Relicensing Study 3.5.1

BASELINE INVENTORY OF WETLAND, RIPARIAN, AND LITTORAL HABITAT IN THE TURNERS FALLS IMPOUNDMENT, AND ASSESSMENT OF OPERATIONAL IMPACTS ON SPECIAL STATUS SPECIES

Study Report

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

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EXECUTIVE SUMMARY

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

As part of the ILP, FERC conducted a public scoping process during which various resource issues were identified. On October 31, 2012, FirstLight filed its Pre-Application Document (PAD) and Notice of Intent with the FERC (FirstLight, 2012). The PAD included FirstLight's preliminary list of proposed studies. On December 21, 2012, FERC issued Scoping Document 1 (SD1) and preliminarily identified resource issues and concerns. On January 30 and 31, 2013, FERC held scoping meetings for the two Projects. FERC issued Scoping Document 2 (SD2) on April 15, 2013. Study No. 3.5.1 *Baseline Inventory of Wetland, Riparian, and Littoral Habitat in the Turners Falls Impoundment, and Assessment of Operational Impacts on Special-Status Species* was developed in order to analyze potential impacts on rare species, submerged vegetation, wetlands, and invasive species.

The geographic area for this study included:

- upland areas along the Turners Falls Impoundment (TFI), including areas within the Turners Falls Project Boundary and areas up to 200 feet from shore where the Project Boundary is along the shoreline;
- upland areas adjacent to the Bypass Reach;
- the approximate 13+ miles of shoreline and riparian habitat between Cabot Station and the Rte. 116 Bridge in Sunderland. Riparian areas were surveyed up to the top of bank in this segment of the study area.

The review of existing information provided helpful background information for field studies completed in 2014 and 2015. Information provided by the Natural Heritage and Endangered Species Program (NHESP) on the location and occurrence of rare, threatened and endangered (RTE) species was helpful in determining study areas and placement of survey transects.

Riparian habitat is dominated by northern hardwood forests with some mixed softwood species; additional detail regarding riparian habitats is discussed in Study Report No. 3.4.1 *Baseline Inventory of Terrestrial Wildlife, and Botanical Species* (GSE, 2015).

Submerged aquatic vegetation (SAV) within the study area is extensive, particularly in the immediate lower portion of the TFI, in the Barton Cove area. Outside of this lower area and within the upper TFI, SAV beds generally occur as narrow bands along the shoreline. Downstream of Cabot Station SAV is generally found as narrow bands along the shoreline and occasionally larger beds associated with protected channels associated with islands. No SAV was observed within the bypass reach. Within the study area, shoals or other shallow areas within the main channel do support SAV beds, but these areas are not common. Based on the extent and overall distribution of SAV beds within the study area, project operations do not appear to be limiting the growth of submerged vegetation in the study area. 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. The bypass reach has no mapped beds of SAV, but this is likely related to the lack of suitable substrate. Within

the overall study area, SAV beds are limited in areas of coarse substrate and bedrock, which is the dominant substrate in the bypass reach. Invasive SAV is present throughout the TFI portion of study area, and most common within the lower portion of the TFI. No invasive SAV was identified below the Turners Falls Dam within the bypass reach and from Cabot to the Route 116 Bridge in Sunderland. Recreational use, as well as introduction from upstream, may continue to spread exotic species within the study area.

The identified Rare, Threatened, and Endangered (RTE) plants within the study area are commonly associated with riparian areas, and several are adapted to frequently flooded locations. Eighteen (18) survey transects were established to investigate the location of occupied and unoccupied habitat and examine relationships with modeled water surface elevation (WSEL[1]) developed as part of Study No. 3.2.2 *Hydraulic Study of the Turners Falls Impoundment, Bypass Reach and below Cabot*[2]. The hydraulic models, operated on an hourly time step, were used to predict WSELs at the surveyed transects. The elevation surveys identified location and occurrence data for several botanical RTE species. Based on the survey results, mountain alder (*Alnus viridis ssp. crispa*) generally occurs within the TFI above the April median WSEL and outside the most commonly occurring daily change in WSEL. Within the bypass reach, the mountain alder was not inundated during the demonstration flow[3] study, which was conducted as part of the instream flow study (Study No. 3.3.3). While it is possible that varying flows may result in wetting of mountain alders within the TFI and below, this species appears to prefer habitats that are generally drier and more removed from project operations. In addition, upland white aster (*Oligoneuron album*) and sandbar cherry (*Prunus pumila var. depressa*), based on the transects surveyed, generally occur above the median April WSEL and in all cases the species occur above the May median and annual median WSEL. This includes transects throughout the study area. Based on the WSEL data developed from the hydraulic models , these species occur within available and suitable habitat at elevations closer to the higher, and less commonly observed fluctuation zones.

The two species most commonly observed below the April WSEL, as well as below or near the annual median WSEL, are the Tradescant's aster (*Symphyotrichum tradescantii*) and the sandbar willow (*Salix exigua ssp. Interior*). Both species are adapted to frequently flooded areas, and this is exemplified by the result of the survey data.. Tradescant's aster, which of all the species appears to be the "wettest", is often found at the lowest elevations. In the bypass reach, the population of Tradescant's aster is estimated at several thousand, the largest population within the study area. Based on modeling within the bypass reach, the Tradescant's aster is often inundated. During the demonstration flow release, the Tradescant's aster was inundated during all demonstration flows (NEE, 2016). Based on observations following the demonstration flows, it was noted that if the existing minimum bypass flow is maintained for fish passage season (i.e., 400 cfs through July 15), impacts to the population of Tradescant's aster would be minimized (NEE, 2016). It is likely that maintaining the current flow regime within the bypass reach would not negatively impact species present there currently. Higher minimum flows would likely not have negative impacts, as long as flows are reduced to allow plant exposure during July.

[1] The WSEL referenced here and below are based on the modeling results from Study No. 3.2.2 *Hydraulic Study of the Turners Falls Impoundment, Bypass Reach and below Cabot* or in the case of Transect T-3 from *Study No. 3.3.1 Conduct Instream Flow Habitat Assessments in the Bypass Reach and below Cabot Station*.

[2] Two HEC-RAS hydraulic models were developed on an hourly time step to predict WSEL at various locations. The models included a) Turners Falls Impoundment for the period January 1, 2000 to September 30, 2015 and b) from the Montague United States Geological Survey Gage to Holyoke Dam for the period January 1, 2008 to September 30, 2015. PHABSIM was used to determine a stage discharge relationship at Transect T-3 in the bypass reach.

[3] In November 2015, as part of Study No. 3.3.1, demonstration flow releases were maintained from a bascule gate at the Turners Falls Dam and consisted of the following releases: 500, 1,500, 2,500 and 4,000 cfs. Steve Johnson of NEE was on-site to observe RTE plants in the bypass reach.

Invasive terrestrial species are present along the entire shoreline and on islands within the study area. Several areas are dominated by Japanese knotweed (*Fallopia japonica*), black swallowwort (*Cynanchum louiseae*), and Oriental bittersweet (*Celastrus orbiculatus*), which appear to be the most common invasive species along the shoreline. These species occur in patches, and, occasionally, Japanese knotweed forms dense monocultures. Mapping of, and further discussion of, terrestrial invasive species is included in the Study Report 3.4.1 *Baseline Terrestrial Wildlife and Botanical Species* (GSE, 2015b).

Wetlands, particularly when associated with riverine systems, provide important functions for wildlife and flood storage as well as important recreational services. 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. Functions of these wetlands are important and are most commonly wildlife habitat and flood flow attenuation. Forested wetlands within the study area are not impacted by project operations; the majority of the forested wetlands within the study area are floodplain wetlands which receive hydrologic input during high flow events (i.e., spring freshet) and then may remain dry for several weeks to months at a time. Emergent wetlands within the study area occur within the fluctuation zone. However, emergent wetland species are often adapted to changes in WSEL. In some cases, increased diversity of emergent species can be attributed to regular changes in inundation, provided inundation is not prolonged.

Cobblestone tiger beetles (*Cicindela marginipennis*) and Puritan tiger beetles (*Cicindela puritana*) are both protected invertebrate species which are declining in population. Cobblestone tiger beetles and Puritan tiger beetles are known to have occurred within the study area, between Cabot Station and the Holyoke Dam. Searches in 2014 resulted in no cobblestone tiger beetles being identified within the study area. With regard to Puritan tiger beetles, elevation surveys of known occupied habitat at Rainbow Beach were also completed in 2014 and the species was identified. Survey data was used in conjunction with hydraulic modeling developed from Study No. 3.2.2 to examine the potential impact of WSEL fluctuations on the Puritan tiger beetle. One potential impact to the beetles are changes in WSEL, which may cause adult dispersal or flood larval burrows. Based on the results it is possible that changing WSEL may disperse Puritan tiger beetles individuals or impact habitat primarily within the lower portion of the habitat. Based reviewing the 15-minute water level logger WSEL data located near Rainbow Beach from May 1 to August 20, 2012, the range of fluctuation most commonly observed at Rainbow Beach is at the lower elevation range of the available habitat. In addition, 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. Rapid changes in WSEL is most likely to occur near the central portion of the beach where available beetle habitat is more level in topography and therefore more susceptible to changes in WSEL. At higher elevations, dense vegetation growth is limiting the available larval habitat.

In general, project operations do not appear to be limiting the growth of submerged vegetation. Based on the results of data collected in 2014, substantial beds of submerged vegetation are present within the study area. There may be potential for additional spread of exotic or invasive species as a result of recreation within the study area. Botanical RTE species within the project do not appear to be affected significantly by project operations. Investigated plants are thriving within habitats that support their growth. All species investigated prefer habitats within or near the high waterline and are adapted to frequent flooding. Invasive species within the study area do occur, but additional spread and establishment are not the result of project operations. The species observed within the study area are invasive species that are commonly observed within large river systems. While these species may pose a threat to native plant communities, project operations are not improving the ability of these species to invade native habitats. Wetland communities within the study area are widespread, and supported by tributaries or flood waters. Project operations do not have a negative effect on the existing hardwood floodplains within the study area. Emergent wetlands appear to be healthy and are expansive within the lower portion of the TFI. Cobblestone tiger beetles, based on surveys conducted, appear to be extirpated from the study area. Puritan tiger beetles are present at one location, Rainbow Beach, and it appears that recreation activities and natural succession within larval habitat is likely having a negative impact on tiger beetle populations.

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LIST OF ABBREVIATIONS

cfs	cubic feet per second
EAV	Emergent Aquatic Vegetation
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FirstLight	FirstLight Hydro Generating Company
GIS	Geographic Information Systems
GPS	Global Positioning System
HG&E	Holyoke Gas and Electric
IFIM	Instream Flow Incremental Methodology
ILP	Integrated Licensing Process
MIPAG	Massachusetts Invasive Plant Advisory Group
NGVD29	National Geodetic Vertical Datum of 1929
NHESP	Natural Heritage and Endangered Species Program
NWI	National Wetlands Inventory
Northfield Mountain Project	Northfield Mountain Pumped Storage Project
PAD	Pre-Application Document
PSP	Proposed Study Plan
RSP	Revised Study Plan
RTE	rare, threatened and endangered
RTK	Real Time Kinematic
SAV	Submerged Aquatic Vegetation
SD1	Scoping Document 1
SD2	Scoping Document 2
SPDL	Study Plan Determination Letter
TFI	Turners Falls Impoundment
Turner Falls Project	Turners Falls Hydroelectric Project
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
USFWS	United States Fish and Wildlife Service
WSEL	water surface elevation

1 INTRODUCTION

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

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

FirstLight filed its Proposed Study Plan (PSP) on April 15, 2013 and, per the Commission regulations, held a PSP meeting at the Northfield Visitors Center on May 14, 2013. Thereafter, FirstLight held ten resource-specific study plan meetings to allow for more detailed discussions on each PSP and on studies not being proposed. On June 28, 2013, FirstLight filed with the Commission an Updated PSP to reflect further changes to the PSP based on comments received at the meetings. On or before July 15, 2013, stakeholders filed written comments on the Updated PSP. FirstLight filed a Revised Study Plan (RSP) on August 14, 2013 (FirstLight, 2013) with FERC addressing stakeholder comments. Study No. 3.5.1 *Baseline Inventory of Wetland, Riparian, and Littoral Habitat in the Turners Falls Impoundment, and Assessment of Operational Impacts on Special-Status Species* was included in the RSP. On September 13, 2014, FERC issued its first Study Plan Determination Letter (SPDL) approving Study Plan No. 3.5.1 with modification. In summary those modifications included a) collecting additional transects in unoccupied areas for suitable habitat for special-status invertebrate species, b) incorporate additional transects in unoccupied areas of suitable habitat for state-listed plant species and c) include additional measurements of flood depth, timing, duration, and extent as well as frequency and changes to substrate characteristics along transects.

1.1 Study Goals and Objectives

The study goals are to characterize and describe the wildlife and botanical resources within the study area and assess the potential impacts of Project-related water level fluctuations on identified resources. The specific study objectives are to:

- Quantitatively describe and field verify National Wetland Inventory (NWI) mapped wetland types, describe and map shallow water aquatic habitat, including submerged aquatic vegetation (SAV) and emergent aquatic vegetation (EAV), substrate type, invasive species, and associated wildlife in the Turners Falls Impoundment (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 (Cicindela marginipennis) and the Puritan tiger beetle (Cicindela puritana).

1.2 Report Datum

Note that the datum used in this study is the National Geodetic Vertical Datum of 1929 (NGVD29). Although a more up-to-date datum is available[4], FirstLight has used the NGVD29 datum in reporting dam elevation data, water level data, etc. over numerous years. Thus, all water level data discussed in this report is based on the NGVD29 datum.

Note: All figures and larger tables appear at the end of each section.

[4] NAVD88- North American Vertical Datum of 1988 (NAVD88).

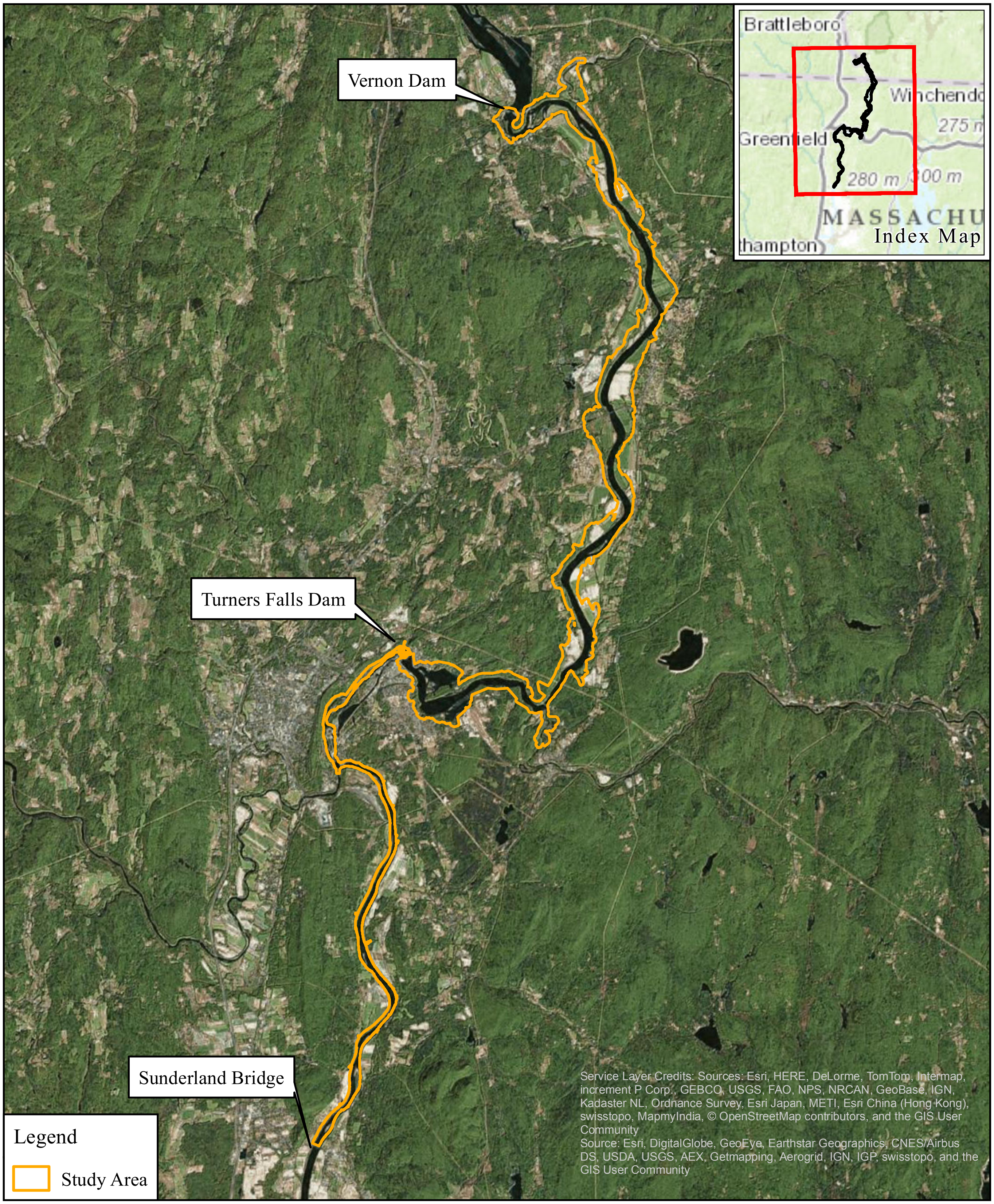
2 STUDY AREA AND SURVEY SITE SELECTION

Field surveys were completed within the uplands adjacent to the shoreline of the TFI, the Bypass Reach, and below Cabot Station to the Route 116 Bridge in Sunderland.

The geographic area for this study included:

- upland areas along the TFI, including areas within the Project Boundary and areas up to 200 feet from shore where the Project Boundary is along the shoreline;
- upland areas adjacent to the Bypass Reach;
- the approximate 13+ miles of shoreline and riparian habitat below the Turners Falls Dam to the Rte. 116 Bridge in Sunderland. Riparian areas will be surveyed up to the top of bank in this segment of the study area.

Figure 2.0-1 shows the study area.



FirstLight GDF SUEZ

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

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

Figure 2.0-1 Study Area

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3 METHODS

The study approach followed the approved study plan (FirstLight, 2014), including FERCs modifications, and consisted of the elements described further below. Input on the approved study plan was received from the United States Fish and Wildlife Service (USFWS) (December 26, 2013 email) and the Massachusetts Natural Heritage and Endangered Species Program (NHESP) (January 6, 2014) relative to data collection and analysis procedures.

3.1 Hydrology and Hydraulics

Observed hydrologic data (cfs) were developed for two hydraulic models developed as part of Study No. 3.2.2 *Hydraulic Study of Turners Falls Impoundment, Bypass Reach and below Cabot*. The geographic extents of the two hydraulic models were a) from Vernon Dam to the Turners Falls Dam or the TFI ("TFI model") and b) from the Montague United States Geological Survey (USGS) Gage downstream to Holyoke Dam ("below Montague USGS Gage model").

Steady and unsteady HEC-RAS hydraulic models were developed for both reaches as part of Study No. 3.2.2. For purposes of this report, both hydraulic models were simulated as unsteady—meaning flows vary over time. More specifically, hourly time step models were developed for both reaches based on observed conditions that occurred from January 1, 2000 through September 30, 2015 for the TFI model and January 1, 2008 to September 30, 2015 for the below Montague USGS Gage model.

In the case of the TFI hydraulic model, the flow inputs included: observed Vernon hourly discharges, observed tributary inflow based on USGS gages on the Ashuelot and Millers River, observed Northfield Mountain Project pumped flows/generation flows, and observed water surface elevation (WSEL) at the Turners Falls Dam. In the case of the Montague USGS Gage model, flow data was based on observations from the Montague USGS Gage and estimated inflows for the tributaries between the Montague Gage and Holyoke Dam as described in Section 3.2.5 of Study No. 3.2.2. The Holyoke Project (P-2004), owned by the City of Holyoke, controls the water level at the Holyoke Dam, the downstream boundary condition of the model. The Holyoke Dam operates under a modified run of river condition with water levels at the dam operating between 99.47 and 100.67 ft. We were not able to obtain hourly data from the City of Holyoke, therefore a low (99.47 ft) and a high (100.67ft) WSEL was used. HEC-RAS modeling runs were completed to estimate the WSEL below the Montague Gage. The modeled WSELs between these two model runs were averaged to estimate the WSEL at the locations for this study. However, most areas showed only about a 0.1 foot difference between low and high downstream boundary model runs and the differences upstream of the Route 116 Bridge to the Montague gage were close to zero.

