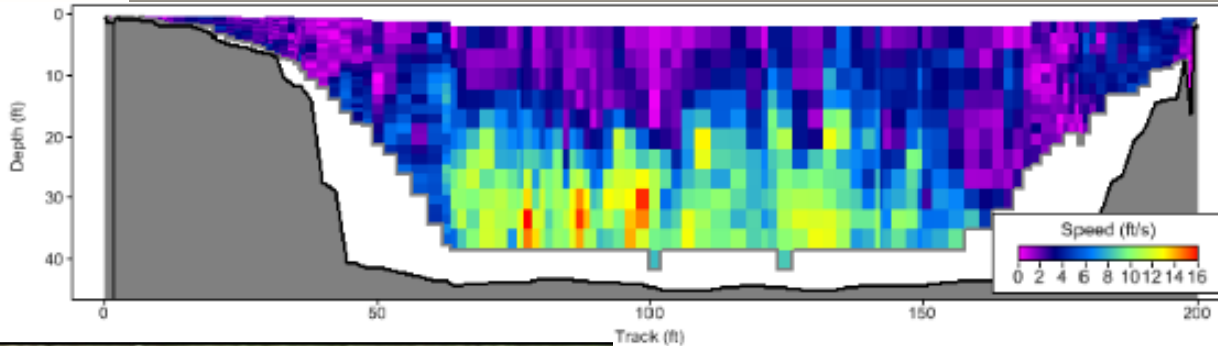
Preface:

- Study examined the direction and magnitude of velocities under a range of conditions
- 4 other studies are using empirical radio telemetry data to evaluate the effects of the NFM Project operations on migratory fish movement including:
 - Study No. 3.2.2 Evaluate U/S and D/S Passage of Adult American Shad
 - Study No. 3.3.3 Evaluate D/S Passage of Juvenile American Shad
 - Study No. 3.3.5 Evaluate D/S Passage of American Eel
 - Study No. 3.3.15 Assessment of Adult Sea Lamprey Spawning within the TF Project and NFM Project Area.
- The telemetry studies, coupled with the two-dimensional hydraulic model results, will be used to determine the impact of Project operations on migratory fish movement.
- For this report, velocity data were compared against fish swim speeds to determine the potential for velocity barriers and entrainment. However, this evaluation is based solely on the hydraulic model; it does not represent how fish will react to in-situ conditions.

3.3.9-Two-Dimensional Modeling of the Northfield Mountain Pumped Storage Project Intake/Tailrace Channel and Connecticut River Upstream and Downstream of the Intake/Tailrace



3.3.9-Two-Dimensional Modeling of the Northfield Mountain Pumped Storage Project Intake/Tailrace Channel and Connecticut River Upstream and Downstream of the Intake/Tailrace



3.3.9-Two-Dimensional Modeling of the Northfield Mountain Pumped Storage Project Intake/Tailrace Channel and Connecticut River Upstream and Downstream of the Intake/Tailrace

60 Scenarios Modeled

Connecticut River Exceedance Flows:

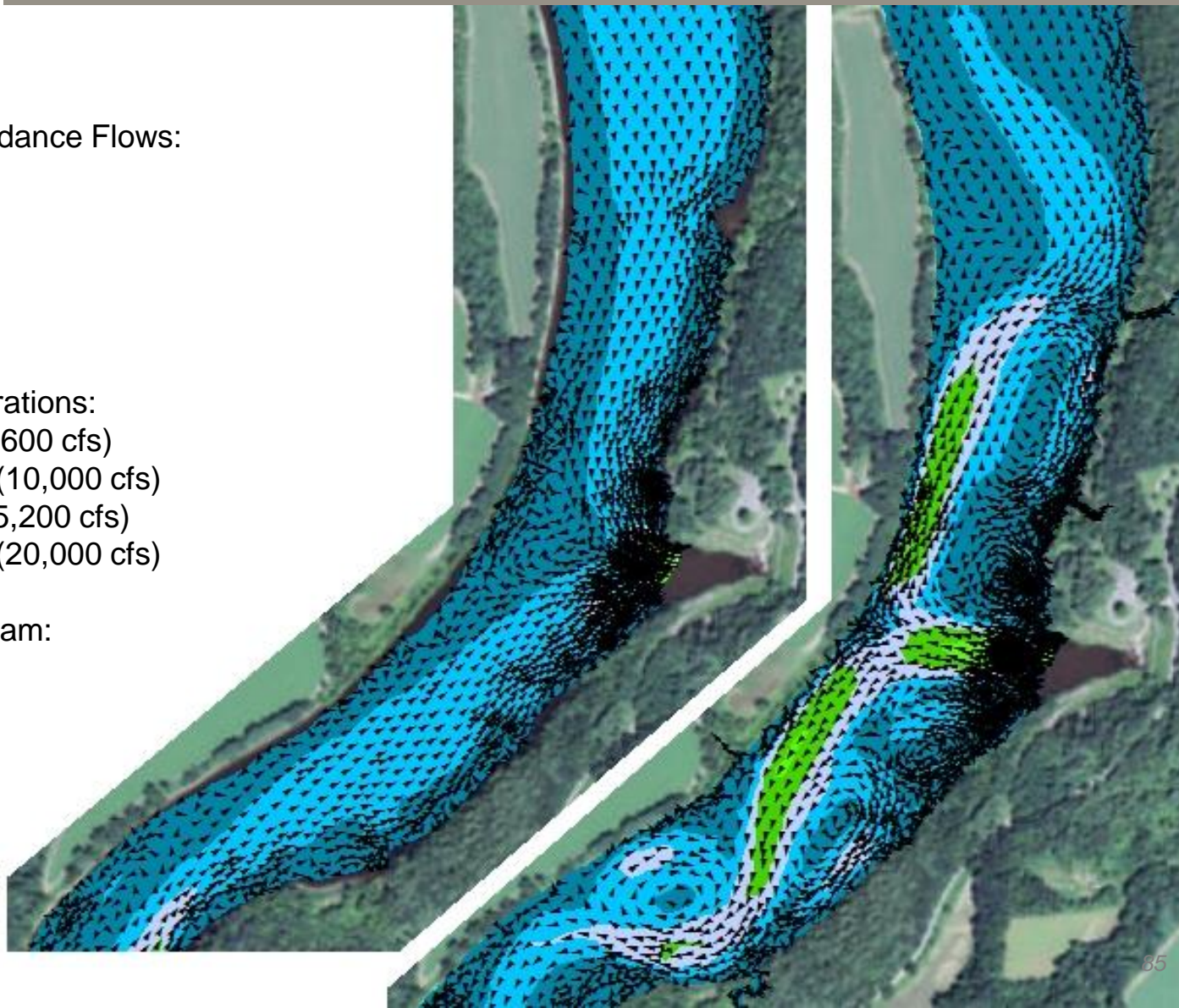
- 95% (1,760 cfs)
- 75% (4,900 cfs)
- 50% (8,440 cfs)
- 25% (15,700 cfs)
- 5% (40,100 cfs)

Northfield Mountain Operations:

- 2-Units Pumping (7,600 cfs)
- 2-Units Generating (10,000 cfs)
- 4-Units Pumping (15,200 cfs)
- 4-Units Generating (20,000 cfs)

WSEL at Turners Falls Dam:

- 176.0 ft
- 181.3 ft
- 185.0 ft



Results Pertaining to Migratory Fish

American Shad, American Eel, Sea Lamprey

Potential Velocity Barriers to Upstream Migration

- French King Gorge area exhibits high velocities during high flow
- Under swift flows that exceed swimming capacities of fish, shoreline areas with lower velocities may be utilized for passage

Flow Reversals and Eddies

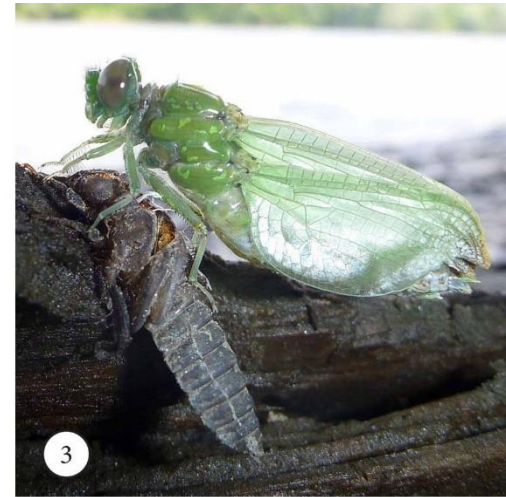
- Pumping – During low incoming flow, flow reversals may occur downstream of Northfield
- Generating – During low incoming flow, flow reversals may occur upstream of Northfield

Effects on Fish (i.e. Passage Failure, Delay, Entrainment)

- Results can be used to predict the conditions that fish encounter, but cannot directly evaluate effects on fish
- Other studies (i.e. telemetry) can use results from this study to better interpret fish behavior by providing better understanding of conditions encountered by fish

Odonates and Mussels

3.3.10-Assess Operational Impacts on Emergence and Eclosure of State-Listed Odonates in the Connecticut River



3.3.10-Assess Operational Impacts on Emergence and Eclosure of State-Listed Odonates in the Connecticut River

Study Objectives

- Conduct field surveys and synthesize existing data to characterize the odonate community and species emergence and eclosure behavior in the Project area.
- Assess the effects of Project operations, especially water surface elevation (WSEL) changes, on the emergence, eclosure, and habitat of state-listed odonate species and the odonate community.

3.3.10-Assess Operational Impacts on Emergence and Eclosure of State-Listed Odonates in the Connecticut River

Phase 1 (2014)

- Qualitative surveys at 8 sites to determine species composition, habitat, and to collect preliminary data on emergence behavior.
- Phase 1 report filed with Updated Study Report (Sept. 2015)

Phase 2 (2015)

- Quantitative surveys at 5 sites to determine species composition, emergence and eclosure behavior, and habitat
- Analysis of the magnitude and rate of change of water surface elevations (WSEL) on a daily and hourly basis during the emergence period (May to September)
- Relate WSEL data to emergence behavior to assess potential operational impacts on odonate species.

3.3.10-Assess Operational Impacts on Emergence and Eclosure of State-Listed Odonates in the Connecticut River

Phase 2 Methods

- Quantitative sampling at 6 transects per site
- Conducted biweekly sampling at each site/transect during 8 sampling periods from late May to early September (2015)
- For every exuvia/teneral: recorded vertical height from the water's surface, horizontal distance from the water's edge, substrate, and other basic information (time, date, etc)
- Specimens were collected, individually labeled, and identified to species.
- Emergence speed was recorded when possible.
- Dataloggers recorded WSEL and water temperature at 15-minute intervals

3.3.10-Assess Operational Impacts on Emergence and Eclosure of State-Listed Odonates in the Connecticut River



3.3.10-Assess Operational Impacts on Emergence and Eclosure of State-Listed Odonates in the Connecticut River

Species	Abbreviation	2015 Phase 2 Survey Site					Total	Percent of Total
		1	2	3	4	5		
<i>Arigomphus furcifer</i>	ArFu	0	0	0	0	0	0	0.0
<i>Basiaeschna janata</i>	BaJa	0	0	0	0	2	2	0.3
<i>Boyeria vinosa</i>	BoVi	58	3	11	6	0	78	12.5
<i>Cordulegaster maculata</i>	CoMa	0	0	0	1	0	1	0.2
<i>Dromogomphus spinosus</i>	DrSp	3	10	1	2	2	18	2.9
<i>Epitheca princeps</i>	EpPr	0	0	0	1	101	102	16.4
<i>Gomphus abbreviatus</i>	GoAb	2	4	0	14	0	20	3.2
<i>Gomphus vastus</i>	GoVa	70	129	2	18	0	219	35.2
<i>Gomphus ventricosus</i>	GoVe	0	0	0	0	0	0	0.0
<i>Hagenius brevistylus</i>	HaBr	2	1	1	0	0	4	0.6
<i>Libellula sp.</i>	Lisp	0	0	0	0	6	6	1.0
Libellulinae (unidentified)	Li	0	0	0	0	12	12	1.9
<i>Macromia illinoiensis</i>	Mall	3	2	6	2	1	14	2.3
<i>Neurocordulia yamaskanensis</i>	NeYa	3	8	4	6	2	23	3.7
<i>Ophiogomphus rupinsulensis</i>	OpRu	5	20	0	0	0	25	4.0
<i>Perithemis tenera</i>	PeTe	0	0	0	0	27	27	4.3
<i>Stylurus amnicola</i>	StAm	3	1	5	0	0	9	1.4
<i>Stylurus spiniceps</i>	StSp	23	25	9	5	0	62	10.0
		172	203	39	55	153	622	

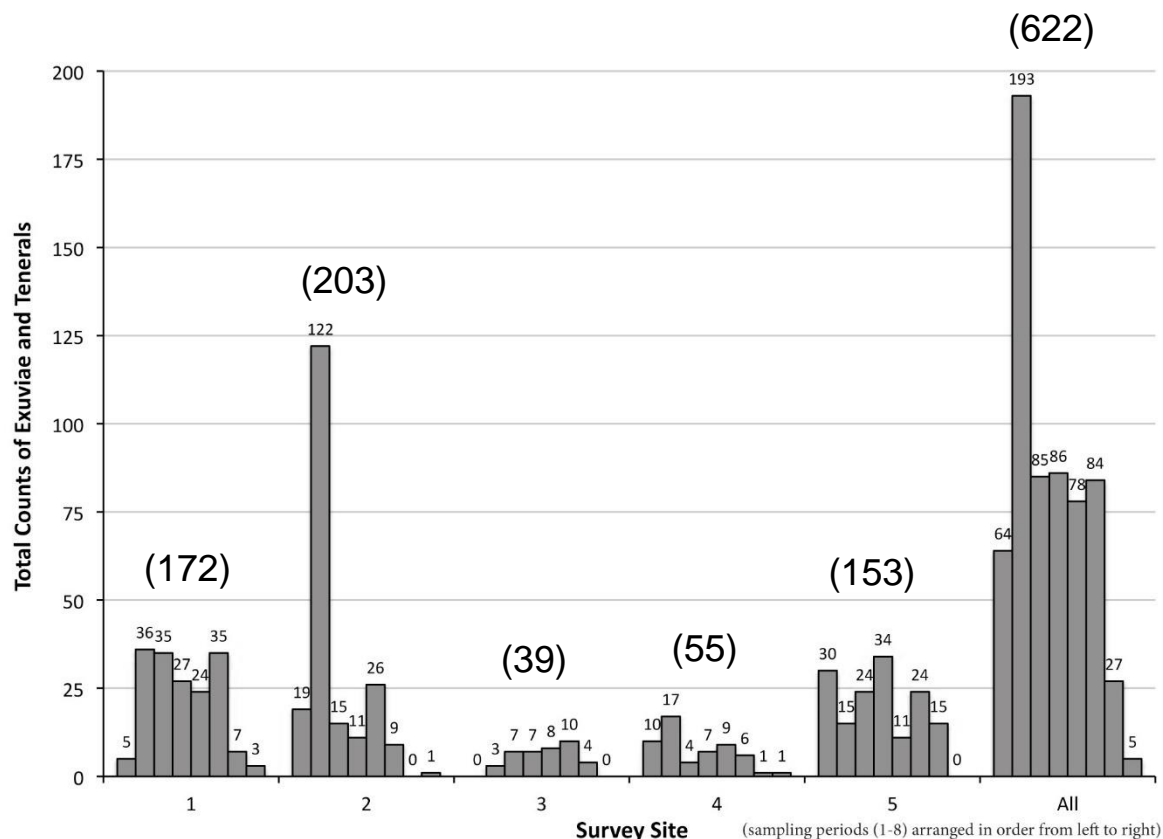
3.3.10-Assess Operational Impacts on Emergence and Eclosure of State-Listed Odonates in the Connecticut River

Emergence Timing

Counts very low at first, then low, then very low, then very very low...