The hydraulic models were used to simulate WSELs at various locations along each reach under the actual conditions that occurred every hour between January 1, 2000 (or January 1, 2008 for the Montague USGS Gage model) and September 30, 2015. From these data, various statistics were developed that are discussed later in this report including:

- At a given location either in the TFI or below the Montague USGS gage, the median monthly or annual WSEL was calculated based on the hourly simulated WSEL over the period of record.
- At a given location either in the TFI or below the Montague USGS gage, elevation duration curves were developed based on the hourly simulated WSEL over the period of record.
- At a given location either in the TFI or below the Montague USGS gage, the maximum and minimum hourly WSEL was determined for each day. For each day, the maximum and minimum elevation was subtracted to yield the maximum daily fluctuation. Categories were subsequently set up to determine how often the maximum daily fluctuation was between increments 0-0.2 ft, 0.2 to

0.4 ft, 0.4 to 0.6 ft… up to 5.8 to 6.0 ft. Plots were developed on an annual and monthly basis as described later in this report.

3.2 Review of Existing Information

Prior to the field reconnaissance surveys, existing information and data were reviewed to identify areas of known, historic, and representative communities; as well as potentially suitable habitat for protected species of interest. Using geographic information systems (GIS) and other available sources of information, a preliminary field map was produced to assist field surveys. Pre-survey, biologists reviewed life histories of wildlife and phenology of plants for known listed species in the study area to select field survey windows to optimize observations.

3.3 Riparian and Littoral Zone Botanical Survey

Botanical assessments were completed to determine the species composition, structure, and distribution of vegetative communities within riparian and littoral zones. The types of data collected included percent cover, estimations of density, and dominate species within the herbaceous, shrub, and tree stratums along with the general distribution and juxtaposition of vegetative communities. Botanical field inventories listed in this task were completed using timed-meander surveys, which involved walking a wandering path through each representative habitat type and recording species present until a period of time (typically 10 minutes) passed where no new species were added to the vegetation list. SAV and EAV beds were surveyed from a boat with use of view buckets or polarized glasses to aid in identification. SAV and EAV beds had their perimeter surveyed.

3.3.1 Riparian Survey

Surveyors compiled a census list of all plants found within each respective habitat, and maintained an overall list of all plant species identified within the study area. Plants were identified to the species level whenever possible. If the plant was outside its phenological peak, the plant was at least identified to the genus. When identification was not feasible in the field, a voucher sample was collected, pressed, and preserved for further identification. Other information that was gathered during meander surveys included general health of communities and site quality conditions. Vegetation communities were classified using NHESP *Classification of the Natural Communities of Massachusetts* (Swain & Kersey, 2011). A complete review of the methodology is included in Study No. 3.4.1 *Baseline Inventory of Terrestrial, Wildlife and Botanical Resources.*

3.3.2 Littoral Zone (SAV) Survey

Mapping of SAV occurred in 2014, and was completed by boat surveys. Mapping of the edge of SAV beds was completed using a Trimble® Geo-7000 Global Positioning System (GPS) unit. In the field, cover of each SAV bed was estimated visually into one of three categories based on the estimated percent cover of dominate species within the mapped polygon. Categories included sparse (0-25%), medium (26-50%), and dense (51-100%). Field-collected GPS data were differentially corrected using Trimble Pathfinder® (Ver. 5.7) and exported to an ESRI shapefile format for further analysis in ArcMap (Ver. 10.2).

3.4 RTE Plant Survey

Survey of the 10 state-listed RTE plant species was completed in the TFI and from the Turners Falls Dam to the Route 116 Bridge in Sunderland, MA during the 2014 and 2015 field seasons. This task included collection of the necessary field information to evaluate the effects of changes in WSELs on the life cycle of state-listed species. This included on-the-ground reconnaissance of known and historic occurrence areas (confidential geographic locations provided by NHESP) and potential habitats.

The primary tasks of the RTE plant survey include the following:

- Delineate all suitable habitat for state-listed plants (particularly species inhabiting mud flats, sand bars and high energy shore rocky outcrops, and cobble island habitat types), at both occupied and unoccupied sites;
- Determine habitat suitability preferences for state-listed plants by comparing flow parameters within and between occupied and unoccupied patches of suitable habitat; and
- Assess how quality, quantity, and location of habitat changes over a range of WSELs and inundation frequency/duration/timing/magnitude, with a focus on Project-related impacts.

This survey was conducted in accordance with the NHESP *Endangered Species Habitat Assessment and Survey Guidelines: Plants* (NHESP, 2011). This work was completed by Kleinschmidt's biological team which included Steve Johnson, a NHESP-approved botanist, with New England Environmental Inc. Field efforts focused on target plant communities that exhibit meta-populations inhabiting the shoreline, mud flats, sand bars and high energy shore, and cobble island habitat types, which are directly affected by WSEL fluctuations. The shoreline of the study area was surveyed to identify and locate key shoreline features that have suitable habitat and a high likelihood for RTE plant associations.

Biologists traveled down river by boat starting at the Vernon Dam. The team stopped at key habitat niches where the target RTE plant species were likely to occur and completed the survey at the Route 116 Bridge. This survey was based on habitat requirements of the RTE plant species and included both occupied and unoccupied sites. Biologists delineated habitat suitability parameters for each species or species group (demonstrating similar micro-habitat requirements) using a GPS unit. These RTE plant preferred habitats were flagged in the field with surveyor's tape and/or staked and located and categorized using a GPS unit. To maximize plant observations, field data were collected based on the targeted plants' phenology when key diagnostic plant features were likely be readily observed for positive identification. FirstLight consulted with NHESP on the concurrence of survey windows following initial field reconnaissance.

At occupied sites where RTE plant populations were observed, information was collected that included: spatial extent of the population, the number of individuals (or visual estimates thereof), substrate type, and spatial extent of potentially suitable habitat (even if unoccupied). Spatial information was collected using a sub-meter accuracy GPS unit. Population boundaries were delineated as polygons using a GPS unit. If the population was too small to delineate with a polygon, a point location was recorded with a radius descriptor.

Positive identification of state-listed plant species and potential habitat sites were documented with photographs. Mr. Johnson retained a commercial scientific collection permit from NHESP prior to the collection of any voucher samples. Voucher sample collection was kept to a minimum, in order to be as environmentally sensitive to the maximum extent practicable. Voucher samples were reviewed with botanist Roberta Lombardi, at the University of Massachusetts, Amherst herbarium. Where RTE plant species were observed, the overall plant or community health and vigor were also documented. Data were collected in the field and uploaded to the Vernal Pool and Rare Species Information System online reporting system on November 19, 2015.

Following the initial field reconnaissance, maps were generated to show all known, current, historic, and potentially suitable habitats. These maps clearly identified sites targeted for in-depth survey. FirstLight used these maps and initial field data collected during the reconnaissance phase to select the location of survey transects. Proposed transects were established in a subset of habitats including 1) occupied, high quality habitats, 2) occupied, low quality habitats, and 3) unoccupied (but otherwise suitable) habitats. These transects represent a subset of habitats that were used to collect information on a fine-scale level to permit the assessment of how the quality and extent of both existing and potentially suitable habitats change over a range of flows within the Study area. FirstLight established 18 transects at a combination of occupied and unoccupied sites. Based on a screening of spatial data provided by NHESP, many current observations and historic records of the RTE plant species occur clustered in similar locations. To the extent possible, transects were located at sites that host several RTE species to maximize the number of species covered by each transect (e.g., one transect may cover two species). The exact location and placement of transects were determined following reconnaissance surveys. To the extent possible and consistent with study plan goals, the 18 transects were distributed throughout the study area.

Many of the RTE plants occur within the bypass reach and the vicinity of Cabot Station. As outlined in Study No. 3.3.1 *Instream Flow Studies in Bypass Channel and below Cabot Station*, there are three instream flow study reaches (Reaches 1, 2, and 3) extending from the Turners Falls Dam to the Montague USGS gage located just below Cabot Station[5]. Based on the data provided by NHESP, seven (7) of the ten (10) RTE plant species are found in these reaches. FirstLight used hydraulic model information and transect information from Study No. 3.3.1 to evaluate hydraulic conditions (WSEL) across a range of flows, which eliminated the need for specific transect placement in the study area. Elevation data at each of the 18 survey transects were collected using a survey-grade Real Time Kinematic (RTK) GPS unit capable of sub-foot horizontal and vertical accuracy. This hydraulic information was used with measured elevation data collected at occupied RTE plant sites to evaluate how Project operations could impact habitat suitability for the plants within the bypass reach.

At established transects, data collection and measurements included:

- Substrate data collection including qualitative description of the substrate;
- Riverbed and bank transect elevations using the survey-grade RTK GPS unit;
- The coordinates of each plant and its vertical elevation (elevation at the point where the plant emerged from the substrate) using the same survey equipment. In cases where more than one plant was observed (i.e., a population), the maximum and minimum elevations occupied by the population were measured; and
- Stem counts within 1 square meter quadrats for RTE species. Quadrats were placed every meter along the length of the transect and associated plant species were also identified. Density was converted to individuals per square foot as elevation data is presented in feet.

3.4.1 Data Analysis

The hydraulic models were subsequently used to determine the flow at which the target plant becomes inundated and whether it is inundated due to Project operations (when river flows are below the hydraulic capacity of the Project) or naturally high flows (above the hydraulic capacity of the Project). Analysis was completed for each of three reaches, the TFI, the bypass reach, and the Montague Gage to the Sunderland Bridge.

3.5 Invasive Plant Survey

The survey of the study area for riparian and aquatic invasive plant species was completed along the entire perimeter of the TFI downstream to Route 116 on both sides of the river, up to the limit of project-influenced streambanks. The intent of this survey was to document infested areas of invasive plant species. Aquatic invasive plant species were located by use of a boat and on foot, with identification aided by the use of

[5] Reach 1 extends from the Turners Falls Dam to the Station No. 1 tailrace. Reach 2 extends from the Station No. 1 tailrace to just above Rock Dam in the bypass reach and Reach 3 extends from Rock Dam to the USGS Gage. In Reach 1 no hydraulic model was developed. In Reach 2 a standard backwater hydraulic model was used. In Reach 3 a River2D model was developed.

look-down buckets. Invasive infestations occurring in areas outside, but adjacent to, the impoundment were surveyed by foot. Survey efforts mapped the known areas of invasive water chestnut beds present in the TFI in the vicinity of Barton Cove. To document an infested area, biologists used a GPS at sub-meter accuracy to delineate the boundary of the infestation as defined by the dominant canopy cover of the invasive plant. Areas containing only occasional invasive species were characterized with a GPS center point and radius necessary to enclose the population. For areas where invasive species were ubiquitous or impractical to map, surveyors characterized the invasive species population using estimates of aerial coverage and percent of species present within a delineated polygon. For areas where dense stands of wetland or aquatic invasive species have formed, areas were photo-documented.

3.6 Mapping Wetlands and Waters of the United States

FirstLight described and field-verified National Wetland Inventory (NWI) mapped wetlands within the study area. Initial determination of wetland areas was conducted through the use of existing information such as existing FirstLight site knowledge, NWI maps, Federal Emergency Management Agency (FEMA) floodplain maps, USGS 7.5 minute quadrangles, soil surveys, and aerial photography. This information was transferred and digitized into a GIS, and preliminary wetland base maps were prepared.

Using the preliminary wetland maps, field assessments were completed to verify, classify, and characterize the wetland communities. A team of qualified wetland scientists completed the field assessments during the 2014 and 2015 growing seasons when vegetation was most readily identifiable. Wetland habitats were not formally delineated, but were further defined based upon the existing NWI maps. NWI wetland boundaries were extended (or reduced) where applicable and non-NWI wetlands were mapped where they were encountered. According to a review of GIS data, there are no NHESP-certified vernal pools within the Project boundary. Potential vernal pools were identified using GIS data.

Wetlands were identified using standard federal criteria and methods outlined in the US Army Corps of Engineers (USACE) *Wetland Delineation Manual* and the *Regional Supplement to the USACE Wetland Delineation Manual: North Central and Northeast Region* (USACE, 1987; USACE, 2012). Wetland types were classified using the USFWS Cowardin wetland classification system (e.g., palustrine, unconsolidated bottom, riverine aquatic bed) (Cowardin *et al*., 1979). General wetland verification and mapping was completed using a Trimble®, sub-meter GPS unit. Field data were differentially corrected using Pathfinder (Ver. 5.7) and were transferred to the GIS database to assist in the creation of the final wetland presentation figures including location, type, and extent.

Evaluations and analysis of wetland functions and values referenced the standard USACE descriptive approach (also known as the USACE Highway Methodology) (USACE, 1999). This USACE method is a descriptive (qualitative) approach for evaluating the functions and values of wetlands, which directs the user to identify the functions and values associated with a particular wetland based on the presence or absence of certain characteristics. For each wetland type, standard data were recorded for the most important biotic and abiotic characteristics as the basis for identifying important wetland functions and values. This assessment was completed holistically for each wetland type. Investigators identified the "principal" or important functions and values associated with each wetland or wetland type.

3.7 Assessment of State-Listed Tiger Beetles

Using a combination of hydraulic modeling and field data collected at key sites, this task provided information to understand the contribution of Project-related water level fluctuations and the effects on hydraulically connected habitats for known populations and potential suitable habitats for state-listed invertebrate species, the Puritan and cobblestone tiger beetles.

The NHESP concern relative to tiger beetles identified in the November 1, 2013 meeting is their potential susceptibility to water level fluctuations during low flow periods in July and August, which coincide with when adults are most active. NHESP expressed concern that, as terrestrial species, tiger beetles may lack strategies to react to an increase in water level changes and could potentially be washed away from their habitat from boat wakes and during flood periods and high flows (both natural and anthropogenic) resulting in mortality. During spring and fall floods, the larval stage tiger beetles can survive in their burrows by using the oxygen attached to fine hairs on their body making them more resistant to flooding, but NHESP indicated that they are potentially susceptible to mortality from scour during that period.

3.7.1 Tiger Beetle Habitat Evaluation

FirstLight completed an on-the-ground reconnaissance surveys in the known and historic locations of beetle habitat and surveyed (both horizontal and vertical control) the microhabitat. This initial step identified where occupied and unoccupied habitats are located and then determine at what flows the habitat becomes inundated. Field assessments occurred from Cabot Station downstream to the vicinity of Rainbow Beach at five (5) occupied and historical areas to identify potential habitat locations (based on known substrate preferences and other micro-habitat requirements). Using data collected during this initial phase, GIS based maps were generated to show all potential suitable habitats at both occupied and unoccupied sites. These maps aided in the selection of where a sub-set of transects were located for the collection of additional field data.

In those areas where there is potentially suitable habitat, Chris Davis, a NHESP-approved biologist, selected a sub-set of transects in both occupied and unoccupied habitats to collect field data at a fine-scale to provide data on microhabitat variables. FirstLight provided NHESP and USFWS the opportunity to comment on the transect locations prior to field data collection efforts. Field data collected along transects included elevations and slopes (i.e. vertical and horizontal locations) with a survey quality RTK type GPS unit, at a sufficient scale to provide a better understanding of where the micro-habitat is submerged or not submerged under a range of flows.

Tiger beetles require specific textured sand for their stages of development; therefore evaluating substrate texture can be used as a method to identify potentially suitable habitat. In addition to collecting site-specific field data, initial identification of habitat locations were screened using existing and planned substrate mapping that was completed as part of other licensing studies.

Chris Davis was part of the field team assessing potential and known tiger habitat locations. Survey work was conducted in accordance with NHESP Endangered Species Habitat Assessment and Survey Guidelines: Wildlife (NHESP, 2011). Biologists traveled by boat in the river, stopping at each sparsely vegetated beach that is at least 5 m wide and 50 m long with fine to medium sand to assess potential suitability for Puritan tiger beetle habitat. If the biologist determined that a sparsely vegetated beach more than 20 m long but less than 50 m long had similar potential suitability for habitat, then that beach was also be inspected. Similarly, the field team stopped at cobble bars and cobble shorelines that were sparsely vegetated (generally less than 10% estimated visual plant coverage) for cobblestone tiger betters. At each beach, a GPS receiver was used to obtain an exact fix on its location. For Puritan tiger beetles, it is important to note that other potentially suitable beaches should be within 1-2 km, as Puritan tiger beetles move little among patches separated by distances of greater than 1-3 km (Omland, 2002), which suggests that there is little chance of regional expansion by natural colonization. Similarly Hudgins *et al*. (2011) report a higher statistical significance of occupied or unoccupied suitable cobblestone tiger beetle habitat when cobble bars occur near other cobble bars. A qualified tiger beetle biologist identified beaches (e.g., occupied or unoccupied but otherwise suitable) that provide suitable Puritan and cobblestone tiger beetle habitat (as defined above) within the Project (i.e. TFI downstream to Rainbow Beach).

At suitable habitat identified during the initial reconnaissance level surveys, data were collected during the active adult season (June-early August). During surveys, biologists searched for tiger beetle larvae excavated burrows in the sand. Tiger beetle burrows can be distinguishable from burrows of other arthropods based on characteristics of the mouth of the burrow as well as its orientation and depth. Criteria used for identification of Puritan tiger beetle larval burrows include 1) a nearly round, neatly maintained hole, 2) vertical orientation, and 3) generally at least 20 cm deep (Omland, 2002). The optimum time for adult tiger beetle observations is during the active adult season in July, between 10:00 and 17:00 on warm sunny days when ambient temperatures are the highest and adults are most active (Hudgins *et al*., 2011). Additional anecdotal observations within tiger beetle habitat were collected by the field team which included Chris Davis and Kleinschmidt.

3.7.2 Water Level Fluctuation Evaluation

The fine-scale elevation data needed to enable analysis of the localized flow velocity and dynamics within near-bank habitats were assessed using field data collection and the hydraulic modeling described above to measure changes in depth and WSEL over a range of flows.

The approach provided data of sufficient relevance to the understanding of how variable flow dynamics affect habitat suitability and applied transects at subset of key habitats for the Puritan tiger beetle. Hydraulic information for the cobblestone tiger beetle was developed from the below Montague USGS Gage hydraulic model as described above. Modeled WSELs provided an analysis of flood depth and duration across a range of flows. FirstLight advised NHESP and USFWS if additional unoccupied, but otherwise suitable cobblestone tiger beetle habitats were identified.

Data provided by these hydraulic models were used to estimate the change in WSEL in the location of the tiger beetles over a range of flows. Outputs from these models include channel depth and velocity, a water surface profile of the entire reach for a given flow, and model transects showing the WSEL.

3.8 Data Analysis

Following field surveys, GIS-based maps were developed depicting wetland habitats, SAVs, EAVs, invasive species, RTE species, and other related information collected during the study. The field data collected were geo-referenced as polygons or point data and overlain on orthophotos at a suitable scale. Field data were then subjected to QA/QC procedures, including spot-checks of transcription and comparison of GIS maps with field notes to verify the locations of wetlands found. The results of this study provided both quantitative and qualitative information that was important for defining existing conditions, as well as providing information on potential Project-related impacts.

4 RESULTS

To document representative botanical and wildlife resources, biologists completed reconnaissance level field surveys over the course of several weeks starting in April 2014 and ending in August 2014. Elevation survey transects were completed over the last week in August (August 24-28th) 2015.

4.1 Review of Existing Information

Existing information did not quantify EAV and SAV in the study area, or other shallow aquatic habitat types and physical features (e.g., depths, substrates, wood structure) that are the environment for aquatic biota in the study area.

Consultation with federal and state agencies regarding the potential presence of RTE species and critical habitats resulted in the identification of three (3) federally-listed threatened and/or endangered species, 39 state-listed threatened and/or endangered species, and 21 state-listed species of special concern. Agency consultation revealed no federally designated critical habitat areas within the study area.

The NHESP commented in its response, regarding protected resources, dated August 29, 2013, that several surveys along this stretch of the river have shown that many state-listed plant species are dynamic local populations and often display meta-population dynamics, changing in size and location from year to year. The NHESP commented that this is particularly true for plant species inhabiting sand bars and high energy shore and cobble islands, including, but not limited to, the state-listed Wright's spike-rush (*Eleocharis diandra),* intermediate spike-sedge (*Eleocharis intermedia*), ovate spike-sedge (*Eleocharis ovata*), Frank's lovegrass (*Eragrostis frankii*), and tufted hairgrass (*Deschampsia cespitosa*). Large and/or rapid changes in WSEL and/or flow dynamics may cause adverse effects to existing and potential habitat for state-listed plant species. FirstLight is not aware of any studies that evaluate the effects of these changes in WSELs on the life cycle of state-listed species and in particular, the germination, growth, and dispersal of species inhabiting mudflats, sand bars, and cobble islands. A list of NHESP state-listed species targeted for investigation by NHESP is included in Table 4.1-1.

Puritan tiger beetle and the cobblestone tiger beetle populations are limited in Massachusetts. The only known population of each species is found along the Connecticut River, with Puritan tiger beetle known from a single site at Rainbow Beach in Northampton, MA, and cobblestone tiger beetle known from a single site in Montague, MA (first observed in 2000). Detailed surveys of Puritan tiger beetle have been conducted at Rainbow Beach for adults and larvae from 1997 to the present, including surveys conducted by FirstLight in 2014.

4.1.1 Rare Plants and Beetle Data Provided by NHESP

At a November 1, 2013 meeting, NHESP provided FirstLight with a list of 10 RTE plant species of concern (target plants) known to occur or have historical records of occurrence within or near the vicinity of the Project between Vernon Dam and the Route 116 Bridge in Sunderland, as shown in Table 4.1-1. NHESP targeted these state-listed plant species as having the highest likelihood of experiencing potential effects due to Project operations - specifically related to inundation (including depth, timing and duration).

Pursuant to the NHESP Data Release Agreement (NHESP File #11-30121) dated November 13, 2013, NHESP provided FirstLight with a list of specific locations where the above listed RTE plant species have been observed or where NHESP has historical records of occurrences. For some locations, NHESP has spatial data it provided to FirstLight to better focus survey efforts. Pursuant to the data release agreement, FirstLight is not permitted to disclose the specific location of the plant specimens in publicly available documents.

Tiger Beetle Data

At the November 1, 2013 meeting, NHESP provided maps showing the generalized known and historical locations of Puritan and cobblestone tiger beetles. In addition, NHESP and USFWS provided references to past tiger beetle studies and life history which are summarized below.

Tiger beetles are holometabolous[6] insects, spending the majority of their life cycle in the larval stage. Larval tiger beetles are essentially sessile[7], restricted to burrows where they spend a two year period where their embryonic egg development occurs. Larvae are dormant during the winter months when they hibernate, becoming more active again in the spring and fall. Larvae burrow into the substrate for a prolonged period of time before pupating and emerging as adults in the summer. Larvae hatch from eggs in late summer and molt within two to four weeks. In the Connecticut River, adults emerge in June, July, and August, depending on weather conditions. An estimated adult survivorship ranges from less than one week to more than four weeks (Abbott, 2003). Unlike their sessile larval stage, adults are decidedly agile being well-known as fast runners and strong flyers (Omland, 2002).

Omland (2002) and Abbott (2003) describe model Puritan tiger beetle habitat sites as sparsely vegetated beaches at least 50 meters long and 5 meters wide with fine to medium size (<0.5mm) sand particles, adjacent to banks where woody plant growth is suppressed by water flow dynamics or human land use and are also located within 1-2 km of other suitable habitat. Tiger beetle larvae life stages typically occur for longer periods and are more localized than adult stages and, being a sessile life stage, larvae tolerate less variation in abiotic conditions. Tiger beetle larvae require sand textured substrate and soil to successfully construct and maintain burrows throughout their stages of development.

There have been few studies on cobblestone tiger beetles, and many of the specific habitat requirements and dispersal biology of the species are poorly understood. As the name implies, cobblestone tiger beetles inhabit cobble bars that are deposited at bends in the river and as islands (Hudgins *et al*., 2011). These areas are frequently scoured by spring flooding and their locations can shift from year to year (Hudgins *et al*., 2011). Most occupied cobble bars are located along the river's edge and at bends in the river and rarely are cobble bars that are completely isolated from the shoreline occupied (Hudgins *et al*., 2011). Most occupied cobble bars are likely to occur in habitat patches with greater interior areas and elevation relief with some area above high water levels that are characteristically covered with loosely packed cobbles that have few boulders.

4.1.2 Existing Water Level Monitoring

The USGS maintains the Montague Gage (No. 01170500 Connecticut River at Montague City, MA) located just below the confluence with Deerfield River which measures both river stage (elevation) and flow (cfs). From May 1 to October 24, 2012, FirstLight installed water level recorders at two locations downstream of the Cabot Station to record water level elevations at 15 minute intervals at:

- The Route 116 Bridge in Sunderland, MA and
- Near Rainbow Beach.

Note that Section 4.3.1.6 of the Pre-Application Document includes background on the 2012 water level monitoring baseline study.

In 2013, within the TFI, six (6) water level recorders were installed on August 1 and retrieved on November 19 to record data on 15 minute intervals. In 2014, nine (9) water level recorders were installed on about

[6] Holometabolous means the tiger beetle undergoes complete metamorphosis.
[7] Sessile means the larval stage of the tiger beetle is essentially immobile.

March 24-25 and retrieved on November 7, also set to record data on 15 minute intervals. These water level recorders supplemented the existing water level recorders at:

- The Vernon Dam Tailrace;
- The Northfield Tailrace; and
- Just upstream of the Turners Falls Dam.

Additional data on this the water level recorder monitoring in 2012, 2013, and 2014 is available in Section 2.1 of Study No. 3.2.2.

In 2014 in the Bypass Reach, as part of the Study No. 3.3.1 *Instream Flow Habitat Assessment Study*, 20 water level recorders were installed from generally mid-May until early November in the lower part of Reach 2 and Reach 3. Also in 2014, five (5) water level recorders were installed in Reach 1 as part of the Study No. 3.3.1.

In 2015, as part of Study No. 3.3.13 *Littoral Zone Fish Spawning Study*, six (6) water level recorders were installed in the TFI from April to June. In the bypass reach, two (2) water level recorders were installed from April to mid-November for Study No. 3.2.1 *Water Quality Study* and two (2) from May to early September for Study No. 3.3.10 *Assess Operational Impacts on Emergence of State-Listed Odonates*. Downstream of Cabot Station, eight (8) water level recorders were installed from April to mid-November for Study No. 3.2.1.

4.1.3 Invasive Plant Species

The Massachusetts Invasive Plant Advisory Group (MIPAG) maintains a list of 35 invasive plant species and 29 likely invasive plant species occurring in Massachusetts. Invasive plants as defined by the MIPAG are, “non-native species that have spread into native or minimally managed plant systems [in Massachusetts], causing economic or environmental harm by developing self-sustaining populations and becoming dominant and/or disruptive to those systems.” Of the 64 invasive or likely invasive plants listed by the MIPAG, a total of nine (9) invasive species have been identified with the potential to occur in the aquatic habitats associated with the study area. Invasive plants identified by the MIPAG not included in this study were omitted based on regional occurrence (coastal areas) or habitat type. Terrestrial invasive species are addressed as part of Study No. 3.4.1. A list of wetland and aquatic invasive plant species with potential to occur in the study area are provided in Table 4.1-2.

Table 4.1-1: RTE Plant Species of Concern

Scientific Name	Common Name	State (MA) Status	Preferred Habitat	Survey Window
Alnus viridis ssp. crispa	Mountain Alder	Threatened	Exposed ledges/ Boulders/ Cobble Bars	Late April –end of May
Deschampsia cespitosa ssp. glauca	Tufted Hairgrass	Endangered	Rocky / Gravelly Shores	Mid June- Early October
Eleocharis diandra	Wright's Spike-rush	Endangered	Along Shores of River's After Spring Floods Recedes	Mid July – Mid September
Eleocharis intermedia	Intermediate Spike-sedge	Threatened	Open Sandy Margins	Mid July – End of September
Eleocharis ovate	Ovate Spike-sedge	Endangered	Open Sandy Margins	Mid July- End of September
Eragrostis frankii	Frank's Lovegrass	Special Concern	Sandy River Banks & Sandbars	September-October
Oligoneuron album	Upland White Aster	Endangered	Open Rocky Habitat	Mid July- Mid September
Prunus pumila var. depressa	Sandbar Cherry	Threatened	Flooded Scoured Areas of Islands, Shores, & Peninsulas	Late April – end of May
Salix exigua ssp. interior	Sandbar Willow	Threatened	Island Sandbars, and Sandy Beaches	Late April – end of May
Symphyotrichum tradescantii	Tradescant's Aster	Threatened	Rooted Fissures & Cracks of Rocky Streams	Mid July - September

Table 4.1-2: Wetland and Aquatic Invasive Plant Species

Scientific Name	Common Name	Lifeform Type	Notes
Cabomba caroliniana	Carolina Fanwort	Aquatic herb	Chokes waterways
Iris pseudacorus	Yellow Iris	Perennial herb	Wetland habitats, primarily in flood plain areas, grows in full sun to full shade
Lysimachia nummularia	Creeping Jenny	Perennial herb	Problematic in flood plains forms dense mats
Lythrum salicaria	Purple Loosestrife	Perennial herb	Overtakes wetlands, high seed production
Myriophyllum heterophyllum	Variable water-milfoil	Aquatic herb	Chokes waterways, spreads by humans, boat traffic, and possibly birds
Myriophyllum spicatum	Eurasian water-milfoil	Aquatic herb	Chokes waterways, spreads by humans, boat traffic, and possibly birds
Phalaris arundinacea	Reed Canary Grass	Perennial grass	Forms dense stands
Potamogeton crispus	Curly Pondweed	Aquatic herb	Forms dense mats in the spring and persists vegetatively
Trapa natans	Water-chestnut	Aquatic herb	Forms dense floating mats on water

4.2 Riparian and Littoral Zone Botanical Survey

4.2.1 Riparian Habitat

A detailed description of riparian habitat within the study area is described in Study No. 3.4.1. In general, riparian forests are Hardwood Floodplain forests and Northern Hardwood forests, which are common to the region (see Study No. 3.4.1).

4.2.2 Littoral (SAV) Vegetation

During the summer of 2014, the TFI was surveyed for SAV. The intent was to describe dominant species as well as estimate the coverage within mapped patches of SAV. Figure 4.2.2-1 shows the location of mapped SAV beds as well as estimated density. Figure 4.2.2-2 through Figure 4.2.2-4 show representative views of each of the three estimated densities for mapped SAV beds. In most cases, very dense stands were dominated by exotic species, primarily variable leaf and Eurasian milfoil (*Myriophyllum heterophyllum* and *Myriophyllum spicatum*).

Several exotic and invasive aquatic species are currently found within the study area including variable leaf milfoil, Eurasian milfoil, curly-leaf pondweed (*Potamogeton crispus*), fanwort (*Cabomba caroliniana*), and water chestnut (*Eleocharis dulcis*). In total, 41 of the mapped 107 SAV beds had some level of infestation by exotic species, which accounts for 38% of the SAV beds. The majority of the exotic species occur immediately upstream of the Turners Falls Dam with fewer occurrences upstream of the French King Bridge. In general, exotic species upstream of the French King Bridge are not as widespread and occur at lower densities. No exotic SAV was identified in mapped SAV beds below the bypass reach. Beds of SAV vegetation, outside of the areas near Barton Cove, generally occur as narrow bands located parallel to the TFI shoreline. In some cases, shallow shoals within the TFI, often associated within islands, support large beds of SAV. Native species include wild celery (*Vallisneria americana*), various pondweeds (*Potamogeton spp.*), muskgrasses (*Chara ssp.)*, and coontail (*Ceratophyllum demersum*). Downstream of the Turners Falls Dam species are dominated by wild celery and pondweeds. Wild celery occurs throughout the majority of the identified SAV beds within the entire study area. Table 4.2.2-5 includes SAV species identified during the survey work.

The greatest area of SAV beds are dense, with the largest being beds located near Barton Cove and the Turners Falls Dam. These beds account for approximately 223 acres of the total area of dense SAV beds (approximately 75%) mapped with estimated density of 51-100%. No SAV beds were mapped within the bypass reach, and the Montague to Sunderland Bridge reach contained only medium and sparse beds of SAV. Table 4.2.2-6 includes a summary of density and area of mapped SAV beds within the study area.

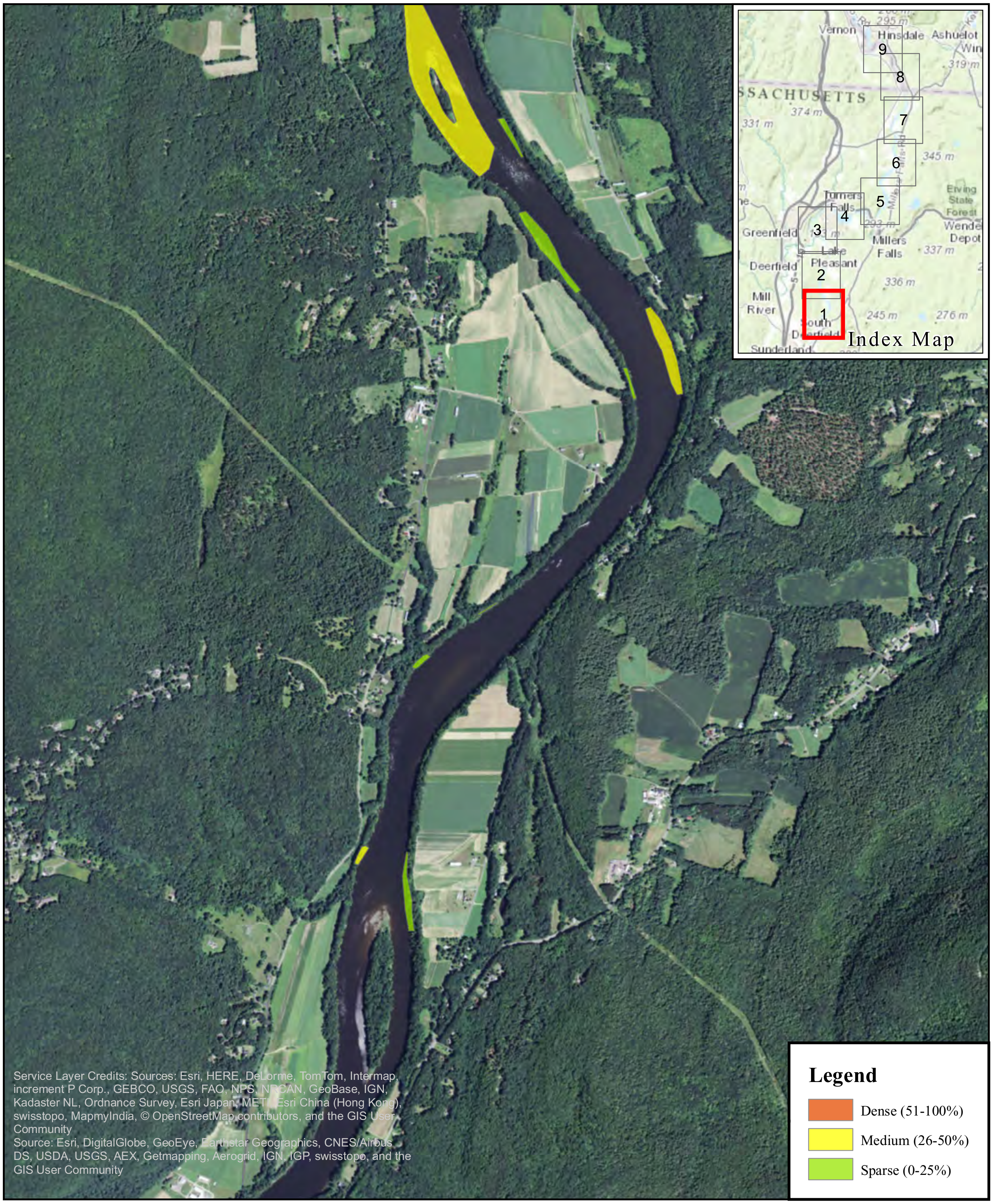
Table 4.2.2-5: Identified Submerged Vegetation within the Turners Falls Impoundment

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

*Exotic Species

Table 4.2.2-6: Summary of Submerged Vegetation Beds by Density and Size within the Turners Falls Impoundment

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**



FirstLight GDF SUEZ

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

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

Figure 4.2.2-1
Submerged Aquatic Vegetation Mapping
Map 1

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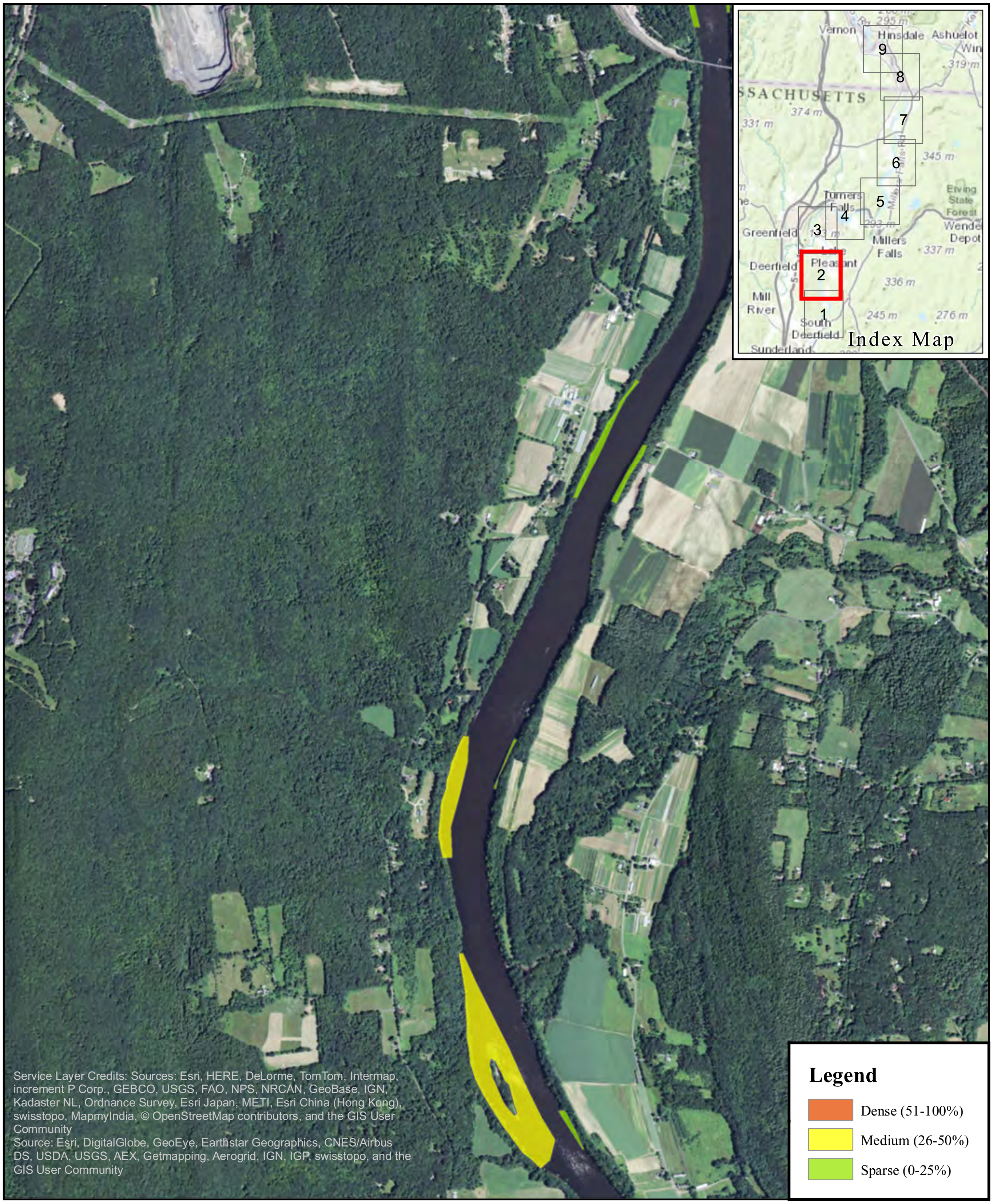