Overall, much lower densities than what had been observed in 2014

Small sample sizes, especially for Sites 3 and 4



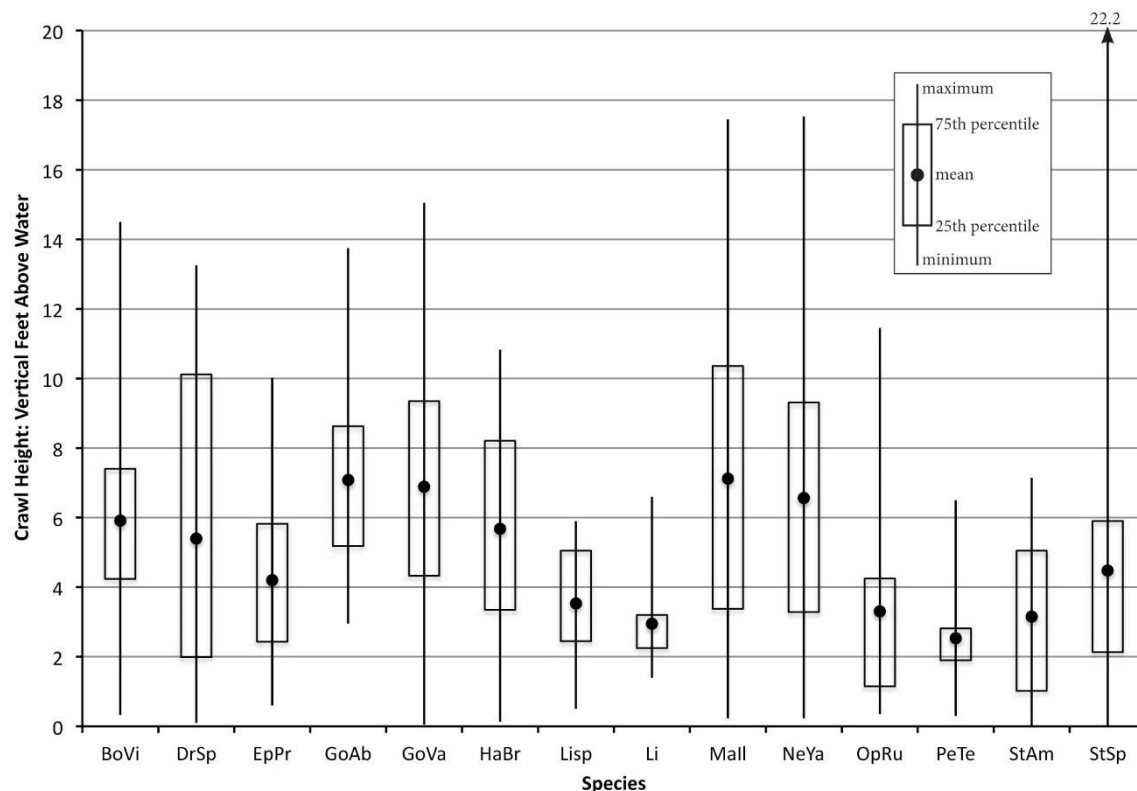
3.3.10-Assess Operational Impacts on Emergence and Eclosure of State-Listed Odonates in the Connecticut River

Crawl Height

Crawled average 5.0 ft from the water surface

Shorter distances for more lentic species at Site 5

Among riverine species: shortest for *S. amnicola*, *S. spiniceps*, and *O. rupinsulensis*.



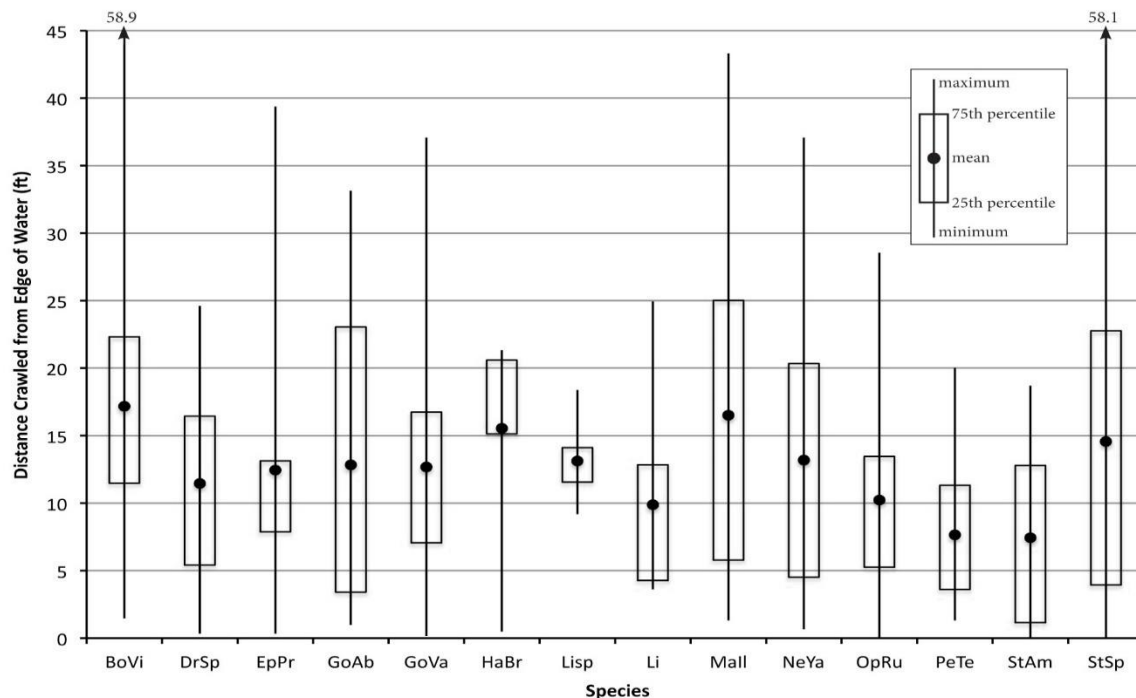
3.3.10-Assess Operational Impacts on Emergence and Eclosure of State-Listed Odonates in the Connecticut River

Crawl Distance

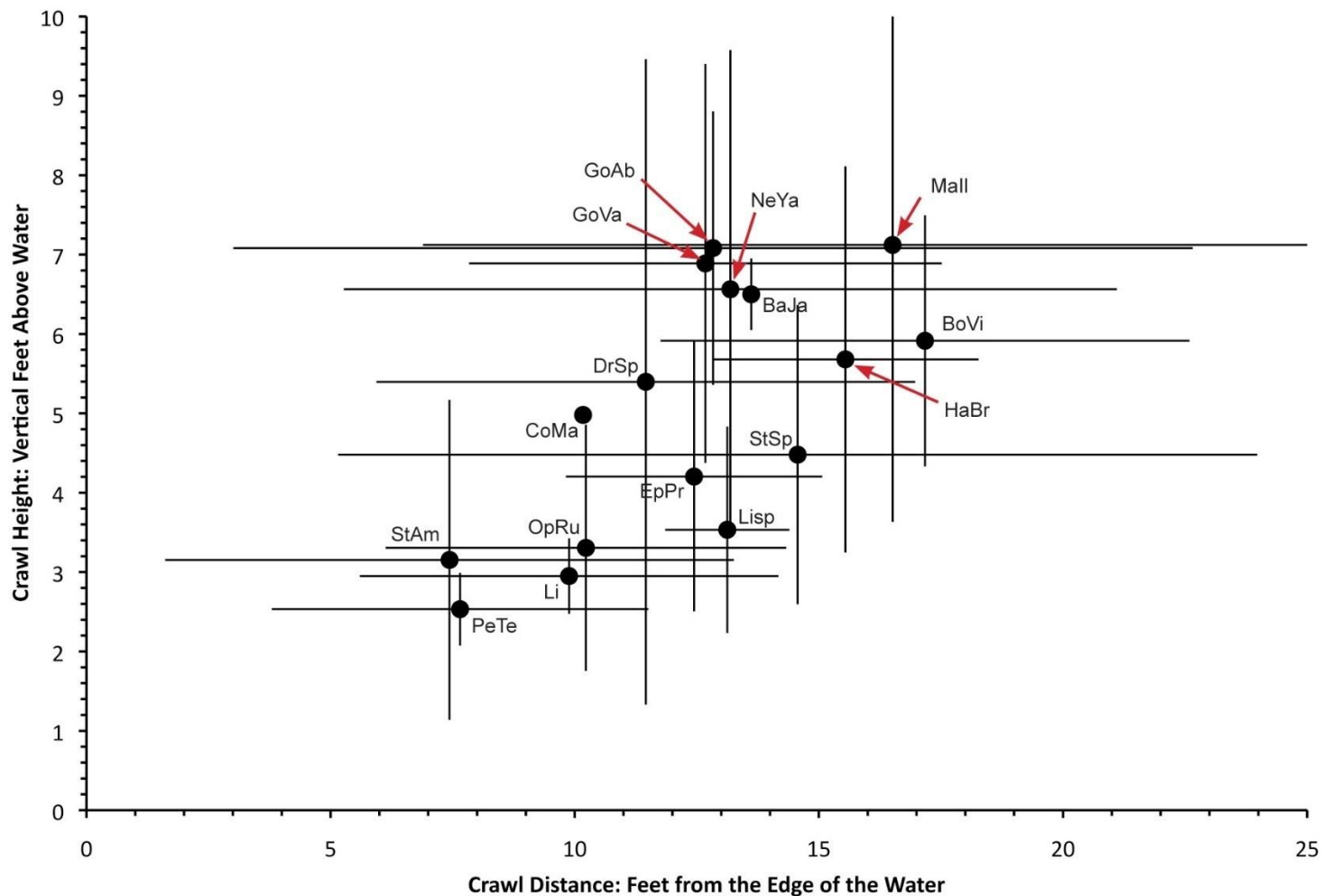
Crawled average 12.4 ft from edge of water

Shorter distances for more lentic species at Site 5

Among riverine species: shortest for *S. amnicola* and *O. rupinsulensis*.



3.3.10-Assess Operational Impacts on Emergence and Eclosure of State-Listed Odonates in the Connecticut River



3.3.10-Assess Operational Impacts on Emergence and Eclosure of State-Listed Odonates in the Connecticut River

Eclosure Speed

Low sample sizes due to low emergence and other factors

Average time from start to end of metamorphosis was 36 minutes (range: 9 to 81)

Average time from end of metamorphosis to flight was 47 minutes (range: 7 to 235)

Observed 9 specimens for entire process: average 70 minutes (range: 54 to 123 mins)



3.3.10-Assess Operational Impacts on Emergence and Eclosure of State-Listed Odonates in the Connecticut River

Assessing Effect of WSEL Changes on Odonate Emergence/Eclosure

Assume 2-hr critical eclosure time (start of eclosure to adult flight)

Assume larva begins to eclose at a daily low, just when water levels begin to rise at varying rates (hourly mean, hourly max, highest recorded max)

Assume that only larvae that have begun to eclose are susceptible.

Based on recorded crawl heights, determine percent that would be inundated by rising flows at the three rates before adults flew away (within 2 hours)

3.3.10-Assess Operational Impacts on Emergence and Eclosure of State-Listed Odonates in the Connecticut River

Sites 1 -2

Rate of change rarely exceeded 1.0 ft/hr over the entire period.

Low percent of odonates at risk from WSEL changes.