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0 0.125 0.25 0.5 Miles

Figure 4.2.2-1
Submerged Aquatic Vegetation Mapping
Map 2

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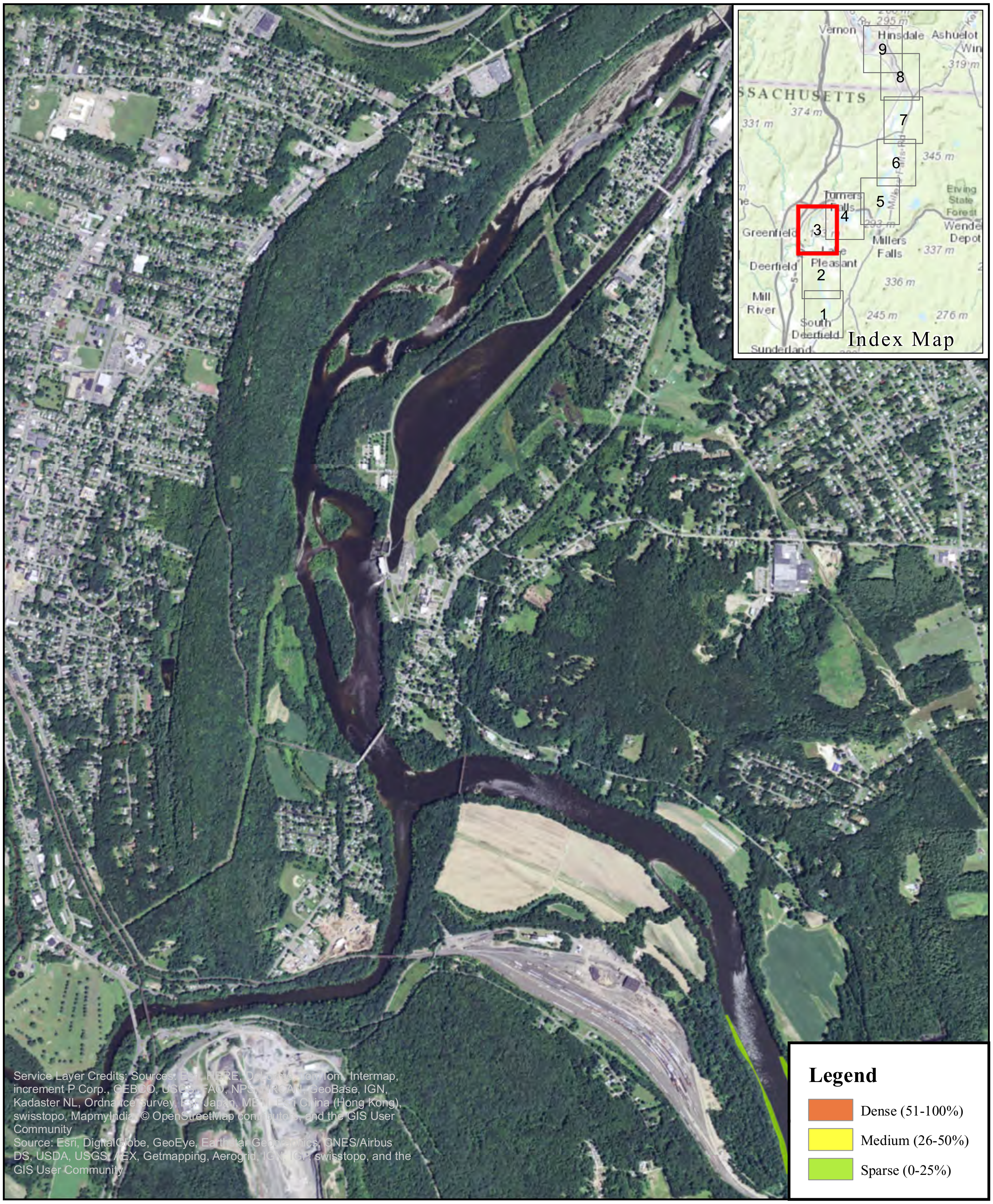

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N

0 0.125 0.25 0.5 Miles

Figure 4.2.2-1
Submerged Aquatic Vegetation Mapping
Map 3

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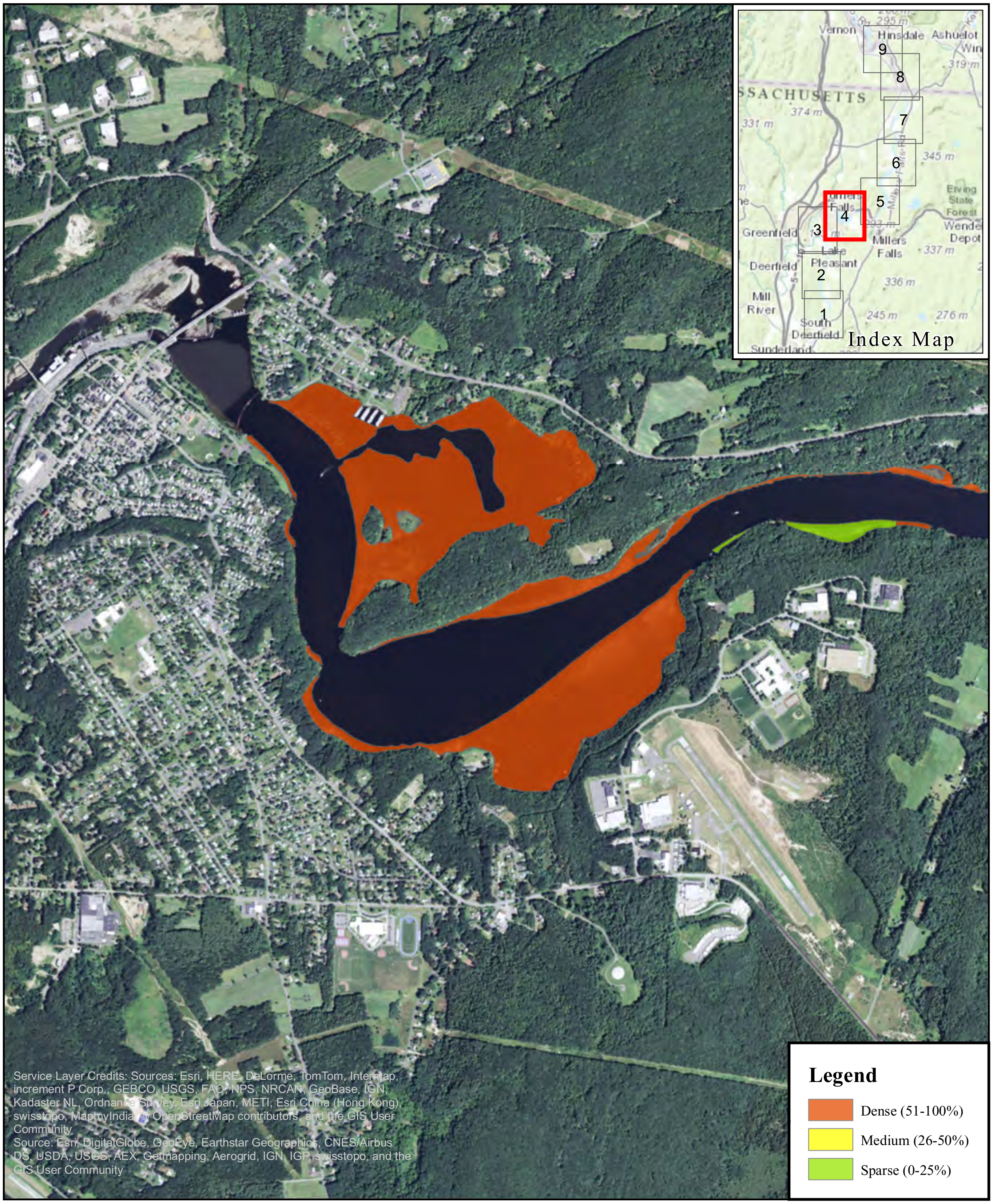

FirstLight GDF SUEZ

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

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

N

0 0.125 0.25 0.5 Miles

Figure 4.2.2-1
Submerged Aquatic Vegetation Mapping
Map 4

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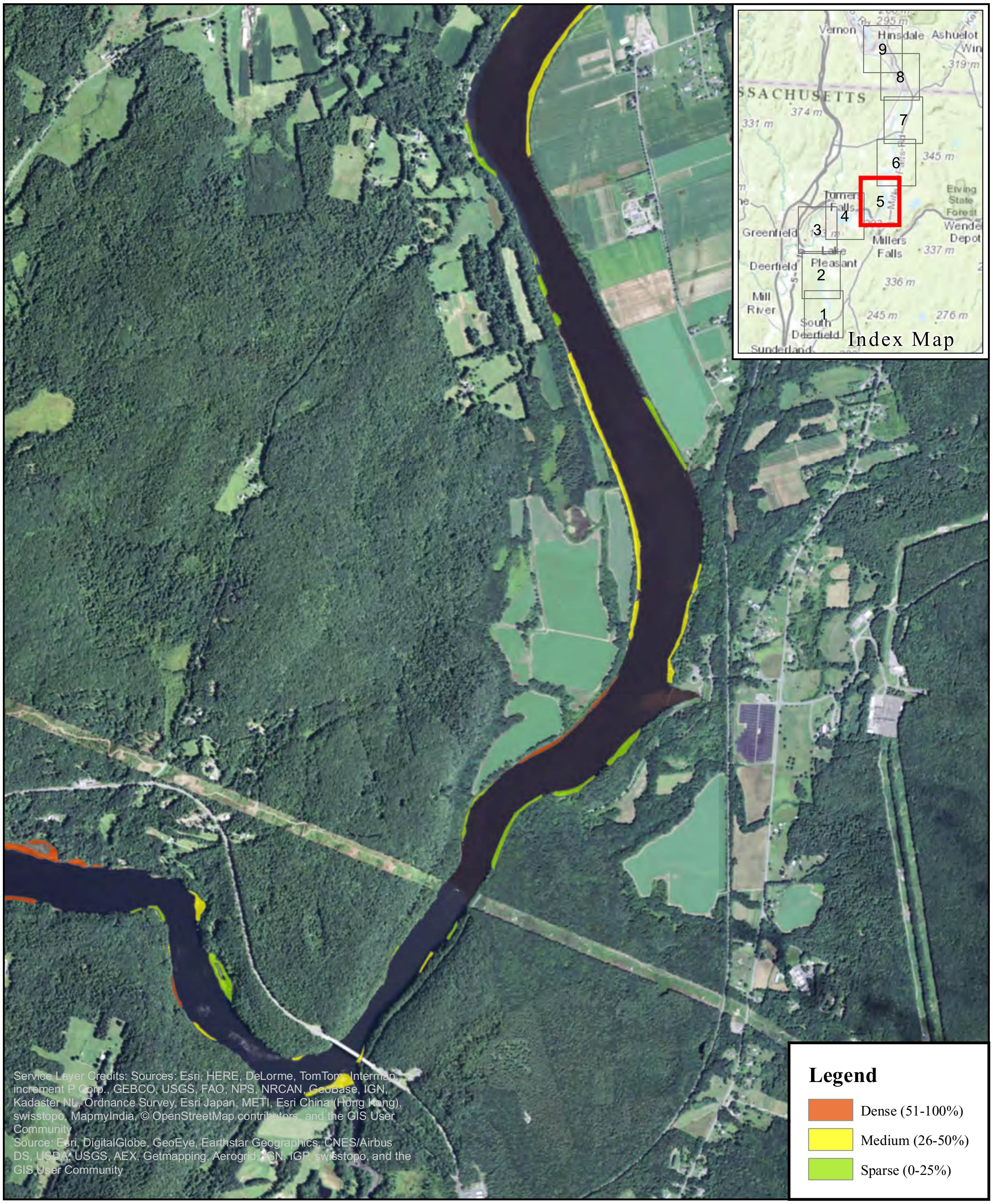

Northfield Mountain Pumped Storage Project (No. 2485) and Turners Falls Hydroelectric Project (No. 1889)

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

Figure 4.2.2-1
Submerged Aquatic Vegetation Mapping
Map 5

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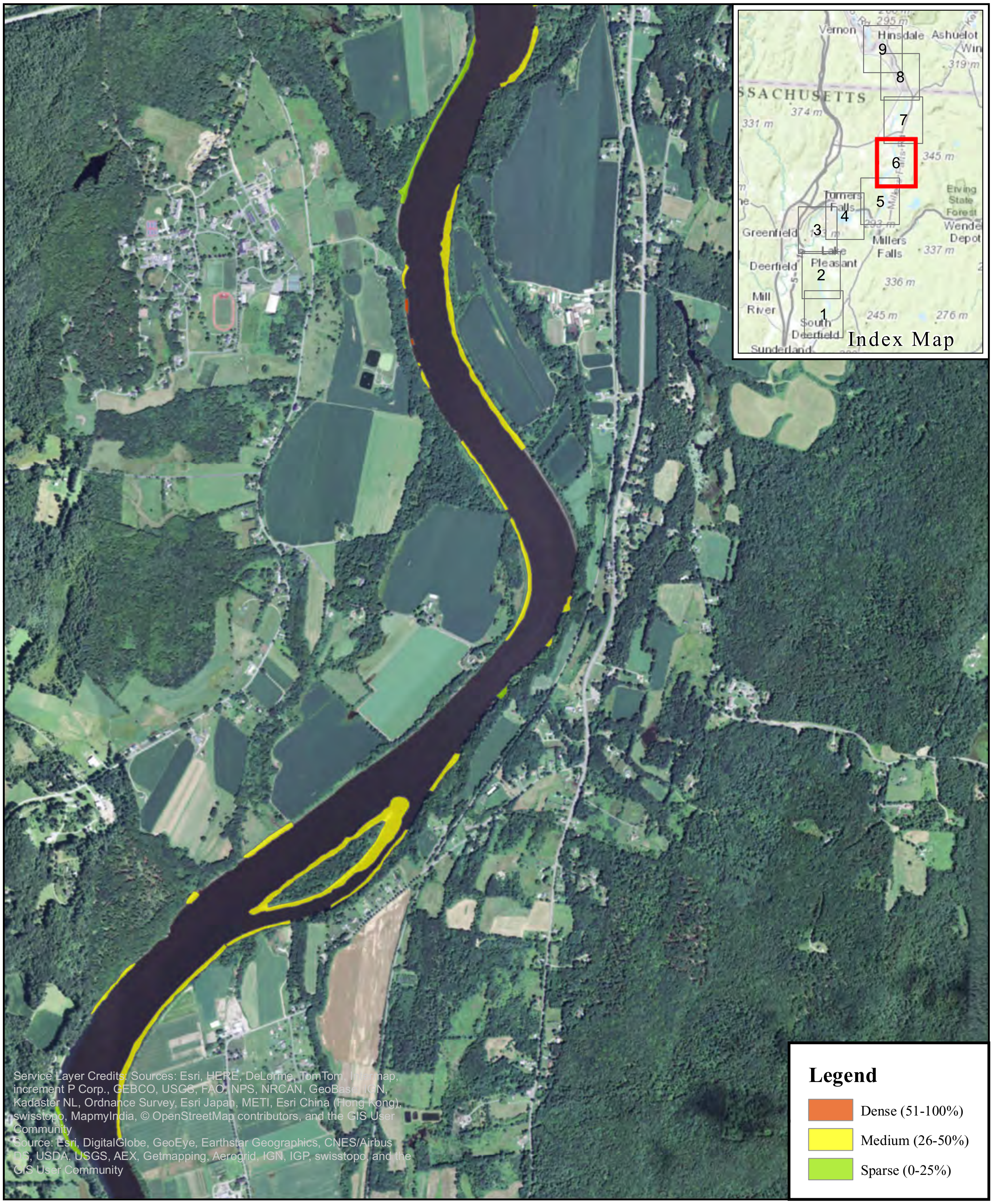

Northfield Mountain Pumped Storage Project (No. 2485) and Turners Falls Hydroelectric Project (No. 1889)

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

N

0 0.125 0.25 0.5 Miles

Figure 4.2.2-1 Submerged Aquatic Vegetation Mapping Map 6

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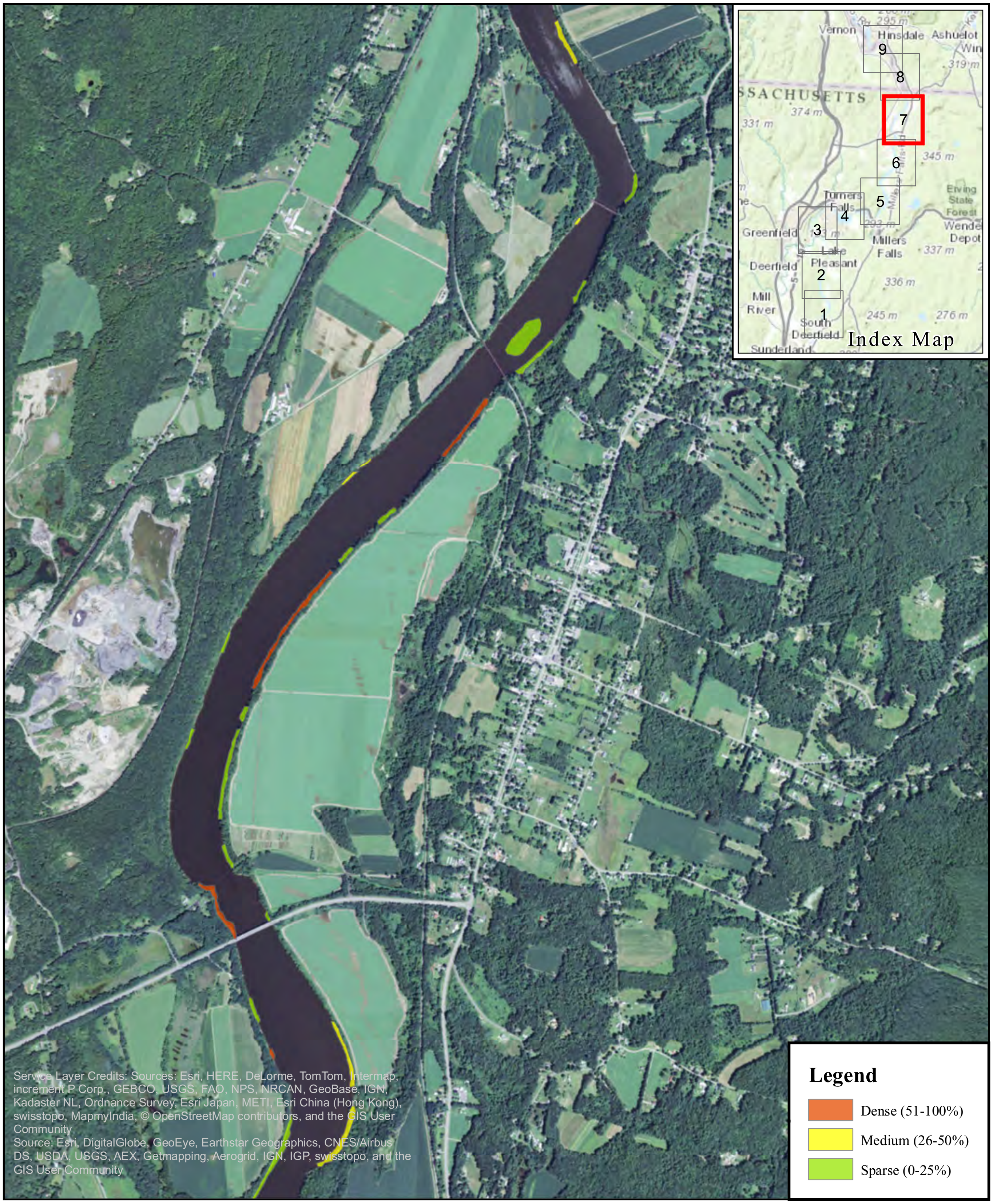


FirstLight GDF SUEZ

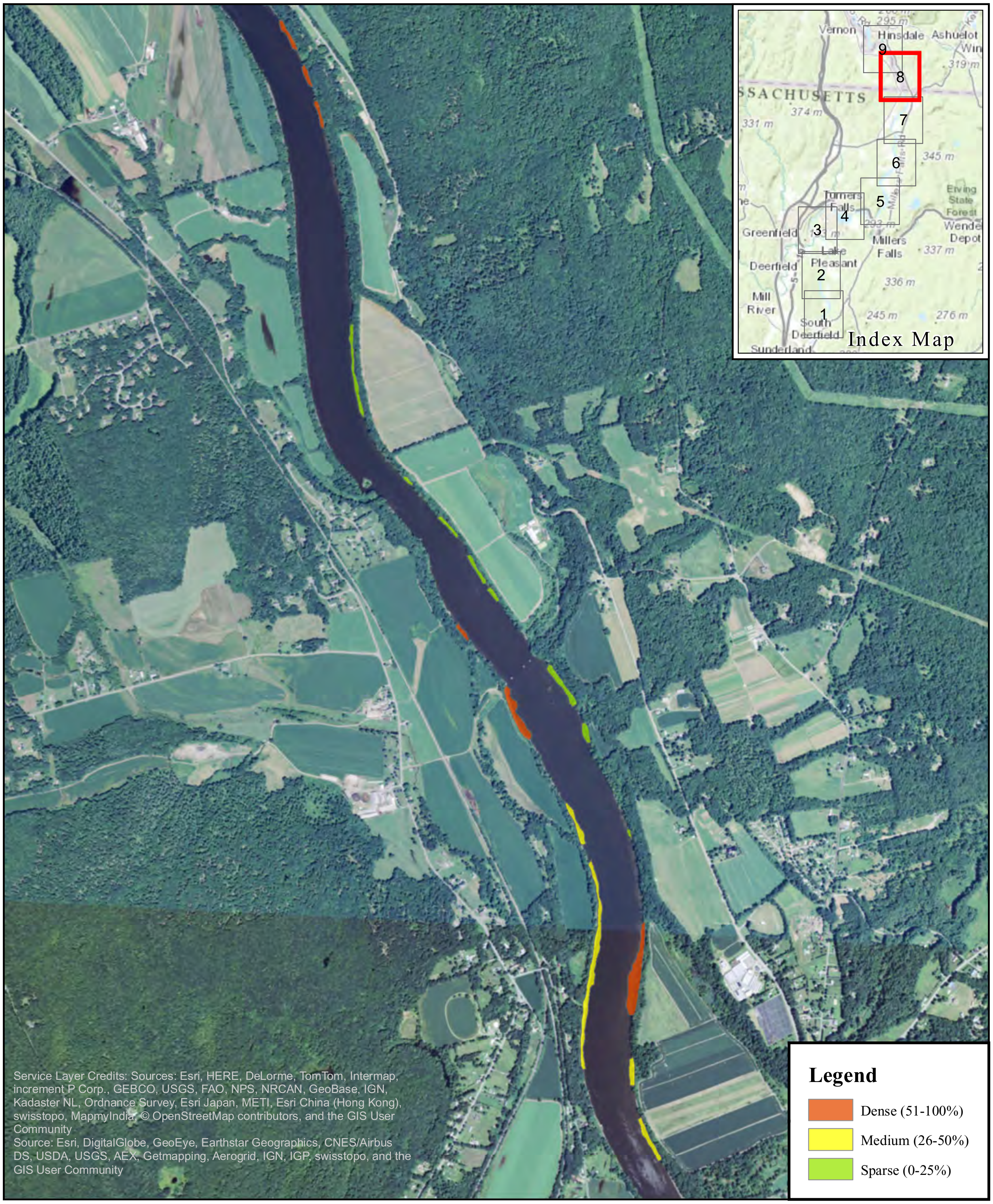
Northfield Mountain Pumped Storage Project (No. 2485) and Turners Falls Hydroelectric Project (No. 1889)
Study 3.5.1 Baseline Inventory of Wetland, Riparian and Littoral Habitat in the Turners Falls Impoundment and Assessment of Operational Impacts on Special Status Species

N

0 0.125 0.25 0.5 Miles

Figure 4.2.2-1
Submerged Aquatic Vegetation Mapping
Map 7

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



FirstLight GDF SUEZ

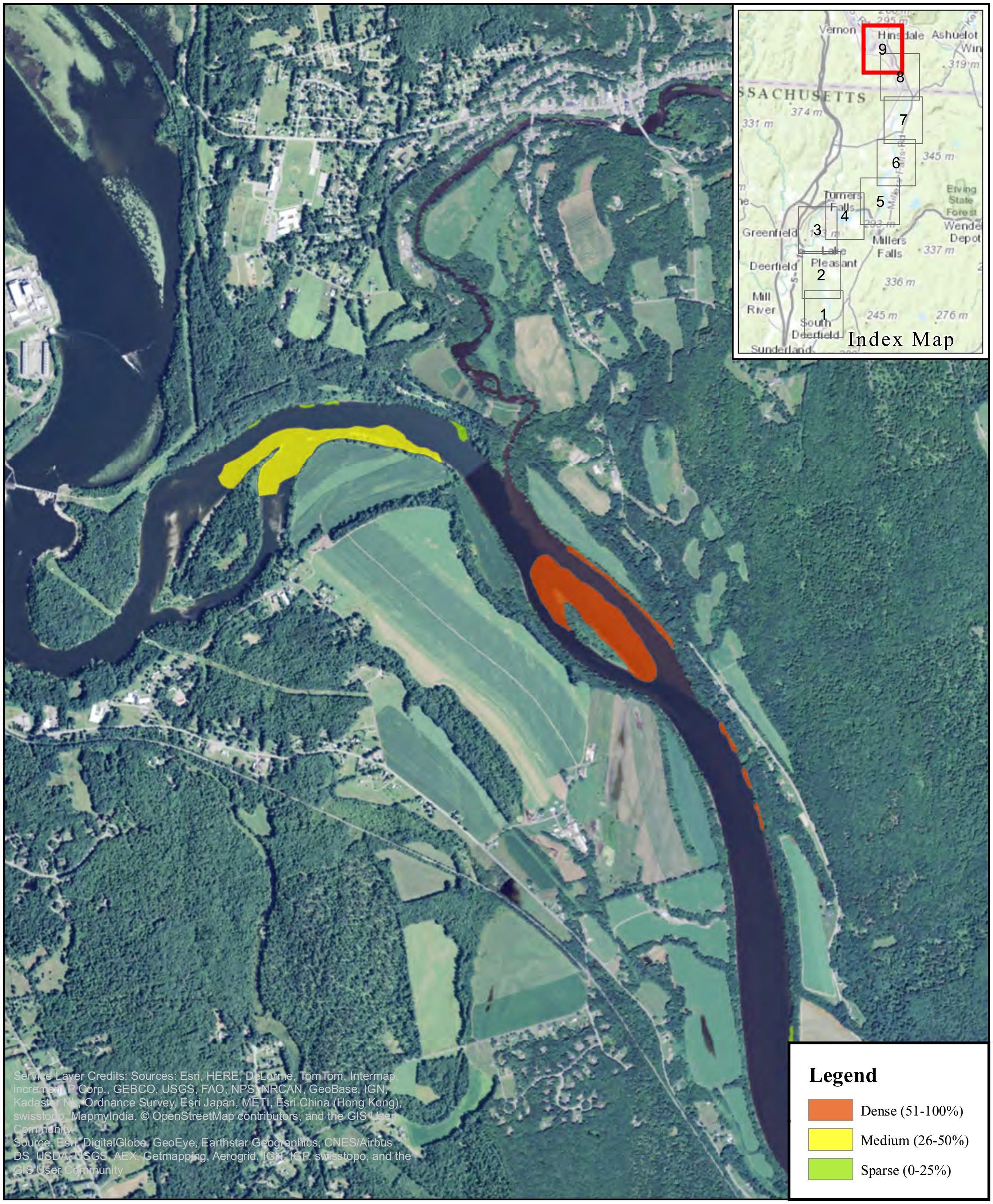
Northfield Mountain Pumped Storage Project (No. 2485)
and Turners Falls Hydroelectric Project (No. 1889)
Study 3.5.1 Baseline Inventory of Wetland, Riparian and Littoral Habitat in the Turners Falls Impoundment and Assessment of Operational Impacts on Special Status Species

N

0 0.125 0.25 0.5 Miles

Figure 4.2.2-1
Submerged Aquatic Vegetation Mapping
Map 8

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



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N

0 0.125 0.25 0.5 Miles

Figure 4.2.2-1
Submerged Aquatic Vegetation Mapping
Map 9

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

Figure 4.2.2-2: Example of Sparse (0-25%) Density of SAV (Approximate Area Shown in Yellow)

Figure 4.2.2-3: Example of Medium (25-50%) Density of SAV (Approximate Area Shown in Yellow)

Figure 4.2.2-4: Example of Dense (50-100%) Area of SAV

4.3 RTE Plant Survey

The 2014 RTE plant survey dates were May 29 and May 30, June 2 and June 3, July 21, August 18 through August 22, August 25 through August 29, September 8 through September 12, and October 22. The October survey included on-site consultation with NHESP staff (Jesse Leddick and Karro Frost). In August of 2015, elevation transect data were collected at each of the 18 habitat transects (Figure 4.3-1). The transects include the following in upstream to downstream order:

- 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).

RTE Plant Species

In addition to the NHESP listed species, FirstLight's team recorded three (3) new NHESP RTE species, which included great blue lobelia (*Lobelia siphilitica*), purple cliff brake (*Pellaea atropurpurea*), and Frank’s lovegrass. The great blue lobelia is a tall, showy perennial wildflower that inhabits circumneutral wetlands and transitional habitats. The species generally prefers open areas or areas of partial shade. While this species is listed, the plant was formerly cultivated and continues to be popular in gardening, and therefore some populations are likely introduced. A single stem of this species was located within the bypass reach in 2014. The plant was located within the exposed rocky habitat common to the area. Associated plant species include American water-horehound (*Lycopus americanus*), purple loosestrife (*Lyrthrum salicaria*), smartweed (*Polygonum spp*), New York aster (*Symphyotrichum novi-belgii*), and Tradescant’s aster (*Symphyotrichum tradescantii*). Purple cliff brake is a state watch list species; nine (9) plants were recorded in 2014. This small rock fern is situated high above the waterline on a calcareous cliff face just upstream of the French King Bridge on the west side of the Connecticut River. Frank's lovegrass was included on the target list by NHESP. NHESP environmental occurrences for Frank’s lovegrass were recorded in 1984, 1985 and 1987 making these historic records. Regardless, intensive field searches were made in these historic locations. No observations of Frank's lovegrass were recorded in 2014; however, the species was identified near the Pauchaug Boat Launch in 2015. Frank’s lovegrass is a state species of concern. A single clump was identified near the walking trail along the shoreline just south of the Pauchaug Boat Launch.

Biologists positively identified six (6) of the nine (9) NHESP threatened or endangered species known to occur within the study area. The bypass provides the majority of the suitable and preferred habitat, particularly for Tradescant's aster, which was the most abundant targeted state-listed species recorded. In 2015, elevation data was collected at each of 18 transects.

Species Identified Within the Survey Area

Mountain Alder

The mountain alder (*Alnus viridis ssp. crispa*) is a shrub that can reach approximately 12 feet in height, similar to other alders. It has toothed leaves, generally with 6-9 main veins. The range of the mountain alder extends from Canada, south to northern New England, and in Massachusetts the species is primarily found on exposed ledges, boulders, and cobble bars. Often these habitats coincide with high energy rivers. The primary threat to this species is from disturbance of habitat as well as competition from exotic, invasive species such as Japanese knotweed (*Fallopia japonica*).

Within the study area, mountain alder is primarily found within the bypass reach. A typical example of the habitat present in the bypass reach is shown in Figure 4.3-2. Eight polygons of mountain alder were mapped within the bypass reach in 2014; these polygons included approximately 73 individuals. In total, 83 shrubs were recorded in 2014, and the species occurs in several habitats, but most commonly on exposed ledges and large boulders and cliffs in areas with shade and cooler temperatures. Based on survey work completed in 2014, mountain alder was mostly found scattered in the bypass at higher elevations, likely outside of project influence. ~~Common areas to find the alder include in the bypass include: Rock Dam[8], under power lines south of Station No. 1 (both sides of bypass), rocky boulders and ledge at the tip of Rawson Island, and the backside of the island located just downstream of the Turners Falls Dam.~~ Associated species include dogbane (*Apocynum sp.*), upland white aster (*Oligoneuron album*), sweet gale (*Myrica gale*), speckled alder (*Alnus incana*), and switchgrass (*Panicum virgatum*). A full list of associated species is included in Table 4.3-1.

Intermediate Spike Sedge

The intermediate spike sedge is a small, densely tufted annual herb with very wiry stems. The primary aid to identification of this species is to examine the achene, which is hard and nut-like. The achene for the intermediate spike sedge matures in mid to late summer and is three-sided with a narrow tubercle. Habitat for the intermediate spike sedge includes marshes and freshwater mudflats, or areas with muddy substrates. Potential threats to this species are unknown. Based on habitat preference, the species is generally found in the proximity of freshwater (i.e., streams, rivers, and ponds). The NHESP has noted that regular WSEL fluctuations may benefit the species as fluctuations maintain the exposed muddy habitat preferred by the species (NHESP, 2009). In 2014 and 2015, the species was only identified by NHESP-approved botanist Steve Johnson in one location in the study area, ~~the~~ in the vicinity of the Pauchaug Boat Launch. The boat launch is an area of exposed sand and mud (~~Figures 4.3-1 and~~ Figure 4.3-3). Associated species include joe-pye weed (*Eutrochium maculatum*), jewelweed (*Impatiens capensis*), monkey flower (*Mimulus ringens*), woolgrass (*Scirpus cyperinus*), and, at higher elevations, rough cocklebur (*Xanthium strumarium*). Additional species associated with the intermediate spike sedge are included in Table 4.3-2.

Upland White Aster

The upland white aster is a small composite plant that flowers from July into early September. The species prefers rocky outcrops of sandstone, shale, or limestone. It is commonly found growing in cracks or fissures in bedrock outcrops. The upland white aster requires significant sunlight exposure and shading may be a threat. In addition, as the species is often located along exposed river banks, water level and recreational activities may pose threats to the species. Within the study area, a number of polygons of upland white aster were mapped in 2014 in the bypass reach and overall study area. Based on stem counts within these polygons, in excess of 638 individual plants were located within the bypass area. The bypass reach is ideal habitat which includes exposed areas of bedrock (Figure 4.3-4). Associated species include big bluestem (*Andropogon gerardii*), dogbane, flat-top white aster (*Doellingeria umbellate*), monkey flower, and joe-pye weed (Table 4.3-3).

Sandbar Cherry

The sandbar cherry (*Prunus pumila var. depressa*) is a member of the rose family that is a low growing shrub forming mats up to 6 feet in breadth. The species, in Massachusetts, rarely grows above three feet in height. The species prefers flood-scoured areas, often along islands and shores. Habitat is generally dominated by cobble, gravel, and sloping rock at or near the highwater line. In 2014, approximately 1,400 individuals were identified within several mapped polygons in the bypass reach ~~(Figure 4.3-1)~~. The habitat within this area, as described above, is ideal for species which prefer regularly scoured habitat. Figure 4.3-5 shows a typical view of sandbar cherry within the bypass reach. In addition, the species was identified on several ~~islands~~ locations below the bypass reach as well as ~~in the upstream extent of the TFI,~~ below Vernon

~~[8] Rock "Dam" is a high natural ledge in the bypass reach.~~

Dam (Figure 4.3-1). Associated species include mountain alder, dogbane, cottonwood (*Populus deltoids*), sycamore (*Platanus occidentalis*), sandbar willow (*Salix exigua ssp. interior*), black willow (*Salix nigra*), and big bluestem (Table 4.3-4).

Sandbar Willow

The sandbar willow is a small shrub, growing up to ten (10) feet in height, which forms interconnected thickets. In Massachusetts, the willow is commonly found on islands, sandbars, and beaches within the flood zone. It prefers sandy, gravely, or rocky substrates that are tied closely to the annual flood regimes and disturbance from WSEL fluctuations and are subjected to annual inundation by high water. The plants are usually low and sprawling, and, in the Connecticut River drainage, stems are generally less than six (6) feet in height. The primary threat to this species is a scarcity of habitat, which is related to shoreline development. Survey work completed in 2014 identified the sandbar willow in several locations. The species occupies areas within the bypass reach as well as ~~on islands~~areas near Sunderland and to the north near the Vernon Dam. All these habitats share common characteristics in that all are dominated by cobble and rock and are within actively flooded areas. Figure 4.3-6 shows a representative view of the typical willow habitat on First Island (near the Sunderland Bridge). Associated species include dogbane, purple loosestrife, black willow, blue vervain (*Verbena hastata*), and big bluestem (Table 4.3-5).

Tradescant's Aster

The Tradescant's aster is a small, white-rayed aster that rarely grows more than one and a half feet in height. It is often found with a basal rosette of leaves and a cluster of erect stems. This aster is typically found rooted in fissures and cracks of rocky stream shores or river banks (Figure 4.3-7). These habitats are generally subjected to flooding throughout the year. The plant flowers late in the summer, when water levels are normally lower. Due to the dynamic nature of the Tradescant's aster's preferred habitat, invasion by exotic species or damage from development are uncommon. The primary threats are modification of flood regimes that would allow the establishment of other species, and occasional invasive plant species such as spotted knapweed (*Centaurea maculata*) and purple loosestrife, which have been found in Tradescant's aster's habitat. Surveys completed in 2014 identified the aster as occurring throughout the bypass reach as well as a few discrete patches; one occurring on the rock face just downstream from the French King Bridge and a few near the confluence with the Deerfield River. Populations within the bypass, mapped in 2014, are quite robust and approximately 16,770 stems were counted during fieldwork. In all locations, the habitat was dominated by exposed bedrock, boulders, and large cobbles. Associated species include mountain alder, big bluestem, dogbane, purple loosestrife, and seedbox (*Ludwigia alternifolia*) (Table 4.3-6).

Transects

Transects were established within occupied and unoccupied habitat from Vernon Dam to Sunderland Bridge. All transects, except Transect T-3 in the bypass, do not fully extend across the river. During the survey, the lower limit of the transect was placed at or slightly below the WSEL at the time of the survey; in all cases the lower limit was below any observable terrestrial vegetation. Results from the transect survey are presented below in order, from the downstream most transect (Transect 1) to upstream most transect (Transect 10). Transect 7 was excluded, as this location occurred on a sheer cliff downstream, of the French

King Bridge. The cliff resulted in access constraints which did not allow for a survey transect to be placed at this location.

Reach: Montague USGS Gage to Sunderland Bridge- Transects 1, 2, 3, and 4

Transect 1 (Sandbar Willow) - Below Montague USGS Gage Model Reach

A single transect, Transect 1, was established on the upstream end of First Island. The transect bisects the upstream tip of the island and is 230.0 feet in length. The substrate for the entire transect is dominated by cobble, gravel, and sand, which is frequently flooded. Higher elevations include areas of vegetation consisting primarily of spreading dogbane and sandbar willow (Figure 4.3-8). Transect 1 includes nine (9) individuals of sandbar willow with a calculated density of 0.01 individuals/ft^2. Sandbar willows identified on the transect occur within the elevation range of 105.7 feet to 105.9 feet. Figure 4.3-9 shows the surveyed elevations as well as the simulated median WSEL based on the below Montague USGS Gage model. The range of occurrence of the sandbar willow is shown along the transect line as a green highlight. Four additional sandbar willow individuals where located within the area, but do not occur on the established transect. These additional individuals occur at elevations ranging from 104.0 feet to 105.1 feet; the minimum elevation occupied by the sandbar willow is 104.0 feet. The majority of sandbar willows at Transect 1 occur above the July median flow (9,500 cfs) which corresponds to an elevation of 105.7 feet.

As described earlier, hydraulic modeling data from Study No. 3.2.2 were used to compute elevation duration curves based on hourly simulated WSELs for the period January 1, 2008 to September 30, 2015. In addition, histograms were developed showing the maximum daily WSEL fluctuation on an annual basis and during early spring and part of the growing season. The median WSEL (i.e., 50% exceedance) at Transect 1 varies greatly from the spring through the summer; between April and May, the median WSEL varies by as much as 4.0 feet. The annual median WSEL at Transect 1 is 106.9 feet, which is sufficient to fully inundate the entirety of Transect 1 by approximately 1.0 feet. The April median WSEL is 112.0 feet, which inundates the transect by approximately 6.0 feet. Figure 4.3-10 contains the monthly WSEL duration curves.

As shown in Figure 4.3-11 nearly 70% of the daily changes in WSEL are between 0.6 and 2.2 feet, annually. During April and May, the majority of daily fluctuations range from 0.4 to 1.4 feet (Figure 4.3-12). During every month the majority of daily fluctuations range from 1.0-3.0 feet, but fluctuations of between 2.0 and 3.0 feet are approximately two times as common during the summer months when compared to spring (Table 4.3-7). These larger fluctuations are the result of peaking operations that occur during the low flow period of the summer. For most of the season, large fluctuations (i.e., 3.0 feet or greater) are limited and occur less than 5% of the time, however; during August and September fluctuations greater than 3 feet are more common (9-10%) (Table 4.3-7). Based on the April and May median flows of 33,200 cfs) and 17,900 cfs, respectively it is likely that Transect 1 is inundated during the majority of days in April and May. The peak generation capacity from the Turners Falls Project (Cabot Station and Station No. 1) is (15,938 cfs) above the annual median flow (13,300 cfs) and the resulting annual median WSEL of 106.9 feet fully inundates Transect 1. The licensed minimum flow from the Turners Falls Project (1,433 cfs), while not shown on Figure 4.3-9, would be lower than the September median (4,800 cfs), and most or all of Transect 1 would be exposed during low or minimum flow scenarios even with inflow from the Deerfield River and other tributaries.