Site 1	Rate of Change	Height at Risk	% of Odonates
Daily Mean	0.15 ft/hr	<0.30 ft	1.1%
Daily Max	0.41 ft/hr	<0.82 ft	4.0%
Highest Max	1.15 ft/hr	<2.30 ft	8.0%
Site 2	Rate of Change	Height at Risk	% of Odonates
Daily Mean	0.18 ft/hr	<0.36 ft	6.8%
Daily Max	0.51 ft/hr	<1.02 ft	11.2%
Highest Max	1.12 ft/hr	<2.24 ft	22.4%

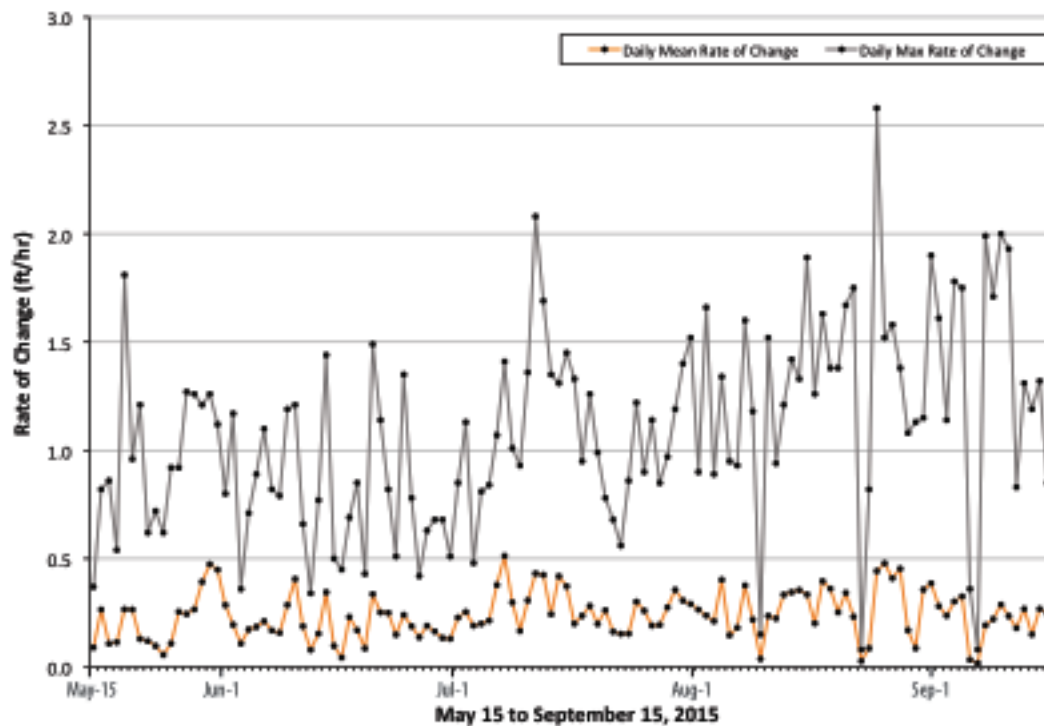
3.3.10-Assess Operational Impacts on Emergence and Eclosure of State-Listed Odonates in the Connecticut River

Site 3

Daily range in WSEL averaged 3.1 ft. Rates of change affected by operations at Cabot Station.

A higher percent of odonates at risk from WSEL changes at Site 3 compared to other sites.

Site 3 had lowest odonate densities of all sites.



	Rate of Change	Height at Risk	% of Odonates
Daily Mean	0.24 ft/hr	<0.48 ft	9.8%
Daily Max	1.09 ft/hr	<2.18 ft	17.0%
Highest Max*	2.58 ft/hr	<5.16 ft	65.9%

* Highest max = 1.89 ft/hr when bypass flows were stable (July 25-Aug 22, 2015).

3.3.10-Assess Operational Impacts on Emergence and Eclosure of State-Listed Odonates in the Connecticut River

Site 4: Above and Below Rock Dam

Site 4 had the second lowest odonate densities of all sites; transects below Rock Dam had very low density.

Downstream: Daily range in WSEL averaged 1.9 ft. Rates of change affected by operations at Cabot Station and Station 1.

Upstream: Rates of change affected by Station 1 and spill over dam. Fairly stable WSEL and minimal effects on odonates during normal operations.

Upstream	Rate of Change	Height at Risk	% of Odonates
Daily Mean	0.07 ft/hr	<0.14 ft	0%
Daily Max	0.55 ft/hr	<1.1 ft	0%
Highest Max*	2.8 ft/hr	<5.6 ft	50.0%
Downstream	Rate of Change	Height at Risk	% of Odonates
Daily Mean	0.15 ft/hr	<0.30 ft	0%
Daily Max	0.99 ft/hr	<1.98 ft	4.8%
Highest Max**	1.91 ft/hr	<3.82 ft	19.0%

*One time event when Station No. 1 came on-line. **For stable bypass flow period (July 25-Aug 22, 2015)

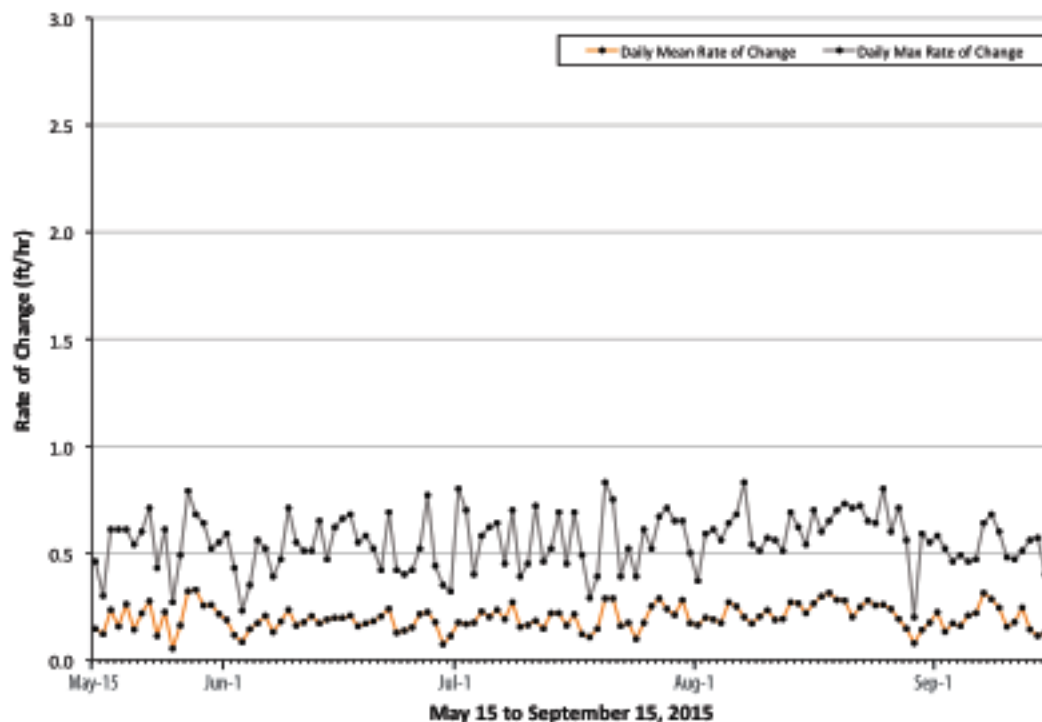
3.3.10-Assess Operational Impacts on Emergence and Eclosure of State-Listed Odonates in the Connecticut River

Site 5: Barton Cove

Daily range in WSEL averaged 2.5 ft.

Fairly stable WSEL and low rate of change compared to other sites.

Minimal effects on odonate emergence or eclosure.



	Rate of Change	Height at Risk	% of Odonates
Daily Mean	0.20 ft/hr	<0.40 ft	1.3%
Daily Max	0.56 ft/hr	<1.12 ft	8.5%
Highest Max	0.83 ft/hr	<1.66 ft	13.1%

3.3.10-Assess Operational Impacts on Emergence and Eclosure of State-Listed Odonates in the Connecticut River

Summary of Potential Effects

Near Cabot Station and the Bypass Reach

- Water level fluctuations and rates of change resulting from Project operations may affect odonate emergence in areas of the Connecticut River closest to Cabot Station.
- Depends on the timing and magnitude of flows through Cabot Station, Station No. 1, and spill over the Turners Falls Dam.

Downstream from Cabot Station

- Effects of Project operations on hourly/daily changes in WSEL and rates of change diminish with increasing distance downstream from Cabot Station.
- Neither hourly/daily changes in WSEL nor rates of change appeared to have a strong effect on odonate emergence at Sites 1 and 2.

Barton Cove

Neither the hourly/daily changes in WSEL or rate of change in Barton Cove appear to affect odonate emergence.

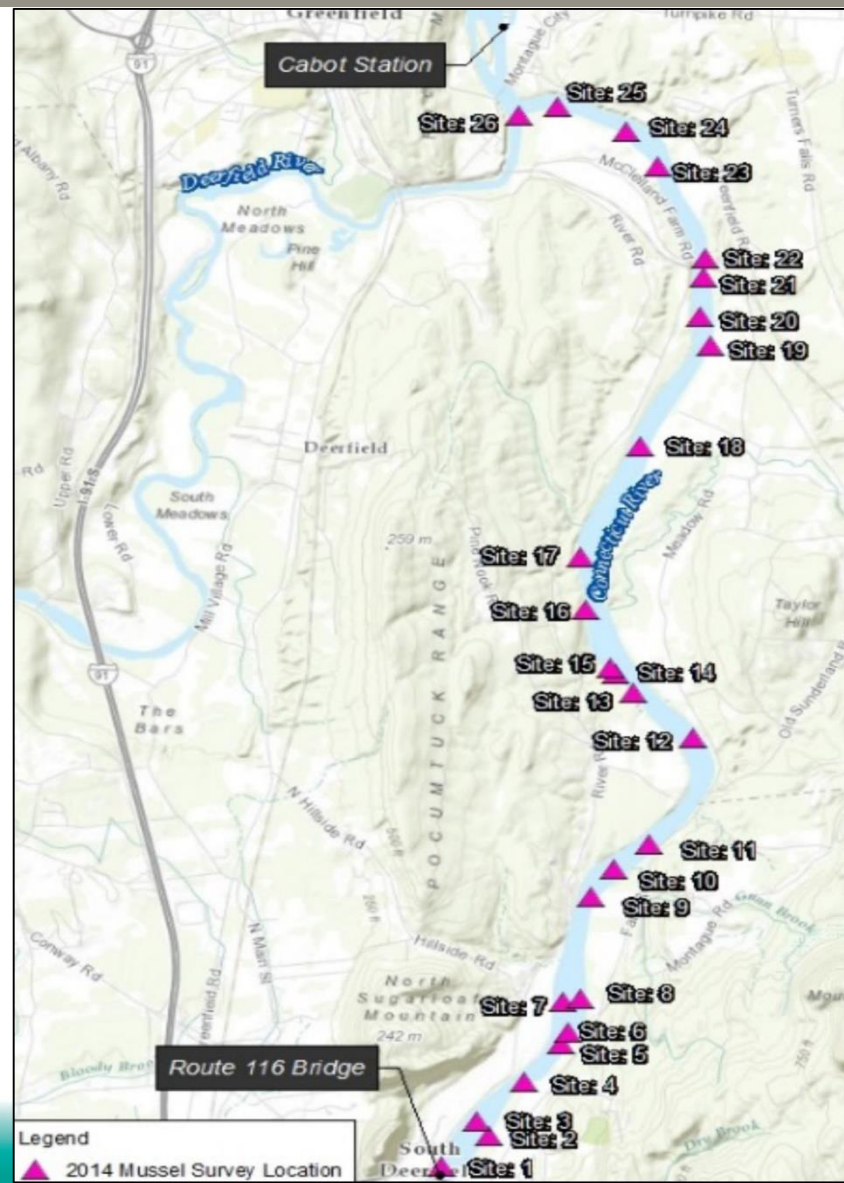
Study Objectives

- 1. Identify and map potential habitat for state-listed mussel species based on habitat preferences.**
 - Delineate through field surveys, populations of state-listed mussels and suitable habitat downstream from Cabot Station
 - Characterize distribution, abundance, demographics and habitat use of these populations.
- 2. Develop binary HSI curves for all state-listed mussel species found to occur in the 35-mile reach downstream from Cabot Station**
 - Use species-specific data from the CT River and others in Northeast, along with relevant publications and expert review (Delphi Panel).
 - HSI curves to be used in Study No. 3.3.1 *Instream Flow Studies in Bypass Channel and below Cabot Station*

3.3.16-Habitat Assessment, Surveys, and Modeling of Suitable Habitat for State-listed Mussel Species in the Connecticut River below Cabot Station

Objective 1: Mussel Survey and Habitat Assessment (Complete)

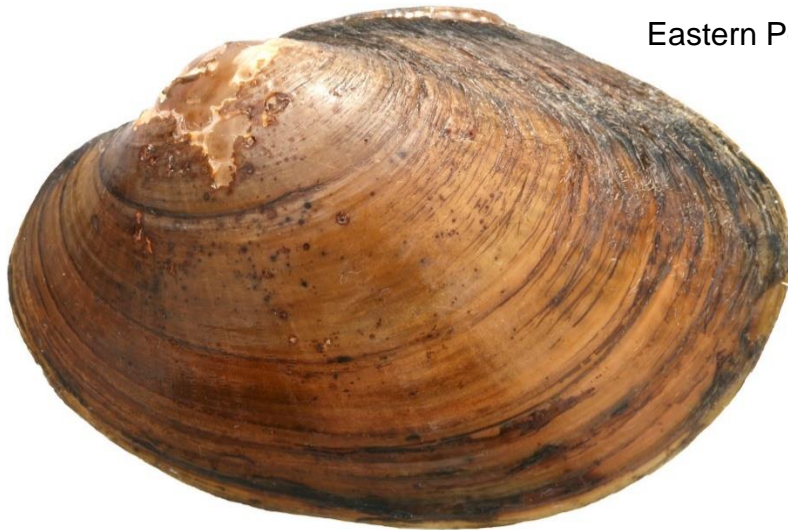
- In June 2014, a habitat assessment and survey was completed throughout the 13-mile reach of the Connecticut River between Cabot Station and the Sunderland Bridge. A summary report of these findings was posted to the relicensing website in January 2015.
- The mussel community in the reach from Cabot Station to the Route 116 Bridge is dominated by a single species, Eastern Elliptio.
- No live state-listed mussels were found in the survey areas. One relic *Lampsilis cariosa* shell was found.
- As part of FERC-required studies for Holyoke Gas & Electric, three state-listed mussel species were documented in the lower end of Holyoke Dam impoundment (Reach 5 of FirstLight's study area).



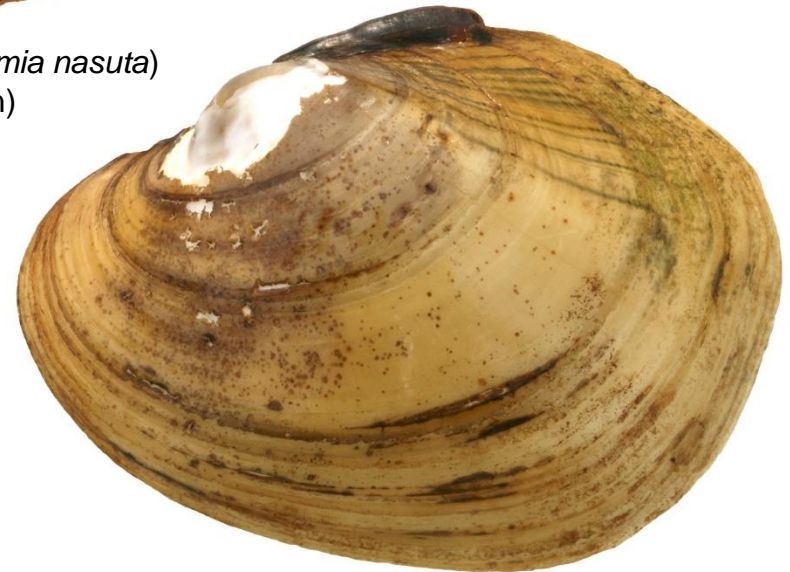
3.3.16-Habitat Assessment, Surveys, and Modeling of Suitable Habitat for State-listed Mussel Species in the Connecticut River below Cabot Station



Eastern Pondmussel (*Ligumia nasuta*)
(Special Concern)



Tidewater Mucket (*Leptodea ochracea*)
(Special Concern)



Yellow lampmussel (*Lampsilis cariosa*)
(Endangered)

3.3.16-Habitat Assessment, Surveys, and Modeling of Suitable Habitat for State-listed Mussel Species in the Connecticut River below Cabot Station

Objective 2 (in progress)

Task 3: Develop Binary HSI Curves for Target Species

1. A Delphi panel was established.
2. HSI criteria for water depth, flow velocity, substrate, cover, and shear stress are being developed using Delphi technique for juveniles and adults of the three target species
3. Round 1 Delphi questionnaire sent out November 2015, round 1 responses compiled and summarized, round 2 Delphi questionnaire sent out February 2016, and round 2 responses are being evaluated.
4. Concurrence reached on water depth, flow velocity, substrate, and cover. Shear stress and relative shear stress more challenging, and expert opinion is being sought in a third round of the Delphi panel.

Task 4: Assess Effects of Flow Regime on State-Listed Mussels

This task will occur once the HSI criteria are complete. HSI criteria will be used in the IFIM study (Study No. 3.3.1) to model the potential effects of flow regime on state-listed mussels.

Task 5: Report

Terrestrial and Rare, Threatened & Endangered Species

3.4.1-Baseline Study of Terrestrial Wildlife and Botanical Resources

Study Objectives:

- Survey and inventory overall upland wildlife habitats;
- Note the occurrence of wildlife sighting during the course of the surveys;
- Survey and inventory vegetation communities and land use;
- Survey and evaluate the presence of targeted RTE species or associated habitats; and
- Survey and inventory the nature and extent of upland invasive, exotic vegetation species.

3.4.1-Baseline Study of Terrestrial Wildlife and Botanical Resources



Findings- Terrestrial Wildlife

A field survey of wildlife species was conducted concurrently with other botanical and wetland studies.

- 15 mammals directly or indirectly observed including beaver, black bear, coyote and gray fox.
 - Total of 36 mammals likely to exist in study area
- 15 reptiles and amphibians directly or indirectly observed
 - 23 amphibians and reptiles are likely to occur within the study area including nine frogs and toads, four salamanders, three turtles, and seven snakes.
- 64 species of birds were observed within the study area
 - Three occupied Bald Eagle nests were located within the study area, downstream on Third Island, Barton Island in Barton Cove, and along the east bank of the TFI across from Stebbins Island located just downstream of Vernon Dam.

3.4.1-Baseline Study of Terrestrial Wildlife and Botanical Resources

Finding- Botanical Resources

- Botanical surveys were completed to determine the distribution of vegetation communities within the study area.
- An overall census list of all plant species identified within the study area
 - over 335 plant species were identified
- Vegetation communities were identified based on aerial photos or other imagery and classified using the NHESP Classification of the Natural Communities of Massachusetts (Swain & Kersey, 2011) and subsequently ground-truthed.
 - 8 vegetation communities were identified



3.4.1-Baseline Study of Terrestrial Wildlife and Botanical Resources

Habitat Type	Dominant Overstory	Dominant Shrub	Dominant Herbaceous	Acres	Percent of Area
Floodplain Forest	silver maple (51-75%), cottonwood (6-25%), red maple (6-25%)	silver maple (trace), cottonwood (trace) red maple (trace)	wood nettle (6-25%), ostrich fern (6-25%), sensitive fern (6-25%)	547.9	7.8
Northern Hardwoods-Hemlock-White Pine	hemlock (75-100%), yellow birch (10-15%), American beech (5-10%)	hemlock (trace), hobblebush (trace), elderberry(trace)	Christmas fern (trace), Canada mayflower (trace), club moss (trace)	1,107.9	15.7
Successional Northern Hardwoods	aspen (26-50%), white birch (6-25%), red maple (6-25%)	arrowwood (5-10%), staghorn sumac (trace),willow (6-25%)	common clotsbur (6-25%), symphyotrichum spp. (trace), carex spp (6-25%)	2.9	.05
Agricultural Lands	N/A	N/A	Agricultural crops (76-100%)	1,624.7	23.0
High Energy Shore	N/A	silky dogwood (trace), sandbar willow (trace), sandbar cherry (trace)	beggartick (6-25%), dogbane (6-25%)	5.17	.07
Development	white pine (trace)	N/A	Kentucky bluegrass (76-100%)	317.3	4.5
Right of Way	N/A	white pine (6-25%), glossy buckthorn (6-25%)	sensitive fern (6-25%), Joe pye weed (6-25%), bracken fern (6-25%), mullein (6-25%)	4.8	.07
Wetlands	See Study 3.5.1	See Study No. 3.5.1	See Study No. 3.5.1	342.2	4.8
Water	N/A	N/A	N/A	3,112.4	44.1
Total				7,065.2	100.0

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

Study Objectives:

- Quantitatively describe and field verify NWI mapped wetland types, describe and map shallow water aquatic habitat, including SAV and EAV, substrate type, invasive species, and associated wildlife in the TFI and up to 200 feet from the TFI shoreline.
- Obtain baseline information, through field surveys, on the locations and population parameters of Massachusetts state-listed rare plant species in TFI and the 13+ miles of riverine habitat below Cabot Station to the Route 116 Bridge in Sunderland.
- Analyze how the Project operations affect botanical and wildlife resources with an emphasis on how Project operations influence habitat of state-listed plant species and state-listed invertebrate species including the cobblestone tiger beetle and the Puritan tiger beetle.

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

Task 2: Riparian and Littoral Zone Botanical Survey

- Riparian habitats mapped and described as part of Study 3.4.1
- Submerged Aquatic Vegetation (SAV):
 - No SAV mapped within the bypass reach
 - No Exotic/Invasive species identified downstream of the Turners Falls Dam

Scientific Name	Common Name
<i>Cabomba caroliniana</i> *	Fanwort
<i>Ceratophyllum demersum</i>	Coontail
<i>Chara Spspp.</i>	Muskgrass
<i>Elodea nuttallii</i>	Waterweed
<i>Myriophyllum spicatum</i> *	Eurasian milfoil
<i>Myriophyllum heterophyllum</i> *	Variable leaf milfoil
<i>Myriophyllum Spspp.</i>	Milfoil
<i>Potamogeton amplifolius</i>	Large-leaf pondweed
<i>Potamogeton perfoliatus</i>	Clasping leaf pondweed
<i>Potamogeton Spspp.</i>	Pondweed
<i>Potamogeton crispus</i> *	Curly-leaved pondweed
<i>Trapa natans</i> *	Water chestnut
<i>Vallisneria americana</i>	Wild celery (Eelgrass)

*Exotic Species

Density Class	Estimated Density (%)	Number of Beds	Area (Sq. Ft.)	Area (Acres)
Dense	51-100%	25	12,878,374	295.6
Medium	26-50%	42	5,758,854	132.2
Sparse	0-25%	56	2,713,116	62.3
Total		123	21,350,344	490.1



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

Task 3: Rare, Threatened, and Endangered Plant Transect Survey

- Mapping of RTE plants occurred in 2014
- Survey transects within occupied/unoccupied habitats were surveyed in August of 2015.
 - A total of 18 habitat transects were established
 - In the TFI: Transect 10, 9A, 9B, 8, 11D, 11C, 11B, 11A, 6A, 6B, 6C 5A, and 5B (total of 13 transects);
 - in the bypass channel: Transect T-3 (total of 1 transect); and
 - in the Montague USGS Gage to Sunderland Bridge reach: Transect 4, 3, 2 and 1 (total of 4 transects).

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

Task 4: Invasive Plant Survey

- Mapping and description of invasive species included in Study 3.4.1
- Commonly occurring species along the impoundment and downstream of Turners Falls Dam are black swallowwort, Oriental bittersweet, and Japanese knotweed.
- Common reed was not widespread.

Task 5: Mapping of Wetlands and Waters of the U.S.

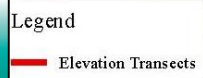
- NWI wetlands verified (~1,400 acres) and new (~ 56 acres) wetlands mapped in 2014
- Most common wetlands are emergent or forested wetlands

Verified Wetland Type	Area (Acres)
Palustrine Emergent Wetland	457.4
Palustrine Forested	872.8
Palustrine Scrub-Shrub	2.4
Palustrine Pond	49.7
Total	1,382.3

New Wetland Type	Area (Acres)
Palustrine Emergent	55.7
Total	55.7



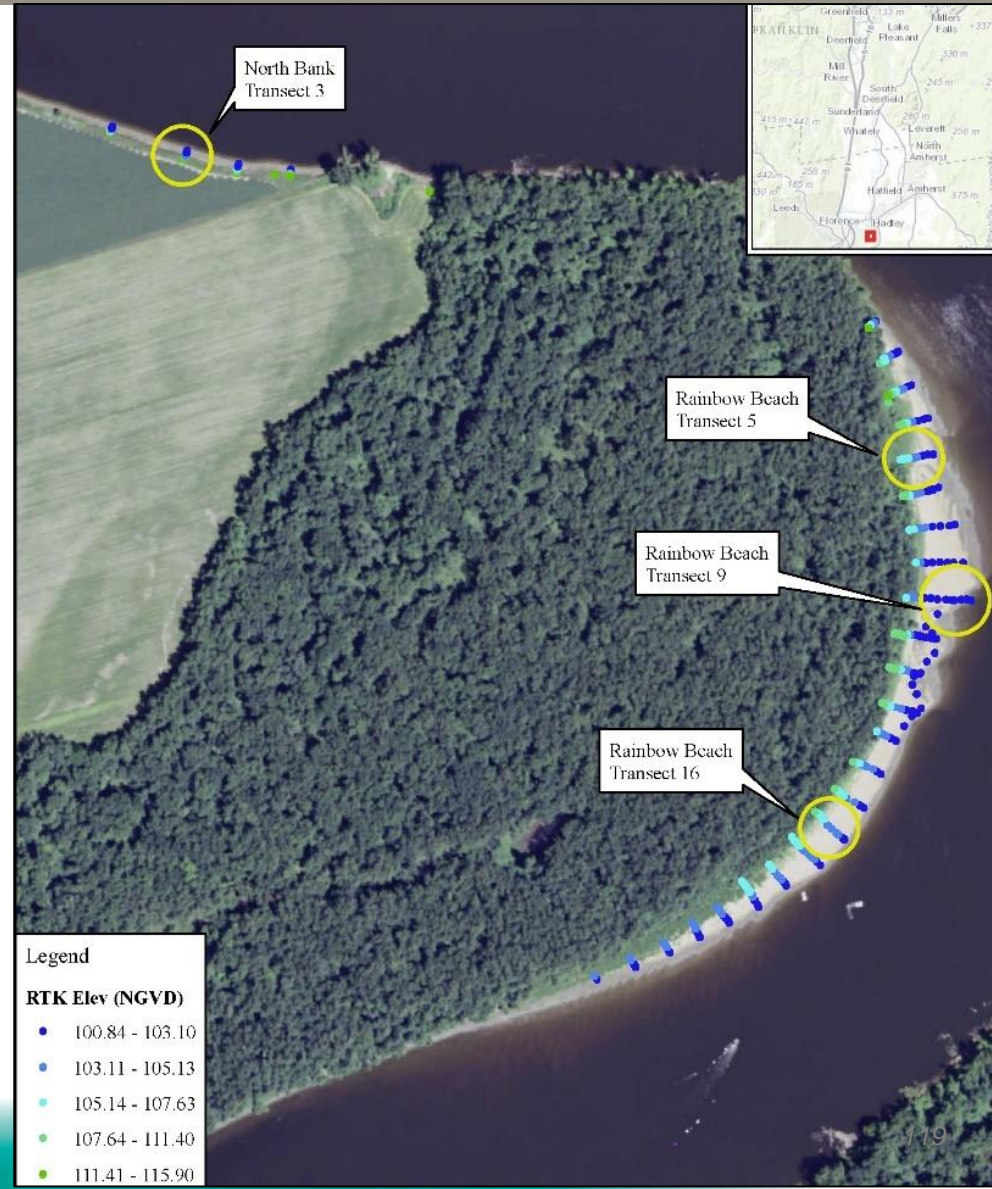
- Transect 1 (First Island, near the Sunderland Bridge)
- Sandbar Willow transect
- Transect length 230 feet
- Nine individual willows identified on the transect
- Willows occur between elevation 104.0 feet and 105.1 feet
- Majority of willows occur above the July median flow (9,500 cfs)



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

Task 6: Project Water Level Fluctuation Assessment-Beetles

- Tiger beetle survey completed from the Vernon Dam downstream to Holyoke, MA in August of 2014.
- No cobblestone tiger beetles were located in 2014.
- Elevation survey at Rainbow Beach was completed in 2014
 - Total of 28 transects (four at North Bank and 24 at Rainbow Beach)



Task 7: Data Analysis

- Riparian habitat in the study area is dominated by northern hardwood forests with some mixed softwood species
- Submerged Aquatic Vegetation (SAV)
 - SAV beds occur within the impoundment and downstream of the Turners Falls Dam, but are not identified within the bypass reach.
 - Invasive SAV is located within the Impoundment and most commonly observed in the area immediately upstream of the Turners Falls Dam.
 - Project operations may result in a loss of SAV establishment in a small band along the shoreline where water fluctuations are most common; however, this does not limit the establishment of SAV within deeper areas away from the shoreline.