Transect 2 (Sandbar willow) – Below Montague USGS Gage Model Reach

A single transect, Transect 2, was established on the upstream end of Second Island. The transect bisects the upstream tip of the island and is 433.0 feet in length. The substrate for the entire transect is dominated by cobble, gravel, and sand, which is frequently flooded. Higher elevations include areas of vegetation consisting of several species including big bluestem, spreading dogbane, and sandbar willow (Figure 4.3-13). Transect 2 includes 55 individuals of sandbar willow with a calculated density of 0.04 individuals/ft². Sandbar willows identified on the transect occur within the elevation range of 106.4 feet to 108.6 feet. Figure 4.3-14 shows the surveyed elevations of Transect 2 as well as the median WSELs based on the below Montague USGS Gage model. The range of occurrence of the sandbar willow is shown along the transect line as a green highlight. Three additional sandbar willow individuals were located within the area, but do not occur on the established transect. These additional individuals occur at elevations ranging from 106.0 feet to 111.0 feet. The minimum elevation occupied by the sandbar willow is 106.0 feet. All identified sandbar willows at Transect 2 occur above the July median flow (9,500 cfs) which corresponds to an elevation of 105.8 feet.

Figure 4.3-15 contains the monthly elevation duration, derived from modeling from Study No 3.2.2. The median WSEL (i.e., 50% exceedance) varies greatly from the spring through the summer. Similar to Transect 1, the median WSEL changes as much as 4.0 feet from April to May. The annual median WSEL is 106.9 feet, which is nearly enough to fully inundate the entirety of Transect 2. The April median WSEL is 112.0 feet which inundates the transect by approximately 3.4 feet.

As shown in Figure 4.3-16, the majority of the daily changes in WSEL are between 0.4 and 2.6 feet, annually. During April and May, the majority of daily fluctuations range from 0.4 to 1.6 feet (Figure 4.3-17). During every month, the majority of daily fluctuations range from 1.0-3.0 feet, but fluctuations of between 2.0 and 3.0 feet are approximately two times as common during the summer months when compared to the spring (Table 4.3-8). These larger fluctuations are the result of peaking operations that occur during the low flow period of the summer. For most of the season, large fluctuations (i.e., 3.0 feet or greater) are limited and occur less than 5% of the time; however, during August and September fluctuations greater than 3 feet are more common (10%) (Table 4.3-8). Based on the April median flow (33,200 cfs) and May median flow (17,900 cfs), it is likely that Transect 2 is inundated during the majority of the days in April. The peak generation capacity from the Turners Falls Project (Cabot Station and Station No. 1) is (15,938 cfs) above the annual median flow (13,300 cfs) and the resulting annual median WSEL of 106.9 feet inundates much of the transect. The licensed minimum flow from the Turners Falls Project (1,433 cfs), while not shown on Figure 4.3-14, would be lower than the September median (4,800 cfs), and most or all of Transect 2 would be exposed during low or minimum flow scenarios even with inflow from the Deerfield River and other tributaries.

Transect 3 (Sandbar Cherry) - Montague USGS Gage Hydraulic Model Reach

A single transect, Transect 3, was established on the upstream end of Fourth Island which is south of the confluence with the Deerfield River. The transect bisects the upstream tip of the island and is 332.0 feet in length. The substrate for the entire transect is dominated by cobble, gravel, and sand, which is frequently flooded. Compared to First and Second Island, the habitat here is more varied with channels and hummocks created by high water events. Higher elevations include areas of vegetation consisting of several species, including big bluestem, spreading dogbane, and black swallowwort (Figure 4.3-18). Lower elevations in the "pits" often is dominated by areas of exposed sand and generally less vegetated cover. Transect 3 includes 129 individuals of sandbar cherry with a calculated density of 0.12 individuals/ft². The sandbar cherries identified on the transect occurred within the elevation range of 114.7 feet and 118.5 feet. Figure 4.3-19 shows the surveyed elevations of Transect 3 as well as the median WSELs based on the Montague

USGS Gage hydraulic model. The range of occurrence of the sandbar cherry is shown along the transect line as green highlights. The minimum elevation occupied by the cherry was 114.7 feet.

In addition, a small population of sandbar willow was identified at the upstream tip of Fourth Island. A transect was not completed within this population; however, elevation data were collected. The small stand has an estimated density of 0.9-3.7 individuals/ft² and occurs within a small depression. Elevations here are lower than those observed at Transect 3 and range from 110.7 feet to 113.5 feet.

Figure 4.3-20 contains the monthly elevation duration curves. The median WSEL (i.e., 50% exceedance) varies greatly from the spring through the summer. Similar to Transect 1 and 2, the median WSEL changes approximately 3.5 feet from April to May. The annual median WSEL is 110.6 feet, which, unlike Transect 1 and 2, leaves much of the transect exposed. The April median WSEL is 115.6 feet, which inundates all but the highest portion of the terrace. It is important to note that nearly all of the sandbar cherries identified on Transect 3 occur above not only the annual median WSEL (110.6 feet), but also the April median WSEL (115.6 feet). In contrast, the sandbar willow population, which occurs off of Transect 3, located on Fourth Island occurs from 110.7 to 113.5 feet which is below the April median WSEL. Similarly to Transect 1 and 2 the sandbar willow near Transect 3 occur slightly above the July median WSEL (109.3 feet).

As shown in Figure 4.3-21, the majority of the daily changes in WSEL are between 0.6 and 3.6 feet, annually. During April and May, the majority of daily fluctuations range from 0.4 to 1.8 feet (Figure 4.3-22). During every month, the majority of daily fluctuations range from 1.0-3.0 feet, but fluctuations of between 2.0 and 3.0 feet are approximately one and a half times as common during the summer months when compared to the spring (Table 4.3-9). These larger fluctuations are the result of peaking operations that occur during the low flow period of the summer. For all seasons, except April, large fluctuations (i.e., 3.0 feet or greater) occur over 40% of the time. Only in April are WSEL variations smaller, but fluctuations greater than 3.0 feet or more still occur 12% of the time. During July through September, fluctuations greater than 3 feet are much more common than at either Transect 1 or Transect 2 (43-49%) (Table 4.3-9). Based on the April median flow (33,100 cfs) and May median flow (17,900 cfs) it is likely that only the highest elevations, greater than 115.9 and 110.6 feet, of Transect 3 are exposed the majority of the days in April. The peak generation capacity from the Turners Falls Project (Cabot Station and Station No. 1) is (15,938 cfs) above the annual median flow (13,300 cfs) and the resulting annual median WSEL of elevation 110.6 feet, inundates only portions of the transect which are not occupied by sandbar cherry. The licensed minimum flow from the Turners Falls Project (1,433 cfs), while not shown on Figure 4.3-19, would be lower than the September median (4,400 cfs), and likely all of Transect 3 would be exposed during low or minimum flow scenarios even with inflow from the Deerfield River and other tributaries.

Transect 4 (Tradescant's Aster) - Montague USGS Gage Hydraulic Model Reach

A single transect, Transect 4, was established on a bedrock outcrop just south of the confluence with the Deerfield River. The transect runs north to south and is 107.0 feet in length. The substrate for the entire transect is dominated by bedrock that is frequently flooded. Vegetation here is limited due to the lack of substrate, and identified asters are located within small cracks and fissures in the bedrock (Figure 4.3-23). Transect 4 includes 34 individuals of Tradescant's aster, with a calculated density of 0.10 individuals/ft². The Tradescant's asters identified on the transect occur within the elevation range of 109.9 feet to 112.4 feet. Figures 4.3-24 shows the surveyed elevations of Transect 4 as well as the median WSEL based on the below Montague USGS Gage model. The range of occurrence of Tradescant's aster is shown along the transect line as a green highlight. The minimum elevation occupied by Tradescant's aster was 109.9 feet. All Tradescant's asters identified at Transect 4 occur below the WSEL for the April median (33,100 cfs) and the annual median (13,500 cfs) flows.

Figure 4.3-25 contains the monthly elevation duration curves. The median WSEL (i.e., 50% exceedance) varies greatly from the spring through the summer. The median WSEL changes 3.0 feet from April to May and by as much as 4.8 feet from April to June. The annual median WSEL is 112.8 feet, which is enough to fully inundate the entirety of Transect 4. The April median WSEL is 117.7 feet which inundates the transect location by approximately 5.3 feet.

As shown in Figure 4.3-26, the majority of the daily changes in WSEL are between 0.6 and 4.6 feet, annually. During April and May, the majority of daily fluctuations range from 0.4 to 1.8 feet (Figure 4.3-27). During most of the year the majority of daily fluctuations range from 0.0-3.0 feet, but fluctuations of between 2.0 and 3.0 feet are much more common during the summer months when compared to the spring (Table 4.3-10). These larger fluctuations are the result of peaking operations that occur during the low flow period of the summer. Unlike Transects 1, 2, but similar to Transect 3, large fluctuations (i.e., 3.0 feet or greater) are common, outside the months of April and May, and occur as much as 53-64% of the time during July through September (Table 4.3-10). Based on the April and May median flows of 33,100 cfs and 17,900 cfs, respectively it is likely that all of Transect 4 is inundated for the majority of the days in April, May, and much of June (Figure 4.3-24) . The peak generation capacity from the Turners Falls Project (Cabot Station and Station No. 1) is (15,938 cfs) above the annual median flow (13,300 cfs) and the resulting annual median WSEL of elevation 112.8 feet, inundates the entire transect. The licensed minimum flow from the Turners Falls Project (1,433 cfs), while not shown on Figure 4.3-24, would be lower than the September median (4,400 cfs), and likely all of Transect 4 would be exposed during low or minimum flow scenarios even with inflow from the Deerfield River and other tributaries.

Reach: Bypass- Transect T-3 from Reach 2 of the IFIM Hydraulic Model

Bypass Reach (IFIM Transect T-3)

In 2014, survey-detailed elevation data were collected within the bypass reach in support of Study No. 3.3.2 *Instream Flow Studies in Bypass Channel and below Cabot Station*. The Instream Flow Incremental Methodology (IFIM) survey transects bisected several polygons of rare species within the bypass. In addition, demonstration flows were released at the Turners Falls Dam in November 2015 to evaluate aquatic habitat in the reach between the Turners Falls Dam and just upstream of the Station No. 1 tailrace. During the field work, Kleinschmidt and Steve Johnson of NEE were in the field to observe how the various flow releases could potentially impact RTE plant species immediately below the spillway and within the bypass. Figure 4.3-1 shows the location of the established IFIM survey transect (Transect T-3) that was used to identify elevation ranges of Tradescant's aster within the bypass reach. Note that Transect T-3 is technically located within Reach 2 of the IFIM study. Currently, a continuous minimum flow of 200 cfs is maintained in the bypass reach starting on May 1st and increases to 400 cfs when fish passage season starts. The 400 cfs is then provided through July 15th, unless the upstream fish passage season concludes earlier in which case the 400 cfs is reduced to 120 cfs to protect shortnose sturgeon. The 120 cfs is provided in the bypass from the date the fishways are closed until the river temp drops to 7ºC (usually by Nov 15). Based on the hydraulic model developed for the Reach 2 IFIM study, four flows were modeled to determine the potential changes in WSEL in relation to the transect. Flows of 150 cfs, 400 cfs, 1,000 cfs, 1,200 cfs, 1,500 cfs, and 2,500 cfs were simulated in the Reach 2 hydraulic model to predict WSELs at IFIM Transect 3. Table 4.3-7 includes the predicted WSELs for the various flows listed above as well as others analyzed as part of the study.

Transect T-3, was used as it is central to the lower portion of the bypass reach and also bisects a large population of Tradescant's aster along the river's western shoreline (river right). The transect is 483.0 feet in length and substrate along the transect is dominated by cobbles, bedrock and boulders (Figure 4.3-28 and Figure 4.3-29). The polygon of mapped Tradescant's asters in this area begins at approximately 18.0 feet from the start of the transect (on river right) and ends at approximately 330 feet, just before reaching the thalweg. Tradescant's asters are present within a large, relatively flat portion of the bypass and the plants occupy openings between cobble and cracks within bedrock. In 2014, the population of the polygon crossed by Transect T-3 is estimated at 1,627 individuals. The population of Tradescant's aster within the entire bypass area is estimated at several thousand. Figure 4.3-30 shows the surveyed elevation transect as well as WSEL predicted using the Reach 2 hydraulic model. The area occupied by the Tradescant's aster is highlighted on the transect line in green. The elevation range for Tradescant's asters along the transect is 118.1 feet to 122.4 feet, which corresponds with the large level area to the west of the main channel. Based on the modeling results, Tradescant's asters occupy areas that are completely or partially inundated during flows ranging from 150 cfs to 10,000 cfs (Table 4.3-11).

In November 2015, demonstration flows of 500 cfs, 1,500 cfs, 2,500 cfs, and 4,000 cfs were observed within the upper bypass reach. Four (4) state-listed plant species occur in this area: mountain alder, sandbar cherry, upland white aster, and Tradescant's aster. Elevations of plants were collected prior to the demonstration flows, and water depths at each demonstration flow were observed in relation to the species within the bypass. As expected, water depth increased with increasing flow; however, increases were not consistent throughout the observation area. Tradescant's aster was typically observed at lower elevations compared to other target species. During the demonstration flow releases, mountain alder, sandbar cherry, and upland white aster were not inundated; however, Tradescant's aster was inundated at some level during all demonstration flows. Depth of inundation ranged from 1.0 inch to a maximum of 30.5 inches (NEE, 2016).

Reach: Turners Falls Impoundment- Transects 5B, 5A, 6C, 6B, 6A, 11A, 11B, 11C, 11D, 8, 9B, 9A, 10)

Transect 5 (Upland White Aster) - TFI Hydraulic Model

Transects 5A and 5B run in a north to south direction along an exposed bedrock shoreline. Transect 5A and 5B were approximately 15.0 feet and 16.0 feet in length, respectively. (Figure 4.3-1). The substrate at each transect is similar and dominated by exposed bedrock with occasional cobbles. Identified upland white asters are located within small cracks and crevices in the bedrock (Figure 4.3-31 and Figure 4.3-32). Both Transect 5A and 5B include five individuals of upland white aster with a calculated density of 0.09 stem/ft². Upland white asters identified on the transects occurred within the elevation range of 183.9 feet to 185.9 feet. Figures 4.3-33 and 4.3-34 show the surveyed elevations at each transect as well as the median WSEL based on the TFI hydraulic model. The range of occurrence of the upland white aster is shown along the transect lines as green highlights. Nine (9) additional individuals are located within the area, but do not occur on established transects. These additional individuals occur at elevations ranging from 182.6 feet to 184.8 feet; the minimum elevation occupied by the upland white aster is 182.6 feet. All upland white asters identified at the Transect 5 location are above the April and annual median WSELs of 181.7 feet.

Figure 4.3-35 contains the monthly elevation duration curves for Transect 5A. In general, the annual median WSEL of 181.7 feet (i.e., 50% exceedance) at the Transect 5 location is similar annually as well as throughout the growing season. During the growing season, the median WSEL changes within one to two hundredths of a foot. The April median WSEL is 181.7 feet. The relatively similar monthly median WSELs in this location are the result of the operations at the Turners Falls Dam as compared to the more riverine hydraulic characteristics of the TFI under higher flows conditions upstream of French King Gorge as discussed in Study No. 3.2.2 *Hydraulic Study of Turners Falls Impoundment, Bypass Reach and below Cabot.*

As shown in Figure 4.3-36, the majority of the daily changes in WSEL are between 1.0 and 3.4 feet, annually. During April and May, the majority of daily fluctuations range from 0.8 to 2.2 feet (Figure 4.3-37). During most of the year, the majority of daily fluctuations range from 1.0-3.0 feet, and fluctuations of 3.0 feet or greater are more common during the summer months (July and August) when compared to the spring (Table 4.3-12). These larger fluctuations are the result of Northfield Mountain pumping and generation cycles and Vernon peaking operations that effect the WSEL to a larger extent during low flow periods. During April, the majority of Transect 5A and 5B remains exposed and all identified upland white asters occur above the April median WSEL (Figure 4.3-33 and Figure 4.3-34).

Transect 6 (Upland White Aster) - TFI Hydraulic Model

Transects 6A, 6B, and 6C run in an east to west direction on an exposed bedrock shelf along the shoreline (Figure 4.3-1). The area of suitable habitat (i.e., exposed bedrock) is limited, as the bank quickly transitions to upland forest; therefore, several short transects were established within the occupied and un-occupied habitat. Transect 6A, 6B, and 6C are 8.0 feet, 11.0 feet, and 6.0 feet in length, respectively. As at Transect 5, identified upland white asters are located within small cracks and crevices in the bedrock (Figure 4.3-38). Transect 6A includes four individuals of upland white aster for a calculated density of 0.12 individuals/ft². Transect 6B includes 10 individuals of upland white aster for a calculated density of 0.23 individuals/ft². Transect 6C includes three individuals of upland white aster for a calculated density of 0.09 individuals/ft². Upland white asters identified on the transects occur within the elevation range of 184.2 feet to 187.6 feet. Figures 4.3-39, 4.3-40 and 4.3-41 show the surveyed elevations at each transect as well as the median WSEL based on the TFI hydraulic model. The elevation range of occurrence of the upland white aster is shown along the transect line as a green highlight. Eleven (11) additional individuals are located within the area, but do not occur on established transects. These additional individuals occur at elevations ranging from 181.6 feet to 184.5 feet; the minimum elevation occupied by the aster is 181.6 feet. In all cases, but one, the upland white asters located at Transect 6A, 6B, and 6D occur above the April median WSEL (182.0 feet) and the annual median WSEL (181.7 feet).

Figure 4.3-42 contains the monthly elevation duration curves developed for the Transect 6 location. In general, the median annual WSEL (181.7 feet) is similar to growing season median WSEL (varying by a few tenths of a foot). The April median WSEL is 182.0 feet. The relatively similar monthly median WSELs in this location are the result of the operations at the Turners Falls Dam as compared to the more riverine hydraulic characteristics of the TFI under higher flows conditions upstream of French King Gorge as discussed in Study No. 3.2.2 *Hydraulic Study of Turners Falls Impoundment, Bypass Reach and below Cabot.*

As shown in Figure 4.3-43 majority of the daily changes in WSEL are between 1.0 and 3.4 feet, annually. During April and May, the majority of daily fluctuations range from 0.6 to 2.4 feet (Figure 4.3-44). During most of the year the majority of daily fluctuations range from 1.0-3.0 feet, and fluctuations of 3.0 feet or greater are more common during the months of July and August when compared to the spring (Table 4.3-13). These larger fluctuations are the result of Northfield Mountain pumping and generation cycles and Vernon peaking operations that effect the WSEL to a larger extent during low flow period. During April, the majority or all of Transect 6A, 6B, and 6C remain exposed and all identified upland white asters on the transects occur above the April median WSEL (Figure 4.3-39, Figure 4.3-40 and Figure 4.3-41).

Transect 11A-11D (Intermediate Spike Sedge) - TFI Hydraulic Model

No rare spike sedges were identified at any of the transects established in 2015, but one clump of blunt spikerush (*Eleocharis obtusa)* was identified in 2014 in the area near Transect 11A. This clump was not located during the survey work completed in 2015, but transects were established in habitat similar to the location found in 2014. In 2015, Frank's lovegrass (*Eragrostis frankii*), a Special Concern Species in Massachusetts, was identified at Transect 11D.

Transect 11A, 11B, 11C, and 11D run in an east to west direction and bisect a portion of exposed shoreline and adjacent flood terrace near Pauchaug Boat Launch (Figure 4.3-1). The transects occur in an area transitioning from a silty flat to an area of alluvial deposits and vegetation at the higher elevations (Figure 4.3-45). The area of suitable sedge habitat is primarily within the short transition area from silt to the vegetated shoreline. Transect 11A, 11B, 11C and 11D are approximately 37.0, 30.0, 35.0, and 27.0 feet in length, respectively. The elevation ranges of the transects are 181.5 feet to 187.9 feet. Figures 4.3-46, Figure 4.3-47, Figure 4.3-48, and Figure 4.3-49 show the surveyed elevations along Transect 11A, 11B, 11C, and 11D as well as the annual and spring median WSELs based on the TFI hydraulic model. Frank's love grass was not included on the Transect figure (Figure 4.3-49) as the transect focus was the spike sedge, and Frank's love grass was not included in the original request for additional information.

The median WSEL varies only one to two hundredths during most of the growing season. The largest change from month to month is the median WSEL for April (185.17 feet) to May (183.4 feet) which represents a change of 1.8 feet. Figure 4.3-50 contains the monthly elevation duration curves for the Transect 11 location. The annual median WSEL (i.e., 50% exceedance) is 182.7 feet. The April and May median WSEL is 185.2 and 183.4 feet, respectively.

As shown in Figure 4.3-51 majority of the daily changes in WSEL are between 0.8 and 3.2 feet, annually. During April and May, the majority of daily fluctuations range from 0.8 to 2.2 feet (Figure 4.3-52). During most of the year the majority of daily fluctuations range from 1.0-3.0 feet, and fluctuations of 3.0 feet or greater are more common during the summer months of July and August when compared to the spring (Table 4.3-14). These larger fluctuations are the result of Northfield Mountain pumping and generation cycles and Vernon peaking operations that effect the WSEL to a larger extent during low flow period. While no spike sedges were observed on transect 11A, 11B, 11C, or 11D in 2015, the location of the blunt spikerush, which has similar habitat requirements as the intermediate spike sedge, was found in the transition zone from silt to vegetation near Transect 11A. This location would likely correspond to an elevation of approximately 183.0 to 184.0 feet. This elevation would fall below the April median WSEL (185.2 feet), but likely above the annual median WSEL (182.7 feet).

Transect 8 (Sandbar Cherry) – TFI Hydraulic Model

Transect 8 (Figure 4.3-1) runs in an east to west direction across Stebbins Island located below Vernon Dam. The area of suitable occupied and unoccupied sandbar cherry habitat includes a vegetated meadow consisting of primarily alluvial deposited materials (i.e., sands and gravel). Transect 8 is 197.0 feet in length (Figure 4.3-53), and includes 81 individuals of cherry with a calculated density of 0.13 individuals/ft². Sandbar cherries identified on the transect occur within the elevation range of 188.2 feet and 190.4 feet. Figure 4.3-54 show the surveyed elevations along Transect 8 as well as the median annual and monthly (April through September) WSELs based on the TFI hydraulic model. The range of occurrence of the sandbar cherry is shown along the transect line as a green highlight. All identified sandbar cherries on Transect 8 occur above the median April WSEL (188.0 feet).

Figure 4.3-55 contains the elevation duration curves. In general, the median annual WSEL (183.9 feet) at Transect 8 location is similar to the median monthly elevations during the growing season. The median WSEL in April, May, June, July, August and September are 188.0, 185.4, 184.2, 183.3, 183.1, and 182.8 feet, respectively.

As shown in Figure 4.3-56, the majority of the daily changes in WSEL are between 1.0 and 2.8 feet, annually. During April and May, the majority of daily fluctuations range from 0.4 to 1.6 feet (Figure 4.3-57). During all of the year, the majority of daily fluctuations range from 1.0-3.0 feet, and fluctuations of 3.0 feet or greater are more common during the summer months of July and August when compared to the spring (Table 4.3-15). From April through June, the majority (60-78% of the time) of daily water fluctuations are between 0.0 and 2.0 feet. Periods with more common elevation changes of 3.0 feet or greater are most common in late summer and early fall with August, September, and October leading the year with 23-26% of the time (Table 4.3-15). These larger fluctuations are the result of Northfield Mountain pumping and generation cycles and Vernon peaking operations that effect the WSEL to a larger extent during low flow period.

Transect 9 (Sandbar Cherry) - TFI Hydraulic Model

Transect 9A and 9B run in an east to west direction across a small island downstream of Vernon Dam (Figure 4.3-1). The island is small enough that both transects completely bisect the island. The transects occur in an area transitioning from cobble and gravel to an area of vegetated sand on higher elevations. The area of suitable occupied and unoccupied sandbar cherry habitat was primarily within the transition from cobbles to sand and vegetation (Figure 4.3-58). Transect 9A and 9B are 50.2 feet and 38.0 feet in length, respectively. Transect 9A includes a single stem of sandbar cherry with a calculated density of 9.3^{-4} individuals/ft², and Transect 9B includes three individuals with a calculated density of 0.03 individuals/ft². Sandbar cherries identified on the transects occur within the elevation range of 187.4 feet to 188.4 feet. Figures 4.3-59 and Figure 4.3-60 show the surveyed elevations along Transect 9A and B as well as the median WSEL annually and for April through July based on the TFI hydraulic model. The range of occurrence of the sandbar cherry is shown along the transect line as a green highlight. All sandbar cherries identified on Transect 9A and 9B occur below the April median WSEL (189.2 feet), but above the annual median WSEL (184.6 feet).

Figure 4.3-61 contains the monthly elevation duration curves. The annual median WSEL (i.e., 50% exceedance) is 184.6 feet. During the growing season, the median WSEL changes are more pronounced from month to month. The median WSEL in April, May, June, July, August and September from the TFI hydraulic model are 189.2, 186.4, 185.0, 183.8, 183.4, and 183.0 feet, respectively.

As shown in Figure 4.3-62, the majority of the daily changes in WSEL are between 1.0 and 3.0 feet, annually. During April and May, the majority of daily fluctuations range from 0.6 to 1.8 feet (Figure 4.3-63). During all of the year, the majority of daily fluctuations range from 1.0-3.0 feet, and fluctuations of 3.0 feet or greater are more common during the summer months (July and August) when compared to the spring (Table 4.3-16). From April through June, the majority (50-73% of the time) of daily water fluctuations are between 0.0 and 2.0 feet. Periods with more common elevation changes of 3.0 feet or greater are most common in late summer and early fall with August, September, and October having daily changes 3.0 feet or greater 33-35% of the time (Table 4.3-16). These larger fluctuations are the result of Northfield Mountain pumping and generation cycles and Vernon peaking operations that effect the WSEL to a larger extent during low flow period.

Transect 10 (Mountain Alder and Sandbar Willow) - TFI Hydraulic Model

Transect 10 is located just downstream of Vernon Dam (Figure 4.3-1) and includes both sandbar willow and mountain alder. The substrate at this transect is dominated by exposed ledges, large cobbles, and bedrock (Figure 4.3-64). The transect extends 44.0 feet in a southerly direction from the water's edge up a boulder and cobble dominated hillslope.

Mountain alder was identified at Transect 10 (shown in green on Figure 4.3-65), growing at an elevation between 197.7 and 197.0 feet. In addition, several individuals of mountain alder are located near Transect 10, at elevations ranging from 193.4 feet to 199.5 feet. Density for the surveyed population was calculated as 0.007 individuals/ft² with one individual identified in a single plot. In addition, two plants were identified on a rocky outcrop near the transmission line upstream from Stebbins Island and were surveyed at elevation 191.4 feet and 191.7 feet. The minimum elevation observed for mountain alder at Transect 10 is 193.4 feet. All mountain alders identified on the transect occur above the April median WSEL; the lowest mountain alder (193.4 feet) is 4.2 feet above the April median WSEL (189.2 feet).

Sandbar willow occupies an elevation range of 184.9 feet to 191.0 feet. The area highlighted in orange in Figure 4.3-65 shows the location of the ten (10) sandbar willows identified along the transect. Density of sandbar willow was calculated at 0.07 individuals/ft². In addition, several sandbar willows were observed away from the transect with the minimum elevation recorded at 184.3 feet. In some cases, sandbar willow was observed within inundated areas during the survey in 2015. Sandbar willow occurs on the transect primarily below the April median WSEL of 189.2 feet.

Figure 4.3-66 shows the annual and monthly elevation duration curves. The annual median WSEL is 184.6 feet and the median elevation during the growing season ranges from 189.2 feet in April to 183.0 feet in September.

As shown in Figure 4.3-67, the majority of the daily changes in WSEL are between 1.0 and 3.0 feet, annually. During April and May, the majority of daily fluctuations range from 0.6 to 1.8 feet (Figure 4.3-68). During all of the year, the majority of daily fluctuations range from 1.0-3.0 feet, and fluctuations of 3.0 feet or greater are more common during the summer months (July and August) when compared to the spring (Table 4.3-17). From April through June, the majority (50-73% of the time) of daily water fluctuations are between 0.0 and 2.0 feet. Periods with more common elevation changes of 3.0 feet or greater are most common in late summer and early fall with August, September, and October having daily changes 3.0 feet or greater 33-35% of the time (Table 4.3-17). These larger fluctuations are the result of Northfield Mountain pumping and generation cycles and Vernon peaking operations that effect the WSEL to a larger extent during low flow period.

Table 4.3-1: Botanical Species Associated with Mountain Alder

Scientific Name	Common Name
Acer rubrum	Red Maple
Alnus rugosa	Speckled Alder
Alnus serrulata	Smooth Alder
Apocynum androsaemifolium	Spreading Dogbane
Betula alleghaniensis	Yellow Birch
Campanula rotundifolia	Bluebell
Hamamelis virginiana	Witch Hazel
Kalmia latifolia	Mountain Laurel
Lythrum salicaria	Purple Loosestrife
Myositis scorpioides	Forget-me-not
Myrica gale	Sweet gale
Oclemena acuminata	Whorled Wood Aster
Oligoneuron album	Upland White Aster
Panicum vargatum	Switchgrass
Pinus resinosa	Red Pine
Platanus occidentalis	Sycamore
Populus deltoides	Cottonwood
Quercus ilicifolia	Scrub Oak
Schizachyrium scoparium	Little Bluestem
Symphyotrichum tradescantii	Tradescant's Aster
Tsuga canadensis	Eastern Hemlock
Ulmus sp.	Elm
Vaccinium angustifolium	Low-bush Blueberry

Table 4.3-2: Botanical Species Associated with Intermediate Spike Sedge

Scientific Name	Common Name
Acer saccharinum	Silver Maple
Eleocharis obtusa	Blunt Spikerush
Eleocharis palustris	Common Spikerush
Eutrochium purpureum	Joe-pye weed
Galium spp.	Bedstraw
Impatiens capensis	Spotted Jewelweed
Lobelia cardinalis	Cardinal Flower
Mimulus ringens	Monkey Flower
Nasturtium officinale	Watercress
Onoclea sensibilis	Sensitive Fern
Pilea pumila	Clearweed
Scirpus cyperinus	Woolgrass
Xanthium strumarium	Rough Cocklebur

Table 4.3-3: Botanical Species Associated with Upland White Aster

Scientific Name	Common Name
Andropogon gerardii	Big Bluestem
Apocynum androsaemifolium	Spreading Dogbane
Campanula rotundifolia	Harebell
Cyperus esculentus	Yellow Nutsedge
Doellingeria umbellata	Flat-top White Aster
Eutrochium purpureum	Joe-pye weed
Lythrum salicaria	Purple Loosestrife
Micranthes virginiensis	Early Saxifrage
Mimulus ringens	Monkey Flower
Polygonum spp.	Smartweed
Prunus pumila var. depressa	Sandbar Cherry
Schizachyrium scoparium	Little Bluestem
Solidago nemoralis	Gray Goldenrod
Symphyotrichum novi-belgii	New York Aster
Symphyotrichum tradescantii	Tradescant's Aster
Xanthium strumarium	Rough Cocklebur

Table 4.3-4: Botanical Species Associated with Sandbar Cherry

Scientific Name	Common Name
Alnus viridis ssp. crispa	Mountain Alder
Andropogon gerardii	Big Bluestem
Apocynum androsaemifolium	Spreading Dogbane
Doellingeria umbellata	Flat-top White Aster
Oligoneuron album	Upland White Aster
Panicum vargatum	Switchgrass
Platanus occidentalis	Sycamore
Populus deltoides	Cottonwood
Salix exigua	Sandbar Willow
Salix nigra	Black Willow
Sorghastrum nutans	Indian Grass
Symphyotrichum tradescantii	Tradescant's Aster
Xanthium strumarium	Rough Cocklebur

Table 4.3-5: Botanical Species Associated with Sandbar Willow

Scientific Name	Common Name
Andropogon gerardii	Big Bluestem
Apocynum androsaemifolium	Spreading Dogbane
Lythrum salicaria	Purple Loosestrife
Panicum virgatum	Switchgrass
Physostegia virginiana	False Dragonhead
Prunus pumila var. depressa	Sandbar Cherry
Salix nigra	Black Willow
Sorghastrum nutans	Indian Grass
Symphyotrichum tradescantii	Tradescant's Aster
Verbena hastata	Blue Vervain
Xanthium strumarium	Rough Cocklebur

Table 4.3-6: Botanical Species Associated with Tradescant's Aster

Scientific Name	Common Name
Agalinis tenuifolia	Slender Gerardia
Alnus viridis ssp. crispa	Mountain Alder
Andropogon gerardii	Big Bluestem
Apocynum androsaemifolium	Spreading Dogbane
Bidens laevis	Smooth Bur Marigold
Cyperus esculentus	Yellow Nutsedge
Eleocharis obtusa	Blunt Spikerush
Lobelia siphilitica	Great Blue Lobelia
Ludwigia alternifolia	Seed Box
Lythrum salicaria	Purple Loosestrife
Oligoneuron album	Upland White Aster
Panicum vargatum	Switchgrass
Platanus occidentalis	Sycamore
Poaceae	un-identified bunch grass
Populus deltoides	Cottonwood
Prunus pumila var. depressa	Sandbar Cherry
Salix exigua	Sandbar Willow
Schizachyrium scoparium	Little Bluestem
Schoenoplectus smithii	Smith's Club Sedge
Stellaria media	Chickweed
Symphyotrichum novi-belgii	New York Aster
Ulmus sp.	Elm

Table 4.3-7: Daily Change in Elevation and Percent of Days at Transect 1

Daily Change-Elevation Range (Feet)	Percent of days												
	All	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.0 to 1.0	25%	20%	13%	35%	46%	35%	22%	15%	15%	24%	18%	28%	28%
1.0 to 2.0	44%	54%	61%	41%	38%	45%	41%	44%	42%	38%	40%	44%	43%
2.0 to 3.0	25%	24%	24%	19%	13%	17%	28%	34%	33%	29%	33%	23%	21%
3.0 to 4.0	4%	1%	2%	2%	2%	1%	7%	4%	8%	8%	5%	3%	6%
4.0 and greater	2%	1%	0%	2%	1%	2%	2%	2%	2%	1%	4%	1%	2%

Table 4.3-8: Daily Change in Elevation and Percent of Days at Transect 2

Daily Change-Elevation Range (Feet)	Percent of days												
	All	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.0 to 1.0	25%	20%	13%	35%	45%	35%	22%	15%	15%	24%	18%	28%	28%
1.0 to 2.0	44%	52%	61%	42%	38%	44%	41%	45%	41%	38%	41%	44%	43%
2.0 to 3.0	25%	25%	24%	19%	13%	18%	28%	34%	34%	28%	33%	23%	21%
3.0 to 4.0	4%	1%	2%	2%	3%	2%	7%	4%	8%	9%	5%	3%	6%
4.0 and greater	2%	1%	0%	2%	1%	2%	2%	2%	2%	1%	4%	1%	2%

Table 4.3-9: Daily Change in Elevation and Percent of Days at Transect 3

Daily Change-Elevation Range (Feet)	Percent of days												
	All	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.0 to 1.0	14%	7%	5%	22%	29%	23%	12%	8%	7%	13%	11%	12%	15%
1.0 to 2.0	28%	27%	20%	32%	48%	37%	23%	23%	19%	20%	22%	30%	35%
2.0 to 3.0	24%	29%	39%	21%	10%	20%	30%	26%	25%	23%	24%	22%	24%
3.0 to 4.0	21%	28%	30%	20%	7%	13%	23%	23%	26%	24%	24%	23%	14%
4.0 and greater	13%	8%	6%	5%	5%	7%	13%	20%	23%	20%	18%	13%	12%

Table 4.3-10: Daily Change in Elevation and Percent of Days at Transect 4

Daily Change-Elevation Range (Feet)	Percent of days												
	All	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.0 to 1.0	12%	6%	3%	21%	27%	21%	11%	6%	5%	13%	9%	11%	13%
1.0 to 2.0	24%	20%	17%	29%	51%	35%	20%	19%	15%	12%	22%	22%	31%
2.0 to 3.0	18%	24%	22%	12%	8%	15%	21%	22%	17%	17%	20%	21%	22%
3.0 to 4.0	18%	25%	31%	21%	5%	15%	19%	17%	22%	22%	12%	16%	15%
4.0 and greater	27%	26%	27%	17%	10%	15%	29%	36%	42%	38%	37%	30%	19%

Table 4.3-11: Predicted Water Surface Elevations at IFIM Transect T-3 over a Range of Flows

Flow (cfs)	Water Surface Elevation* (Feet) at T-3
150	119
200	119.1
250	119.3
400	119.6
500	119.9
600	120.1
700	120.3
800	120.5
1000	120.8
1200	121.1
1400	121.4
1500	121.5
1600	121.6
1800	121.8
2000	121.9
2500	122.3
3000	122.6
4000	123.2
5000	123.7
6000	124.2
7000	124.6
8000	125.1
9000	125.4
10000	125.8

*WSEL obtained from Reach 2 hydraulic model of the bypass channel.

Table 4.3-12: Daily Change in Elevation and Percent of Days at Transect 5

Daily Change-Elevation Range (Feet)	Percent of days												
	All	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.0 to 1.0	8%	3%	2%	8%	17%	12%	10%	7%	6%	8%	11%	7%	3%
1.0 to 2.0	30%	28%	37%	36%	46%	43%	31%	20%	18%	21%	29%	27%	29%
2.0 to 3.0	36%	41%	42%	35%	25%	28%	36%	38%	38%	36%	33%	42%	38%
3.0 to 4.0	19%	22%	15%	16%	10%	14%	17%	25%	26%	24%	23%	19%	22%
4.0 and greater	6%	6%	4%	5%	3%	3%	5%	10%	11%	11%	5%	5%	7%

Table 4.3-13: Daily Change in Elevation and Percent of Days at Transect 6

Daily Change-Elevation Range (Feet)	Percent of days												
	All	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.0 to 1.0	8%	3%	3%	6%	16%	11%	10%	7%	7%	9%	10%	6%	3%
1.0 to 2.0	31%	29%	38%	37%	47%	44%	32%	21%	17%	21%	29%	27%	29%
2.0 to 3.0	37%	42%	41%	37%	26%	29%	37%	38%	39%	35%	34%	43%	41%
3.0 to 4.0	19%	21%	15%	15%	9%	13%	16%	26%	26%	24%	22%	19%	22%
4.0 and greater	6%	5%	3%	5%	2%	3%	5%	9%	11%	11%	5%	4%	6%

Table 4.3-14: Daily Change in Elevation and Percent of Days at Transect 11

Daily Change-Elevation Range (Feet)	Percent of days												
	All	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.0 to 1.0	9%	5%	5%	10%	17%	18%	8%	8%	7%	8%	7%	7%	6%
1.0 to 2.0	37%	36%	42%	44%	63%	50%	41%	24%	21%	24%	32%	36%	37%
2.0 to 3.0	34%	42%	41%	31%	12%	25%	37%	35%	37%	35%	33%	38%	39%
3.0 to 4.0	15%	15%	10%	11%	5%	7%	11%	25%	25%	23%	20%	16%	14%
4.0 and greater	5%	2%	2%	4%	3%	1%	2%	8%	10%	10%	8%	2%	5%