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

Task 7: Data Analysis

RTE Plants

- 18 Transects were surveyed to examine RTE plant species.
- Mountain alder generally occurs within the TFI above the April median WSEL and outside the more commonly observed changes in WSEL.
- Within the bypass, the mountain alder was not inundated during the flow demonstration.
- The mountain alder appears to prefer elevations which are generally drier and more removed from project operations.
- Upland white aster and sandbar cherry also occur, primarily, above the median April WSEL, and in all cases occur above the May median WSEL.
- Tradescant's aster and the sandbar willow are most commonly observed below the April median WSEL.
- Botanical RTE species within the project do not appear to be greatly affected by project operations, in fact the variable water levels may be creating a desirable environment for these species which are adapted to dynamic river systems.

Task 7: Data Analysis

Wetlands

- Wetlands within the study area include a mixture of forested, scrub-shrub, and emergent wetlands. The most commonly observed wetlands within the study area include forested floodplain wetlands and shoreline emergent wetlands.

Invasive Species

- Several areas are dominated by Japanese knotweed, black swallowwort, and Oriental bittersweet, which are the most common invasive plant species along the shoreline. These species do occur in patches, and, occasionally, Japanese knotweed forms dense monocultures.

Task 7: Data Analysis

Tiger beetles

- Elevation surveys of known occupied habitat at Rainbow Beach were completed in 2014. Survey data were used in conjunction with modeling developed from Study No. 3.2.2
- Project operations may impact available habitat and disperse individuals, primarily at the lower range of elevations, at higher elevations the operations may result in similar effects, but less frequently.
- Impacts from recreation at Rainbow Beach are likely to affect both adult and larval beetles. Boat wakes may temporarily and rapidly disperse individuals along the water line, and foot traffic from recreators may result in mortality or dispersal.

Recreation and Land Use

3.6.1-Recreation Use/User Contact Survey

Work Completed

Task 1: Study Preparation

Task 2: Field Work

Task 3: Data Entry and Statistical Analysis

Task 4: Report Writing

- All of the above tasks are complete. Report was posted to the website on 12/31/15 and filed with FERC on 3/1/16.

Findings (if any)

- See next pages.

Variances (if any)

- As we reported at the USR meeting in September 2015, there were no variances from the study plan or schedule in the second year of the study.

Work Remaining

- None.

3.6.1-Recreation Use/User Contact Survey Study Objectives

- 1) Determine the amount of recreation use and demand at the Turners Falls and Northfield Mountain recreation sites.
- 2) Interview the recreating public to determine user opinions and goals with regard to the recreation sites, including the perceived adequacy of recreation facilities and access at the Project.

3.6.1-Recreation Use/User Contact Survey Methodology

Recreation Use

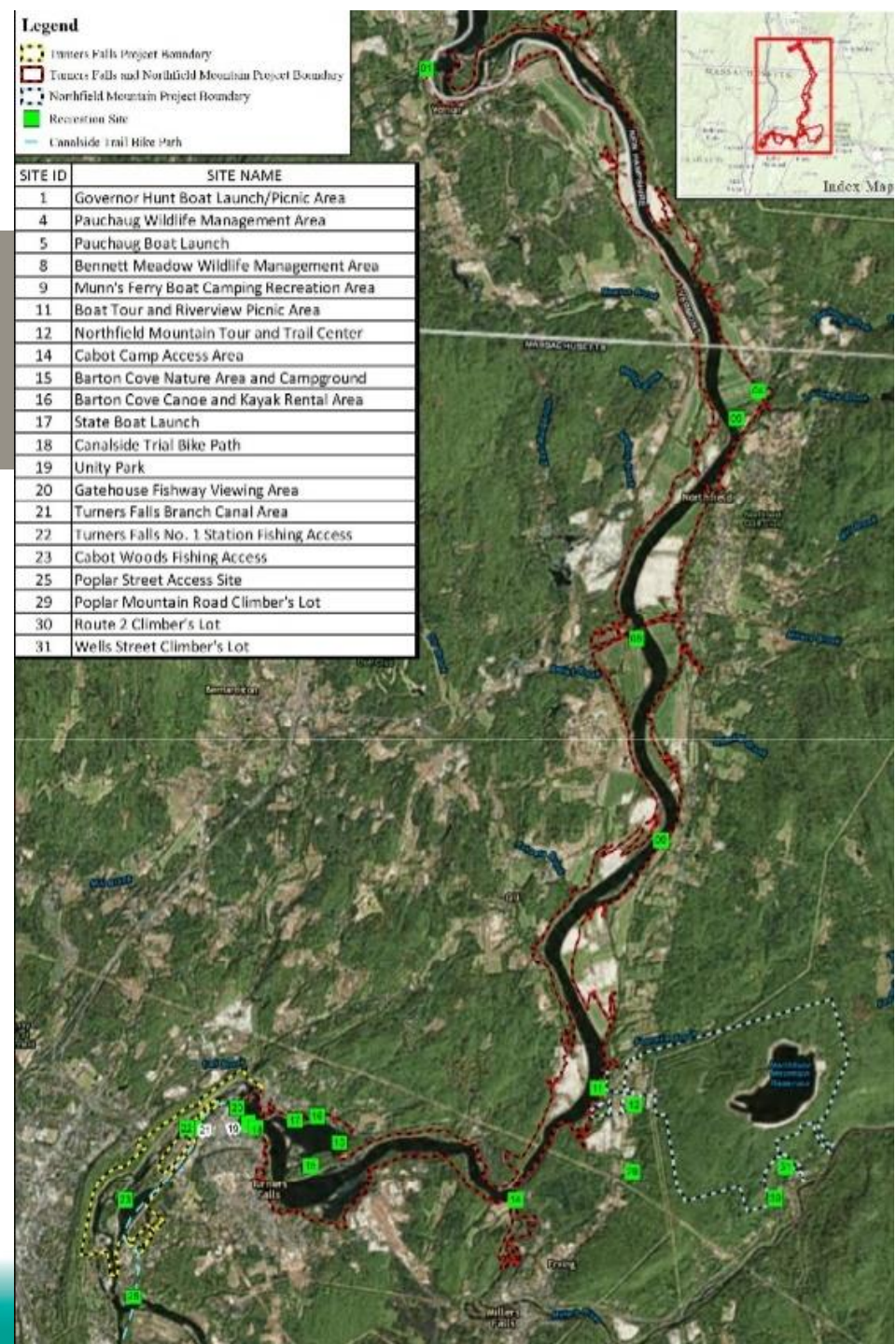
- Spot counts (1,273) and calibration counts (1,226)
 - Conducted at 20 recreation sites located throughout the Projects.
 - 5 days per month: 3 randomly selected weekdays and 2 randomly selected weekend days
- Traffic counters at 11 sites
 - Spring – Fall, 2014
- Actual Recreation Site Use Records and Registrations

Recreation User Surveys

- User Contact Survey
 - Recreation User Survey (733 original, 211 modified)
 - Northfield Mountain Trail User Survey (84 original, 31 modified)
- Residential Abutters Survey
 - 95 returned surveys of 211 mailed
- Phone Survey of Private Recreation Groups within the Projects
- Phone Survey of Law Enforcement
- Review of Open-Space Planning Information

3.6.1-Recreation Use/User Contact Survey - Methodology

Figure: Recreation Use and User Survey Study Area



3.6.1-Recreation Use/User Contact Survey Methodology

Public Recreation Sites and Access Areas Where Recreation Use Counts and User Surveys Were Conducted

Site ID ¹	Site Name/Access Areas	Spot Counts	Calibration Counts	Traffic Counter	User Surveys
1	Governor Hunt Boat Launch/Picnic Area	✓	✓		✓
4	Pauchaug Wildlife Management Area	✓	✓		✓
5	Pauchaug Boat Launch	✓	✓	✓	✓
8	Bennett Meadow Wildlife Management Area	✓	✓	✓	✓
9	Munn's Ferry Boat Camping Recreation Area (campsites only)	✓	✓		✓
11	Boat Tour and Riverview Picnic Area	✓	✓	✓	✓
12	Northfield Mountain Tour and Trail Center	✓	✓	✓	✓
14	Cabot Camp Access Area	✓	✓	✓	✓
15	Barton Cove Nature Area (parking)	✓	✓	✓	✓
15	Barton Cove Campground (campground)	✓	✓	✓	✓
16	Barton Cove Canoe and Kayak Rental Area	✓	✓	✓	✓
17	State Boat Launch	✓	✓	✓	✓
18	Canalside Trail Bike Path	✓	✓		✓
19	Unity Park	✓	✓		✓
20	Gatehouse Fishway Viewing Area	✓	✓		✓
21	Turners Falls Branch Canal Area	✓	✓		✓
22	Turners Falls Station No. 1 Fishing Access	✓	✓		✓
23	Cabot Woods Fishing Access	✓	✓	✓	✓
25	Poplar Street Access Site	✓	✓	✓	✓
27	Rose Ledge Climbing Area (Parking)	✓	✓		✓
28	Farley Ledge Climbing Area (Wells St. parking)	✓	✓		✓
28	Farley Ledge Climbing Area (Route 2 parking)	✓	✓		✓

¹ Site numbers were assigned as part of Study 3.6.2 Recreation Facilities Inventory and Assessment

3.6.1-Recreation Use/User Contact Survey Findings

Overall Recreation Use

Estimated Total Annual Use and Seasonal Breakdown of Use, by Recreation Site, for 2014

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

- 152,769 total recreation days in 2014
- 50% of the recreation use occurred during summer
 - Summer: May 23, 2014 – Sept 1, 2014 (Memorial Day weekend – Labor Day weekend)

3.6.1-Recreation Use/User Contact Survey Findings

Recreation Use by Activity

- Walking/hiking/jogging were most popular (30%), followed by motorized boating, fishing, bike riding, picnicking, rock climbing, and non-motorized boating.

Recreation Use by Activity Type based on Spot Counts and Calibration Counts in 2014

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

3.6.1-Recreation Use/User Contact Survey Findings

Recreation Use and Utilization, by Recreation Site

Recreation Site Capacity Utilization by Site

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

- The Gatehouse Fishway Viewing Area (including adjacent picnic area and a portion of the bike trail) received the most use, followed by the NMTTC, the Cabot Woods Fishing Area, the State Boat Launch, and the Boat Tour and Riverview Picnic Area.
- Estimated capacity utilization per site was identified.
 - All sites were found to have utilization below the design capacity.

3.6.1-Recreation Use/User Contact Survey Findings

Recreational User Survey

User surveys included ratings and users' recreational experiences at the Projects.

- Total number of surveys collected: **945**
- Average age of users: 48.8 years old
- Majority are male (63%)
- Most use is local, with an average distance traveled to the Projects of 23 miles
- Average length of stay is 1.7 hours
- 91% had visited the Project area before
- 96% estimated they spent "less than \$100" during their visit
- User surveys indicated most popular recreation activities were walking and dog walking. This is consistent with the findings from the use counts.

3.6.1-Recreation Use/User Contact Survey Findings

Recreational User Survey

Recreational User Ratings of Recreation Sites, Facilities and Amenities, Reported as Percent of Respondents

Site/Facility/Amenity	Number of Responses	5 Excellent	4	3 Fair	2	1 Poor
Parking	917	46%	35%	14%	4%	2%
Facility Condition	918	42%	40%	14%	4%	<1%
Variety of Amenities	905	28%	35%	25%	9%	3%
Toilets/Restrooms	139	17%	20%	13%	9%	41%
River Access	198	43%	36%	14%	4%	4%
Overall Quality	914	41%	44%	12%	2%	<1%

- Overall quality of the recreation sites/facilities and amenities rated well:
 - 85% rated facilities Excellent or better than Fair
- Parking, facility condition, river access, and variety of amenities also rated well.
- Only restrooms/toilets received notably lower ratings, with 50% rating them from Fair to Excellent and 50% rating them less than Fair.

3.6.1-Recreation Use/User Contact Survey Findings

Recreational User Survey

Recreational User Ratings of Number of the Facilities, Level of Use, and Water Levels, Reported as Percent of Respondents

Topic	Number of Responses	Respondents' Ratings				
		5 Extremely Crowded	4	3 Somewhat Crowded	2	1 Not Crowded
Level of Use	908	6%	16%	21%	19%	39%
		5 Extremely Satisfied	4 Moderately Satisfied	3 Satisfied	2 Slightly Satisfied	1 Not Satisfied at all
Number of Facilities	193	36%	31%	29%	4%	<1%
		5 Extremely Satisfied	4 Moderately Satisfied	3 Satisfied	2 Slightly Satisfied	1 Not Satisfied at all
Water Levels¹	427	13%	43%	37%	5%	2%

¹ The question regarding water levels was included on surveys administered throughout the year. Less than half of the 945 recreationists answered this question.

3.6.1-Recreation Use/User Contact Survey Findings

Recreational User Survey

Summary of Open-ended Responses to: “What did you like **least** about your recreational experience today?”

Response	Number of Comments
Weather	42
Trash/litter	41
Parking lot and road maintenance/plowing	28
Crowded/noisy	27
No restrooms/restrooms closed	23
Goose droppings/goose feedings	23
Dogs	23
Behavior of other recreationists	19
Insects	13
Poor fishing	12
Muddy	7
Access to water	7
Restrictions	6
Low water level	6
Boat access/ramp	6
Poison Ivy/Japanese Knotweed	6
Location	6
Motor boats/boaters	5
Poor/lack of amenities	4
Picnic tables	4
Dangerous drivers	4
Facilities/gate closed	3
Safety	3
Not in guidebook/on map	3
View of power lines	2
Flooding	2
Construction projects	2
Fishway	2
Lack of trees/trees cut	2
Handicapped accessibility	2
Other	12
Total	345

- A host of different factors were indicated across the many surveys collected.
- Factors identified by respondents that they liked the “least” or which “detracted” from their experience included: trash and litter, and parking lot and road maintenance.
- Other factors consistently cited but generally beyond the control of FirstLight included: weather, goose droppings, dogs, and the behavior of other recreationists.

3.6.1-Recreation Use/User Contact Survey Findings

Recreational User Survey

Summary of Open-ended Responses to: “What did you like **most** about your recreational experience today?”

Response	Number of Comments
Peaceful/quiet	178
Beauty/scenery	137
Location/close to home	69
Weather	67
Nature/wildlife	67
Not crowded	61
Fishing	61
Walking	46
Water/River	44
Water access	42
Good for dogs	26
Eagles, geese, ducks, waterfowl	25
Cleanliness	24
Birding	23
Community feel/friendliness	19
Time with family and friends	17
Safety	15
Parking/plowed access	13
Climbing	12
Public access/free	12
Boating/being on water	11
Biking/bike path	9
Recreation/relaxation	8
Historic/geologic interest	6
Picnicking	6
Fishway	5
Hunting	4
Variety	3
Camping	2
Other	18
Total	1,030

- Factors identified by respondents that they liked the “best” or which “enhanced” their experience included: scenery/beauty, nature/wildlife, and peaceful/quiet.
- Weather and location/close to home were also mentioned routinely as contributing factors.
- Interestingly, one of the more commonly mentioned positive features was “cleanliness”; suggesting that there were mixed views among users regarding the trash/litter situation, or that trash/litter might be more of an occurrence at some sites than others.

3.6.1-Recreation Use/User Contact Survey Findings

Residential Abutters Survey

Summary of Responses to Residential Abutter Survey Questions

- Mail survey of the 211 residential landowners abutting or within the Project boundaries.
- 95 surveys (45%) completed and returned.
- Among respondents:
 - 86% were year-round residents.
 - 65% indicated that their property was adjacent to the Connecticut River.
 - 47% use public recreation sites associated with the Projects.
- Results suggest that there is probably some use of Project waters that occurs via access across private property, either by the residents themselves, or by others who have permission to cross the private lands.
- In all four seasons, most popular recreation activities reported by the residents: walking, dog walking, birding, hiking, photography, and nature observation.
- Kayaking, power boating, canoeing, fishing, and picnicking were popular in the spring, summer, and fall.
- In the summer, many residents also reported enjoying swimming, water skiing, and tubing.

3.6.1-Recreation Use/User Contact Survey Findings

Project Area Population Trends and Projected Recreation Demand

Projected 2060 Average Summer Weekend Use by Site

Site	Available Spaces	2060 Projected Spaces in Use, summer weekend	Percent Capacity (rounded)
Governor Hunt Boat Launch/Picnic Area	4	2	50%
Pauchaug WMA	20	0.1	>5%
Pauchaug Boat Launch	32	7	25%
Bennett Meadow WMA	7	1	15%
Boat Tour and Riverview Picnic Area	27	3	15%
Northfield Mountain Tour and Trail Center	57	6	10%
Cabot Camp Access Area	20	3	15%
Barton Cove Nature Area	26	9	35%
Barton Cove Canoe and Kayak Rental Area	28	7	30%
State Boat Launch	46	31	70%
Canalside Trail Bike Path	N/A	N/A	N/A
Gatehouse Fishway Viewing Area	29	7	25%
Turners Falls Branch Canal Area/Turners Falls Station No. 1 Fishing Access	26	0.2	>5%
Cabot Woods Fishing Access	20	6	30%
Poplar Street Access Site	16	2	15%
Rose Ledge Climbing Area Parking	10	6	65%
Farley Ledge Climbing Area—Wells Street Parking	16	10	65%
Farley Ledge Climbing Area—Route 2 Parking	8	2	30%
Total	392	103	30%
Site	Available Sites	2060 Projected Sites in Use, summer weekend	Percent Capacity (rounded)
Munn's Ferry Boat Camping Recreation Area	5	2	45%
Barton Cove Campground	29	11	40%
Total	34	13	40%

- Projected that on the average summer weekend in 2060:
 - All of the recreation sites at the Projects will be under-capacity
 - Only 4 sites predicted to be at 50% capacity or over: Governor Hunt Boat Launch/Picnic Area; State Boat Launch; Rose Ledge Climbing Area Parking; and Farley Ledge – Wells Street Parking
 - Majority to be less than half-filled

3.6.1-Recreation Use/User Contact Survey Findings

Other Information on Recreation Use

Private Clubs and Recreational Facility Survey Results

- Three entities (two clubs and a school) were surveyed
 - Franklin County Boat Club
 - No response
 - Turners Falls Rod and Gun Club
 - Private, non-profit functions open to public for fee
 - 24 boats docked at facility
 - Satisfied with river water levels over the course of the summer
 - Northfield Mount Hermon School
 - Utilize Connecticut river for recreation during spring, summer, fall
 - Concerned about water level changes

Limited results of this survey found that members of these groups do utilize the Projects for recreation (primarily the Turners Falls Impoundment), but that their use does not appreciably add to the level of use of the recreation sites assessed in this study.

Local Recreation Departments and Police

- State and local policing entities were contacted via email and phone.
- No consistent problems observed. Some occurrence of minor incidents, including illegal camping and boating infractions.

3.6.1-Recreation Use/User Contact Survey Conclusions

- The study resulted in the collection of much data regarding recreation use and user perceptions at the Projects.
- Recreation use was greatest at the Gatehouse Fishway Viewing Area, Northfield Mountain Tour and Trail Center, Cabot Woods Fishing Access and Boat Tour and Riverview Picnic Area sites.
- Recreation use greatest in summer (50%), followed by fall (23%), spring (16%), and winter (10%) .
- Most popular recreation activities Project-wide were walking/hiking/jogging, motor boating, fishing, bike riding, and picnicking.
- Based on utilization estimates, all recreation sites were found to be meeting current demand and projected future demand (2060).
- User ratings were very high for Overall Quality of recreation sites, Parking, Facility Conditions, River Access and Variety of Amenities.
- User ratings were more variable for Toilets/Restrooms.

3.6.5-Land Use Inventory

Purpose of the Study:

Develop appropriate land use designations for future land use management decisions for lands within the Project boundary.

Study Objectives

- Identify the current land uses within the Projects' boundaries and on lands abutting the Projects' boundaries up to 200 feet;
- Identify current land use controls on lands within the Projects' boundaries and on lands abutting the Projects' boundaries up to 200 feet;
- Identify FirstLight owned lands adjacent to the Projects' boundaries; and
- Determine the appropriate land use designations for lands within the Projects' boundaries.

Methodology:

- Three specific tasks:
 - Literature and aerial photography review;
 - Development and application of proposed land use designations;
 - Development of maps and summary of results.

3.6.5-Land Use Inventory Findings

Existing Land Uses

- 35 existing land use categories identified within the study area were consolidated into 9 land use categories listed below.

**Existing Land Use within the Projects' Boundaries
and within 200 Feet of the Projects' Boundaries**

Consolidated Existing Land Use Categories	No. of Acres within the Projects' Boundaries	% of Land within the Projects' Boundaries	No. of Acres within 200 ft. of the Projects' Boundaries	% of Land within 200 ft. of the Projects' Boundaries
Agricultural – Crops	1,010 ¹	13.9	330	17.0
Agricultural – Pasture/Grass	37	0.5	31	1.6
Natural/Undeveloped	35	0.5	8	0.4
Developed	333	4.6	422	21.7
Forested	951	13.1	1,067	55.0
Open Water	2647	36.5	25	1.3
Wetland	396	5.5	23	1.2
Shrub/Scrub	1	0.0	4	0.2
Recreation	1,835 ²	25.3	32	1.6
Total	7,246	100	1,942	100

¹ The majority of the agricultural cropland within the Projects' boundaries is on lands, which the Licensee does not own in fee.

² Approximately 1,673 of these acres are the Northfield Mountain Tour and Trail Center.

3.6.5-Land Use Inventory Findings

Conservation Easements within the Projects' Boundaries and within 200 ft of the Projects' Boundaries

- 10 grantors of conserved land within boundaries or 200 ft. These lands total approximately 715 acres.

**Conservation Protections within the Projects' Boundaries
and within 200 Feet of the Projects' Boundaries**

Site Name	Type of Protection	Acres Conserved within the Projects' Boundaries	Acres Conserved within 200 feet of the Projects' Boundaries
Bennett Meadows Wildlife Management Area	Lease Holding ¹	181.71	18.16
Connecticut River Greenway State Park ²	Conservation Restriction (CR), Right-of-Way (ROW), Easement	32.07	137.55
French-Samuels CR	CR	0.24	5.92
Vern-Mont Farm	Agricultural Preservation Restriction (APR)	0.66	5.79
Four Star Farms APR	APR	38.77	21.73
Split River Farm	APR	118.20	39.13
Roberts Farm APR	APR	0.00	2.29
Storrows Cold Spring Farm APR	APR	0.44	14.56
Urgiel Farm APR	APR	15.42	20.41
Nourse Farms APR	APR	26.18	35.80

¹ Identified as Lease Holding in MassGIS.

² The Connecticut River Greenway State Park connects open spaces, parks, scenic vistas, and archaeological and historic sites along the length of the Connecticut River as it passes through Massachusetts. The Connecticut River Greenway State Park permanently protects over 12 miles of shoreline and is comprised of many parcels owned by private landowners over which MADCR holds an an easement, right-of-way, or conservation restriction.

(<http://www.mass.gov/eea/agencies/dcr/massparks/region-west/connecticut-river-greenway-state-park.html>).

**Purpose of Conservation Protections within the Projects'
Boundaries and within 200 Feet of the Projects' Boundaries**

Purpose of Protection	Acres Conserved within the Projects' Boundaries	% Land Conserved within the Projects' Boundaries	Acres Conserved within 200 feet of the Projects Boundaries	% Land Conserved within 200 feet of the Projects Boundaries
Wildlife Management	181.71	2.5%	18.16	0.9%
Recreation	32.07	0.4%	137.55	7.1%
Agriculture	199.67	2.8%	139.71	7.2%
Natural, Undeveloped, and Scenic	0.24	0.0%	5.92	0.3%
Total	413.69	5.7%	301.34	15.5%

3.6.5-Land Use Inventory Findings

Licensee Management of Non-Project Uses of Project Lands

- FirstLight has an established FERC-approved Permit Program through which it administers non-project uses of Project lands.
- Requirements provide a comprehensive regulatory structure that assures that the granting of permission for non-project use does not adversely affect the Projects' scenic, recreational and environmental values.
- Non-project uses generally include:
 - Camps (24)
 - Docks (46)
 - Landscape uses for abutters (8)
 - Water withdrawals (8)
 - Short term organized events such as running races, cross-country meets, horseback riding, and triathlons

Non-Project Uses of Project Lands

Licensed Use	Licensee	Town
Miscellaneous Use (Fire Pond)	Town of Erving	Erving
Utility Use (Communications Equipment)	Verizon Wireless	Erving
Public Marina (Boat Club with 4 boat docks)	Franklin County Boat Club, Inc.	Gill
3 Non-commercial Dock & Landscape	2 Individuals, 1 Trust	Gill
3 Landscape	2 Individuals, 1 Sportsmans Club	Gill
10 Non-commercial Docks	Licensed to separate individuals	Gill
6 Camps with Non-commercial Docks	Licensed to separate individuals	Gill
4 Camps without Docks	Licensed to separate individuals	Gill
Water Withdrawal	Split River Farm	Gill
Water Withdrawal with Dock	Northfield Mount Hermon School	Gill
11 Camps with Non-commercial Docks	Licensed to separate individuals	Montague
2 Camps without Docks	Licensed to separate individuals	Montague
1 Camp (sporting club with 2 docks)	Turners Falls Rod & Gun Club	Montague
2 Landscape	2 Individuals	Montague
4 Non-commercial Dock	4 Individuals	Northfield
Agricultural (crops)	Vern-Mont Farm	Northfield
Residential	Fuller Farm Property (historical home)	Northfield
Water Withdrawal	Smiarowski Brothers, LLC	Northfield
2 Water Withdrawals	Nourse Farms, Inc.	Northfield
Water Withdrawal	Four Star Farm	Northfield
Water Withdrawal and non-commercial dock	Sudbury Nurseries West	Northfield
Truck turn-around	paperlogic™	Turners Falls
Parking area	Franklin County Regional Housing and Redevelopment Authority	Turners Falls
Effluent Line	Australis Aquaculture LLC	Turners Falls
Water Withdrawal	Silvio O. Conte Anadromous Fish Research Laboratory	Turners Falls

3.6.5-Land Use Inventory Findings

Licensee ownership within 200 feet of the Project boundary

- Licensee owns approximately 48 acres on 12 parcels within 200 feet of the Project boundary.
- The parcels range in size from approximately 1/10th acre to 15 acres with most parcels 3 to 4 acres in size.
- Land uses on these lands are primarily forested. Five parcels are developed or have limited development on them, such as a road, laydown area, or are used for parking.

3.6.5-Land Use Inventory Findings: Proposed Land Use Designations

Proposed Land Use Designation Acreages and Percentage of Land within the Projects' Boundaries

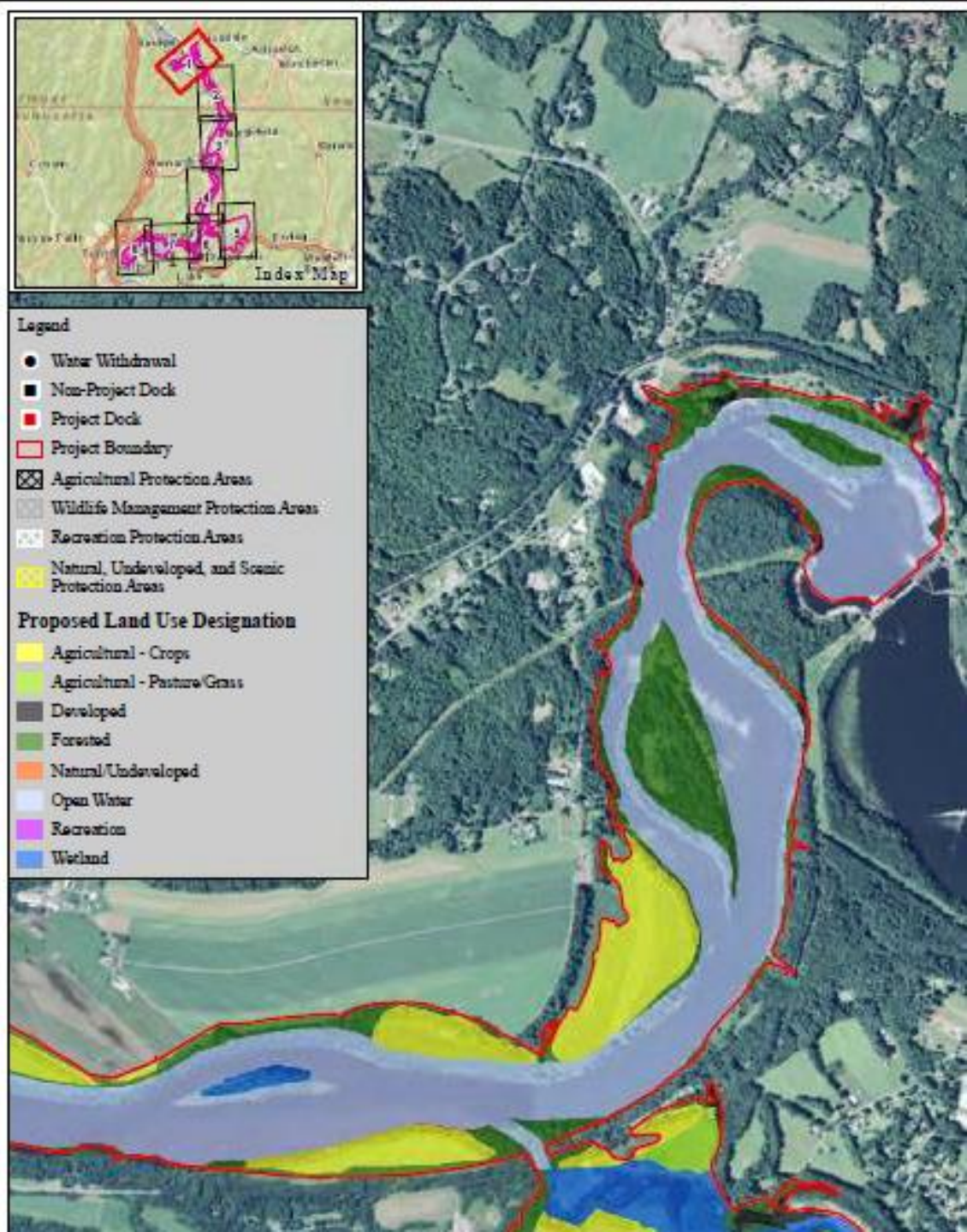
Proposed Land Use Designation	No. of Acres within the Projects' Boundaries	% of Land within the Projects' Boundaries
Open Water	2,647	36.5
Recreation	1,835	25.3
Agricultural – Crops	1,010	13.9
Forested	951	13.1
Wetland	396	5.5
Developed	333	4.6
Natural/Undeveloped	37	0.5
Agricultural – Pasture/Grass	37	0.5
Total	7,246	100%

Proposed Land Use Designation Acreages and Percentage of Land (excluding Open Water) within the Projects' Boundaries

Proposed Land Use Designation	No. of Acres within the Projects' Boundaries	% of Land within the Projects' Boundaries
Recreation	1,835	39.9
Agricultural – Crops	1,010	22.0
Forested	951	20.7
Wetland	396	8.6
Developed	333	7.2
Natural/Undeveloped	37	0.8
Agricultural – Pasture/Grass	37	0.8
Total	4,599	100%

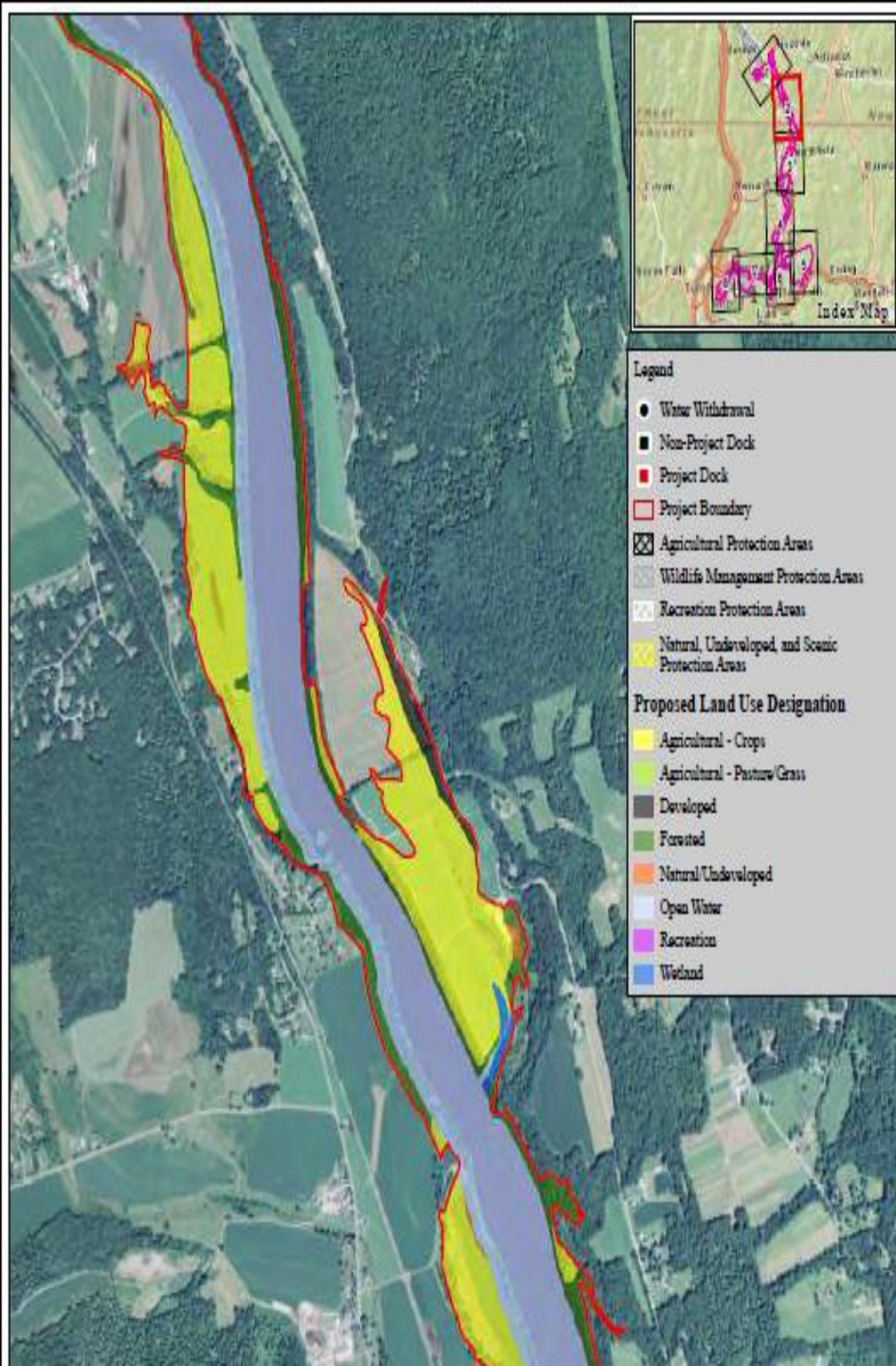
3.6.5-Land Use Inventory Findings

- Proposed Land Use Designations, Conservation Protections, and Existing Docks and Water Withdrawals permitted by the Licensee within the Projects' Boundaries



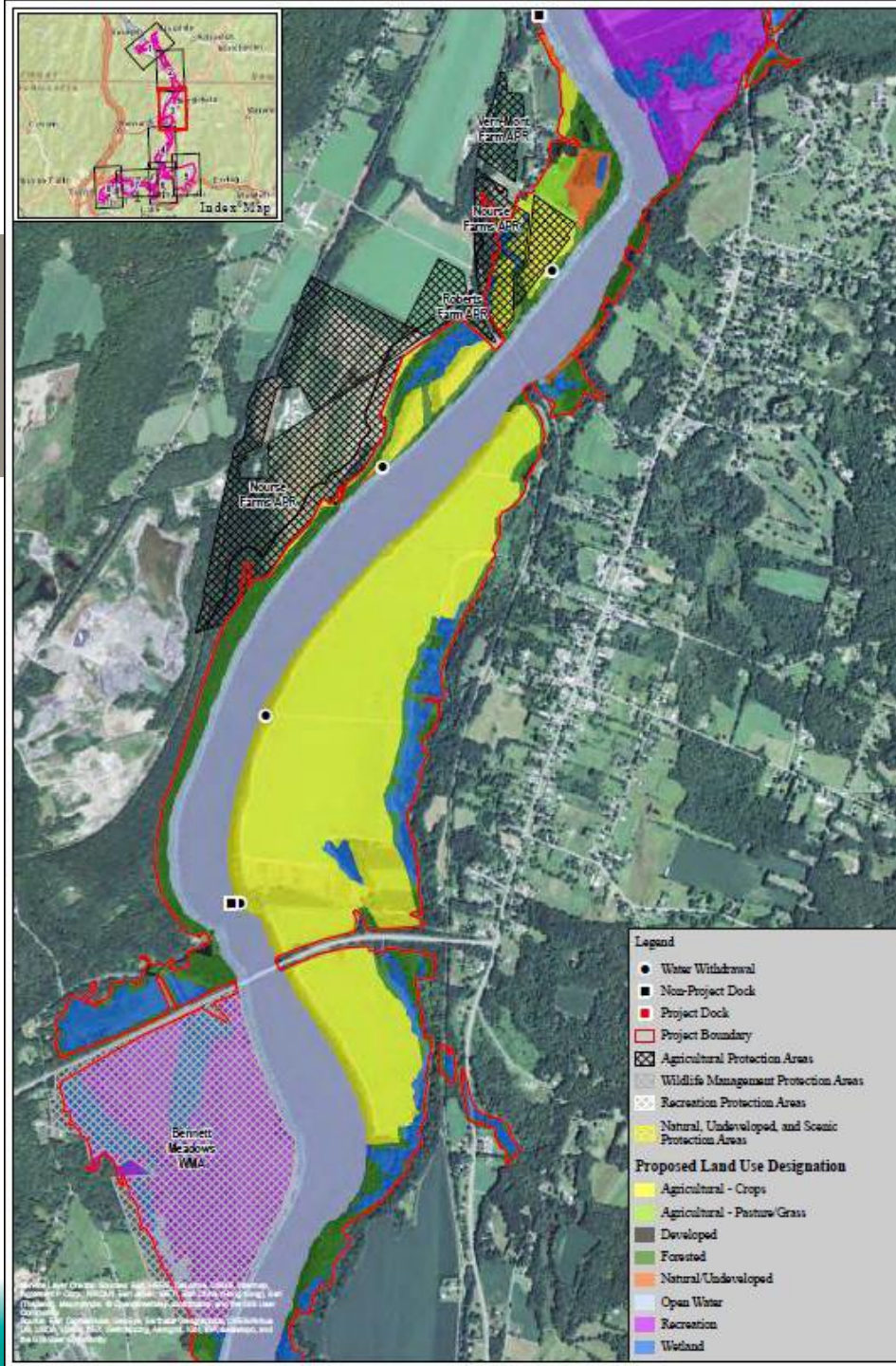
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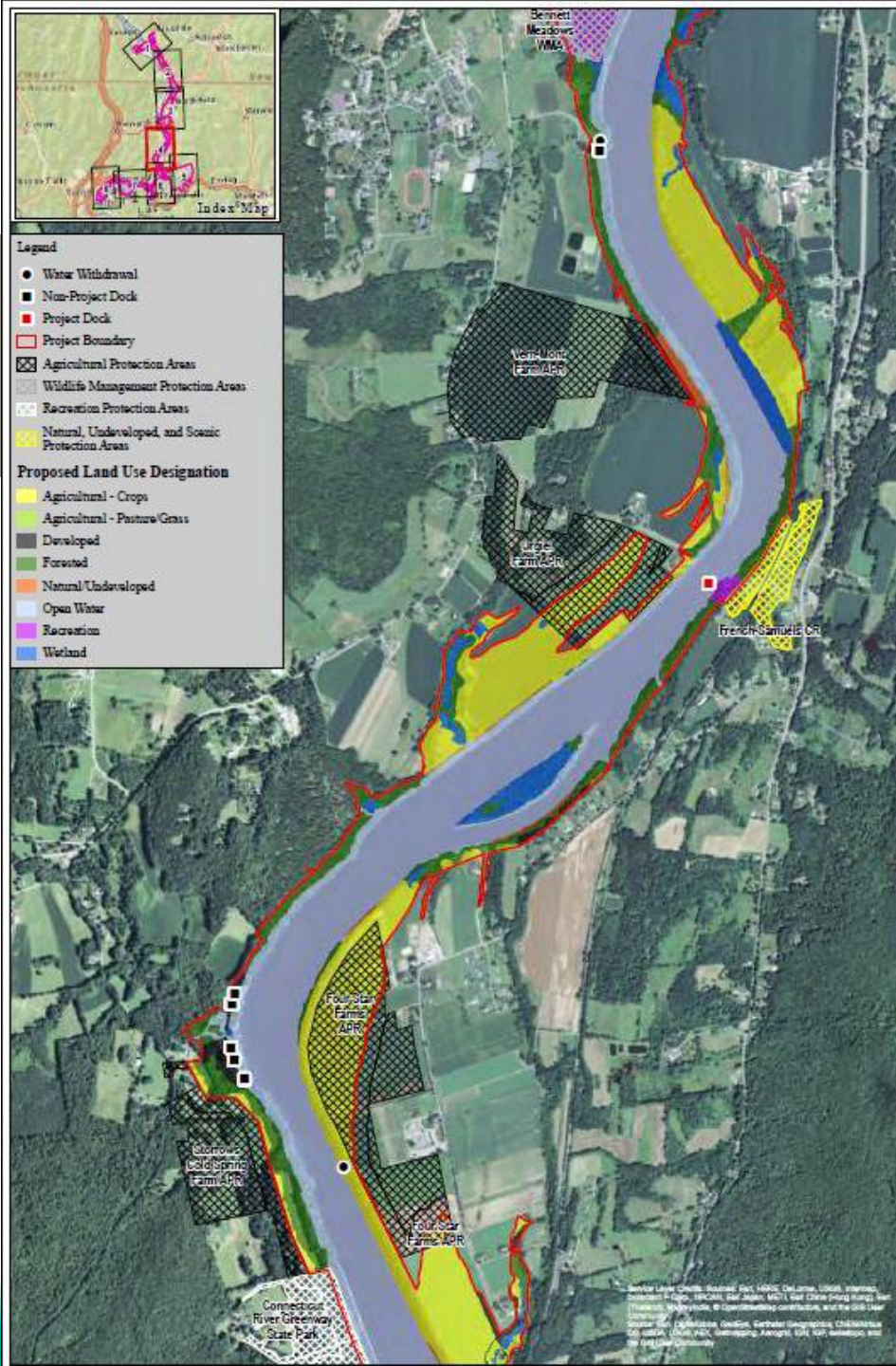


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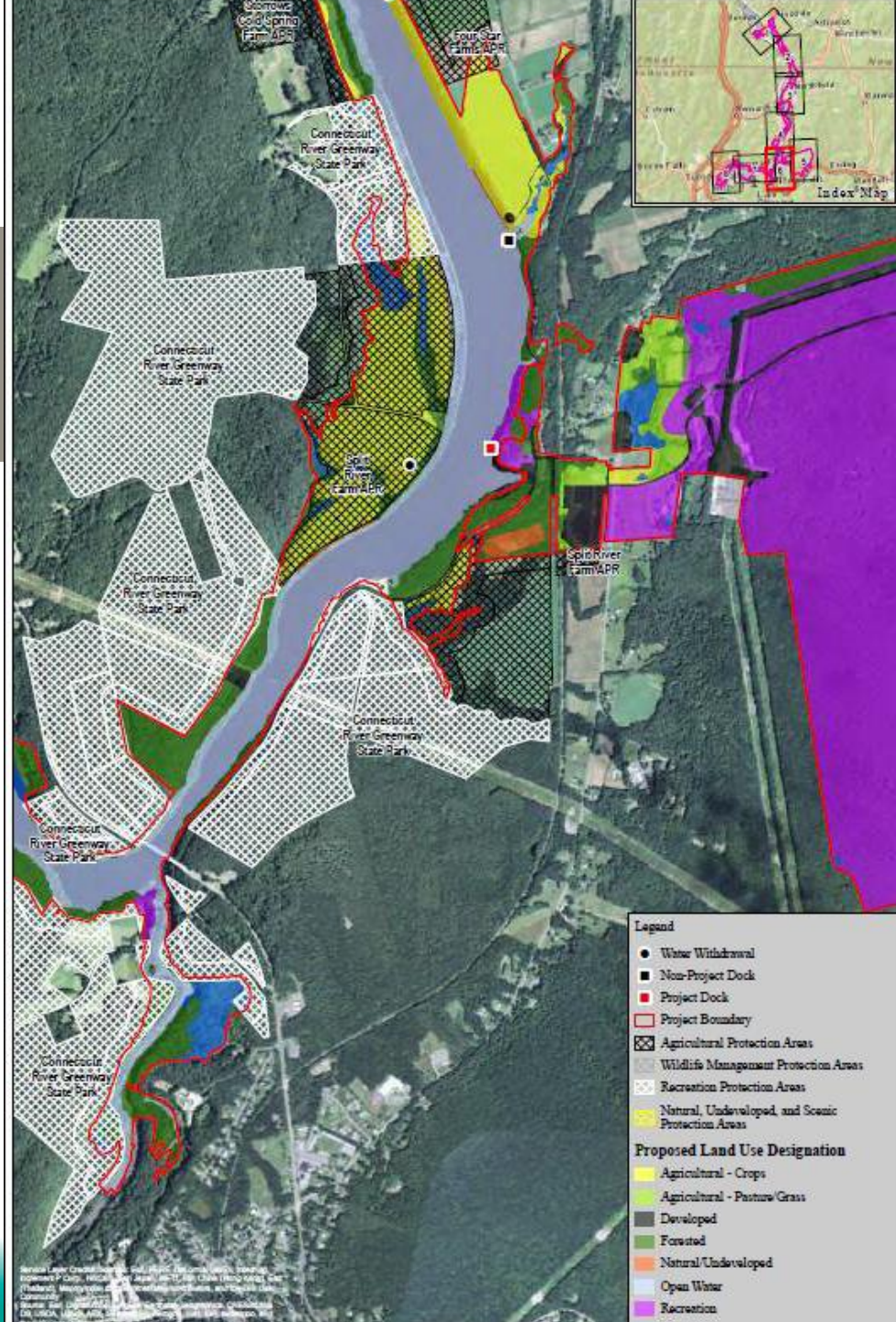
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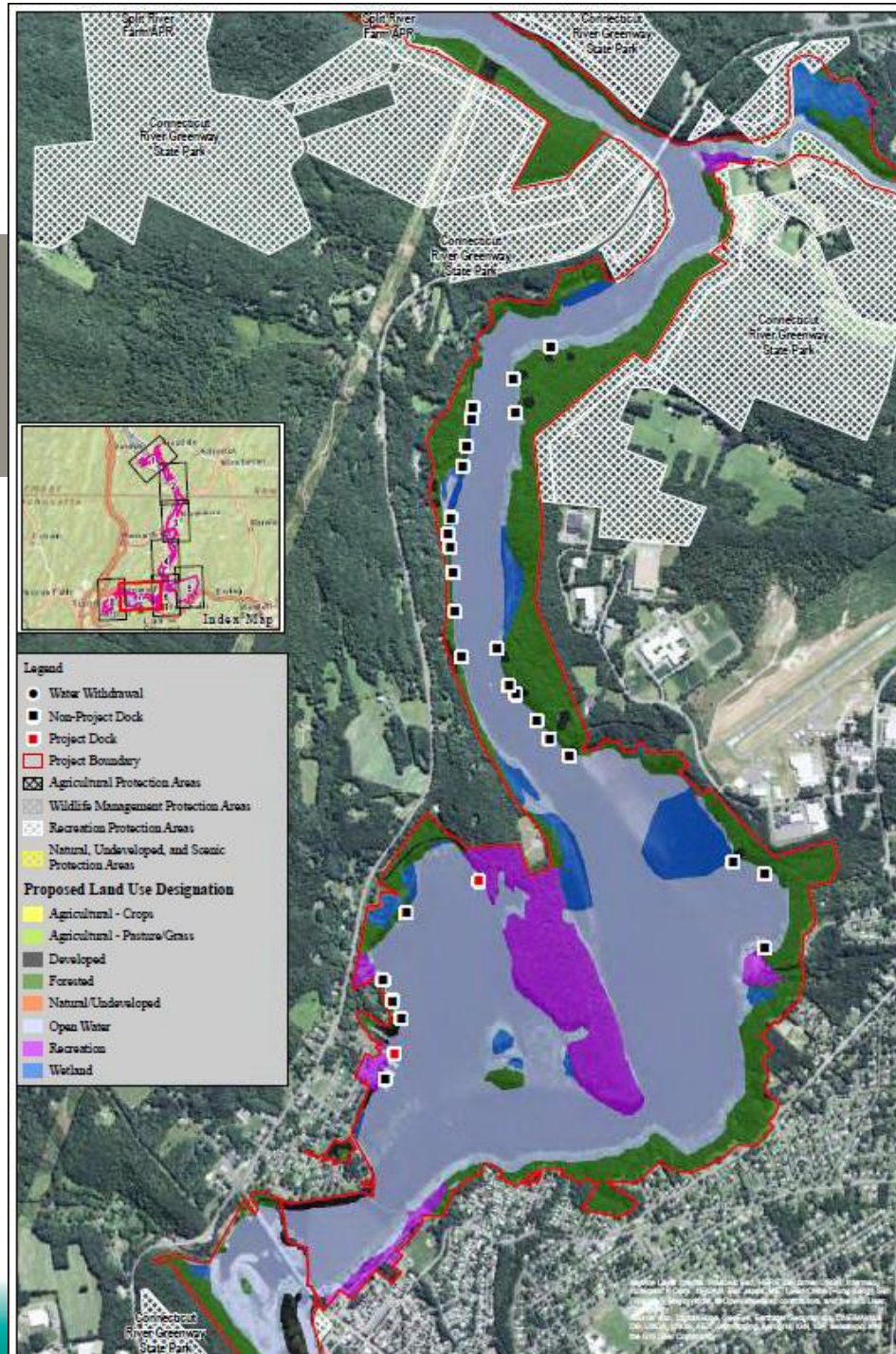


3.6.5-Land Use Inventory Findings

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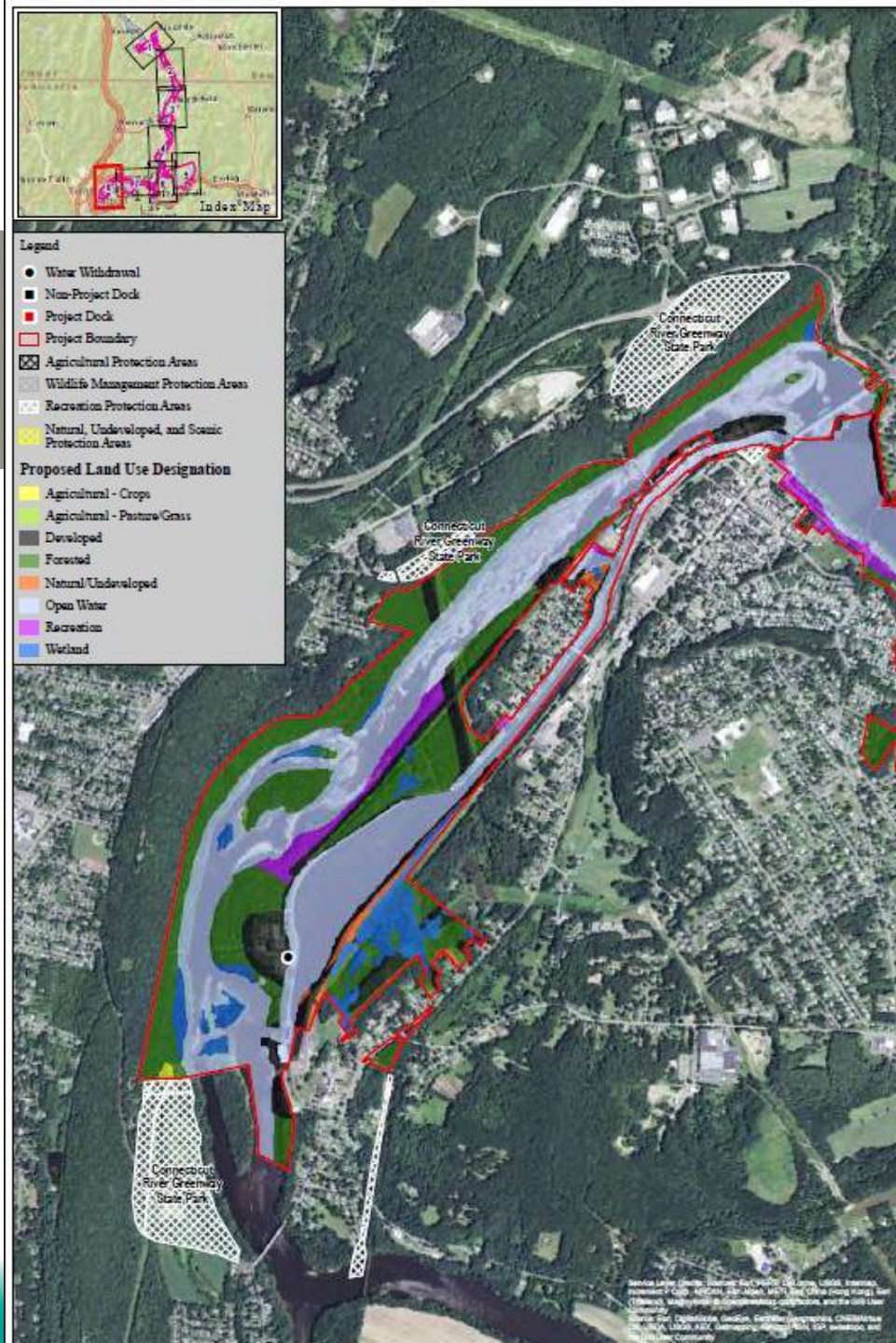


- Proposed Land Use Designations, Conservation Protections, and Existing Docks and Water Withdrawals permitted by the Licensee within the Projects' Boundaries



3.6.5-Land Use Inventory Findings

- Proposed Land Use Designations, Conservation Protections, and Existing Docks and Water Withdrawals permitted by the Licensee within the Projects' Boundaries



3.6.5-Land Use Inventory Summary

- Proposed land use designations in almost all cases are the same as existing land use categories.
- Majority of existing land uses within the Project boundary are forested, recreation, or agriculture – crop lands.
- Majority of existing land uses within 200' of Project boundary are forested, developed, or agriculture – crop lands.
- There are approximately 414 acres of land within the Project boundary and an additional 301 acres within 200' of the Project boundary that are subject to conservation protections (wildlife management; recreation; natural; undeveloped and scenic; and agricultural).
- Non-project uses include camps, docks, landscape, and water withdrawals. A good portion of the non-project uses are in the Barton Cove area.
- The Licensee owns approximately 48 acres of lands within 200' of the Project boundary. Land uses are primarily forested, although there is some limited development such as a road or lay down area.
- Land use designations and sensitive resources overlay will be used by the Licensee when reviewing any proposed non-project use of Project lands and in managing Project lands.