Table 4.3-15: Daily Change in Elevation and Percent of Days at Transect 8

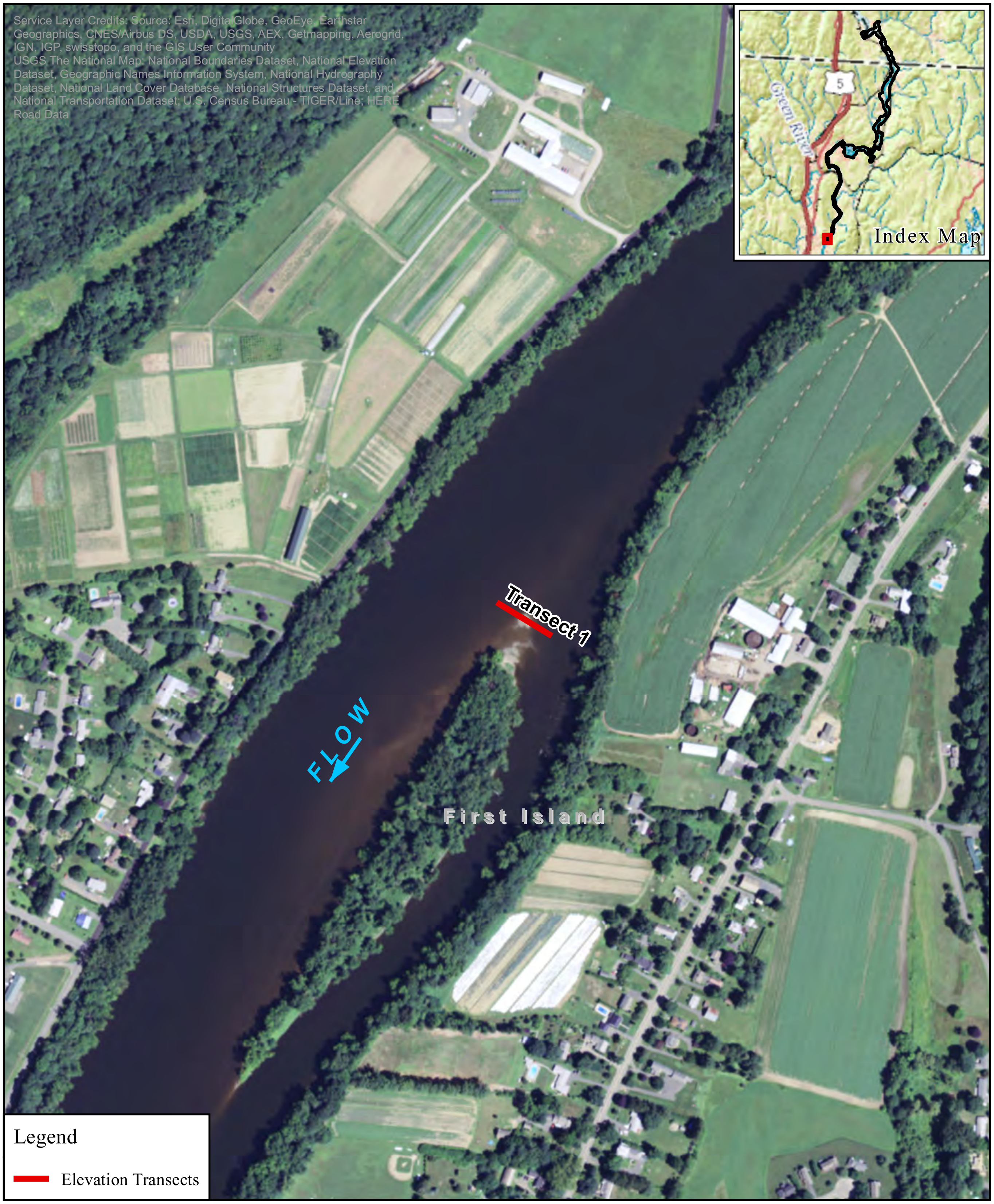
Daily Change-Elevation Range (Feet)	Percent of days												
	All	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.0 to 1.0	15%	10%	11%	19%	34%	27%	17%	8%	7%	10%	8%	15%	13%
1.0 to 2.0	35%	38%	28%	36%	44%	48%	43%	33%	27%	23%	28%	35%	39%
2.0 to 3.0	33%	35%	44%	26%	13%	20%	31%	38%	40%	43%	39%	32%	33%
3.0 to 4.0	14%	15%	17%	16%	6%	4%	8%	17%	21%	20%	20%	16%	12%
4.0 and greater	3%	2%	1%	3%	3%	1%	1%	3%	5%	3%	5%	2%	4%

Table 4.3-16: Daily Change in Elevation and Percent of Days at Transect 9

Daily Change-Elevation Range (Feet)	Percent of days												
	All	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.0 to 1.0	13%	10%	11%	17%	33%	24%	12%	7%	6%	9%	7%	15%	12%
1.0 to 2.0	29%	27%	16%	30%	40%	44%	38%	26%	22%	20%	22%	28%	31%
2.0 to 3.0	29%	30%	34%	22%	14%	21%	28%	33%	37%	38%	37%	27%	32%
3.0 to 4.0	21%	24%	29%	22%	6%	9%	17%	28%	24%	27%	25%	23%	16%
4.0 and greater	8%	9%	10%	10%	7%	3%	5%	6%	11%	6%	10%	8%	8%

Table 4.3-17: Daily Change in Elevation and Percent of Days at Transect 10

Daily Change-Elevation Range (Feet)	Percent of days												
	All	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.0 to 1.0	13%	10%	11%	17%	33%	24%	12%	7%	6%	9%	7%	15%	12%
1.0 to 2.0	29%	27%	16%	30%	40%	44%	38%	26%	22%	20%	22%	28%	31%
2.0 to 3.0	29%	30%	34%	22%	14%	21%	28%	33%	37%	38%	37%	27%	32%
3.0 to 4.0	21%	24%	29%	22%	6%	9%	17%	28%	24%	27%	25%	23%	16%
4.0 and greater	8%	9%	10%	10%	7%	3%	5%	6%	11%	6%	10%	8%	8%



FirstLight GDF SUEZ

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

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

N

0 250 500 1,000 Feet

Figure 4.3-1: Mapping of RTE Plant Species and Survey Transect Locations Map 1

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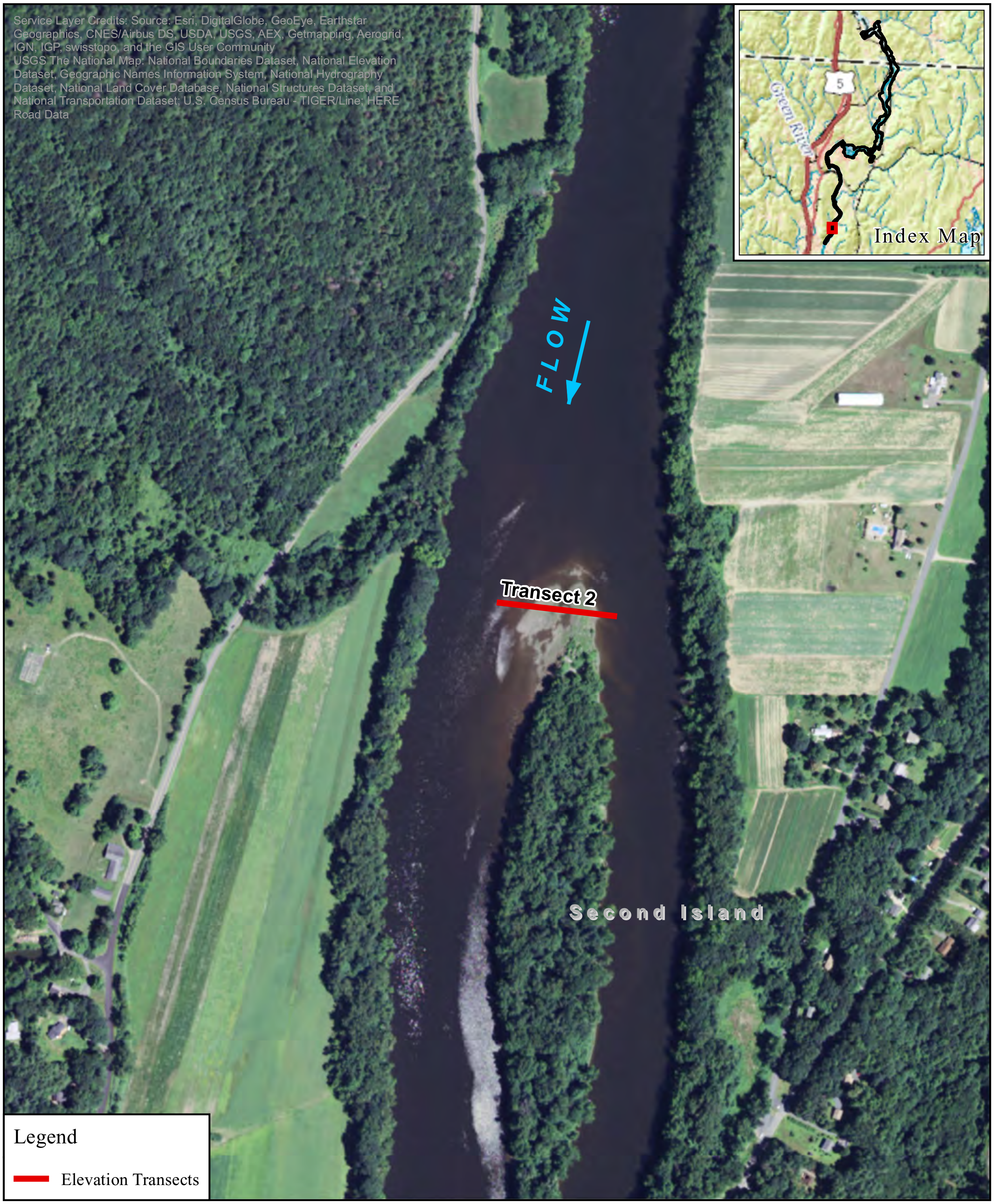

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Northfield Mountain Pumped Storage Project (No. 2485) and Turners Falls Hydroelectric Project (No. 1889)

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

Figure 4.3-1: Mapping of RTE Plant Species and Survey Transect Locations Map 2

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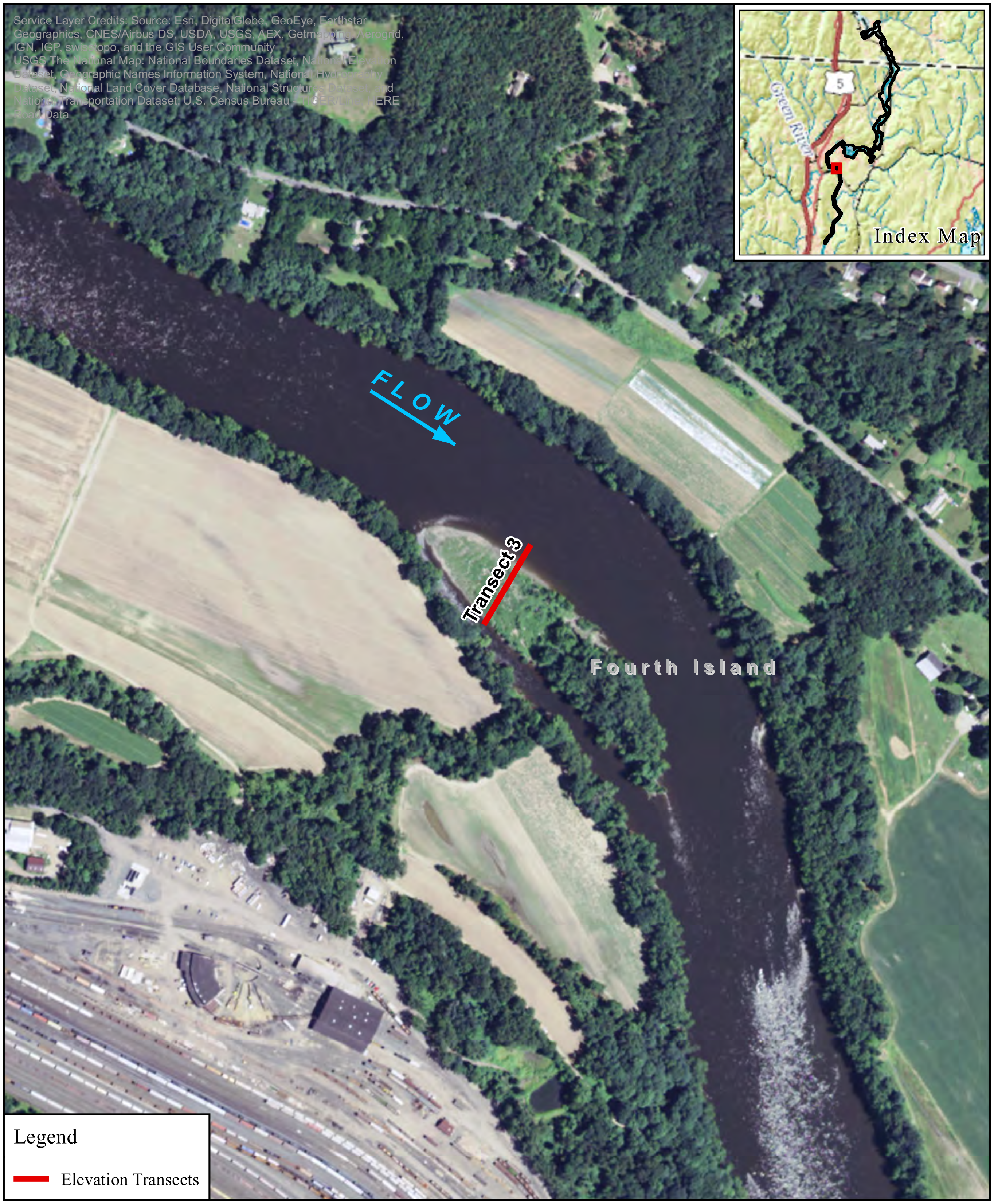

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GDF SUEZ

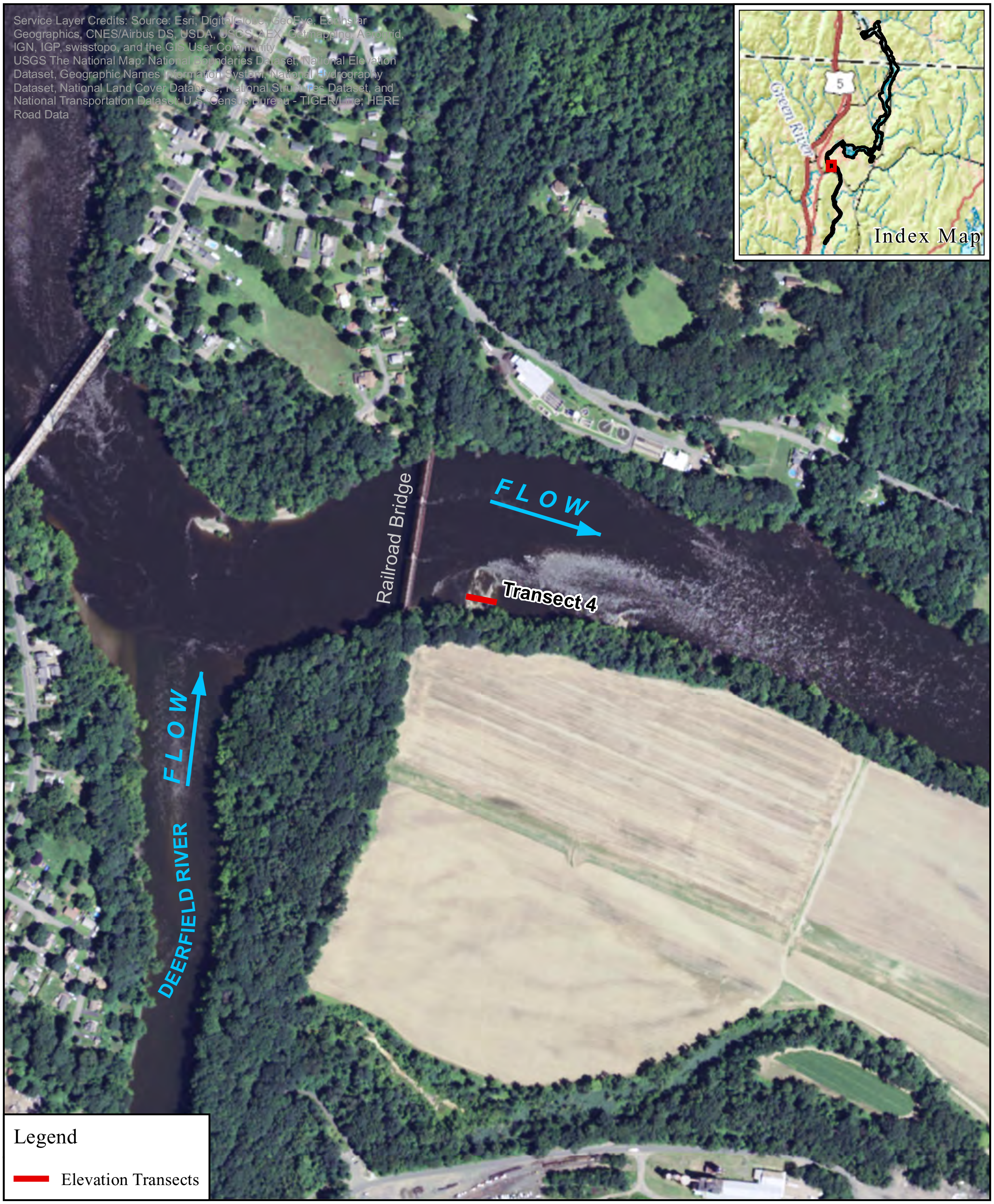
Northfield Mountain Pumped Storage Project (No. 2485)
and Turners Falls Hydroelectric Project (No. 1889)
Study 3.5.1 Baseline Inventory of Wetland, Riparian and Littoral Habitat in the Turners Falls Impoundment and Assessment of Operational Impacts on Special Status Species

N

0 250 500 1,000 Feet

Figure 4.3-1:
Mapping of RTE Plant Species and Survey Transect Locations
Map 3

Path: W:\gis\studies\3_5_1\maps\PUBLIC_Study_3_5_1_RTE_Transect_Figures.mxd



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

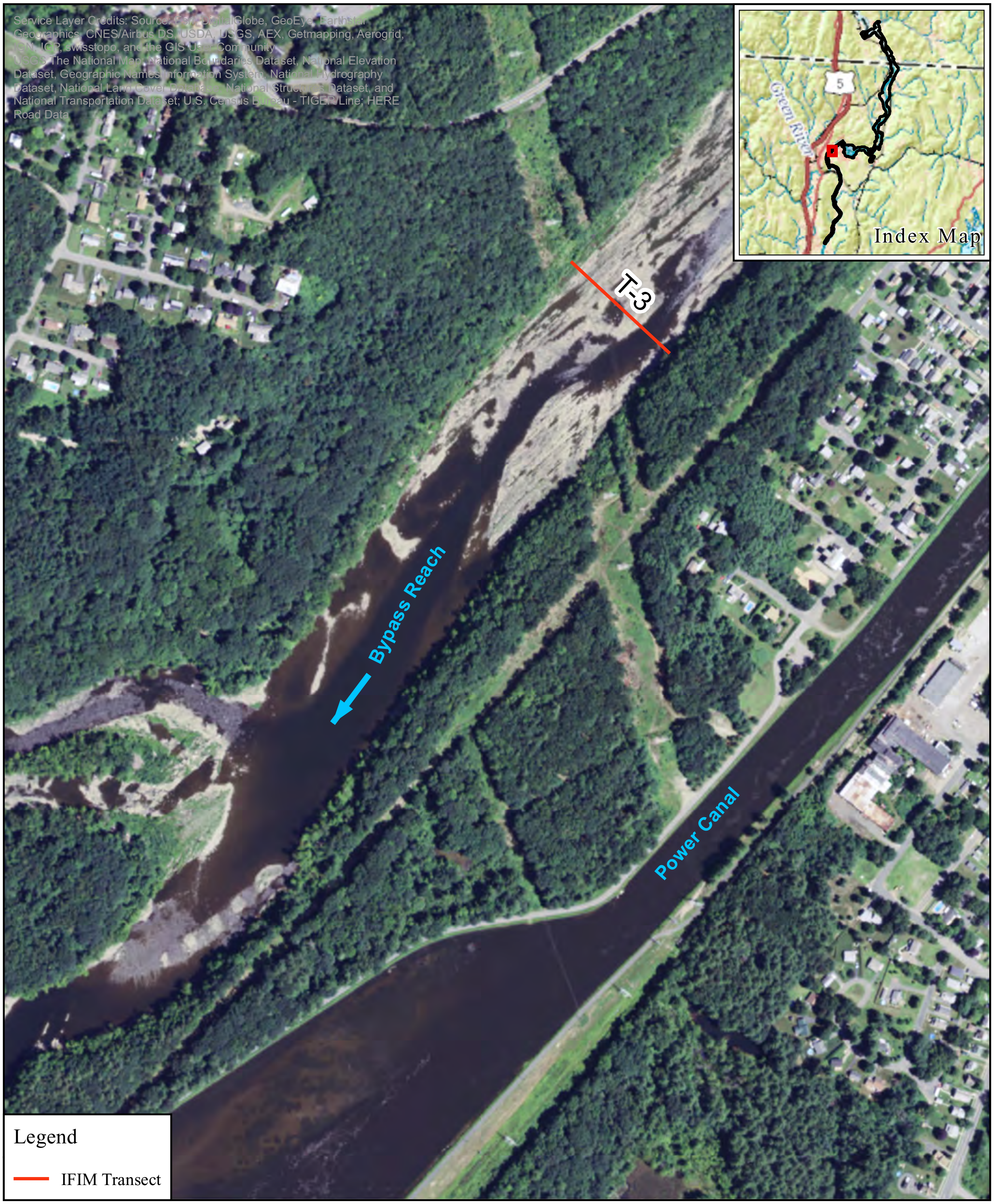
Study 3.5.1 Baseline Inventory of Wetland, Riparian and Littoral Habitat in the Turners Falls Impoundment and Assessment of Operational Impacts on Special Status Species

N

0 250 500 1,000 Feet

Figure 4.3-1:
Mapping of RTE Plant Species and Survey Transect Locations
Map 4

Path: W:\gis\studies\3_5_1\maps\PUBLIC_Study_3_5_1_RTE_Transect_Figures.mxd



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

N

0 250 500 1,000 Feet

Figure 4.3-1:
Mapping of RTE Plant Species and Survey Transect Locations
Map 5

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

N

0 250 500 1,000 Feet

Figure 4.3-1:
Mapping of RTE Plant Species and Survey Transect Locations
Map 6

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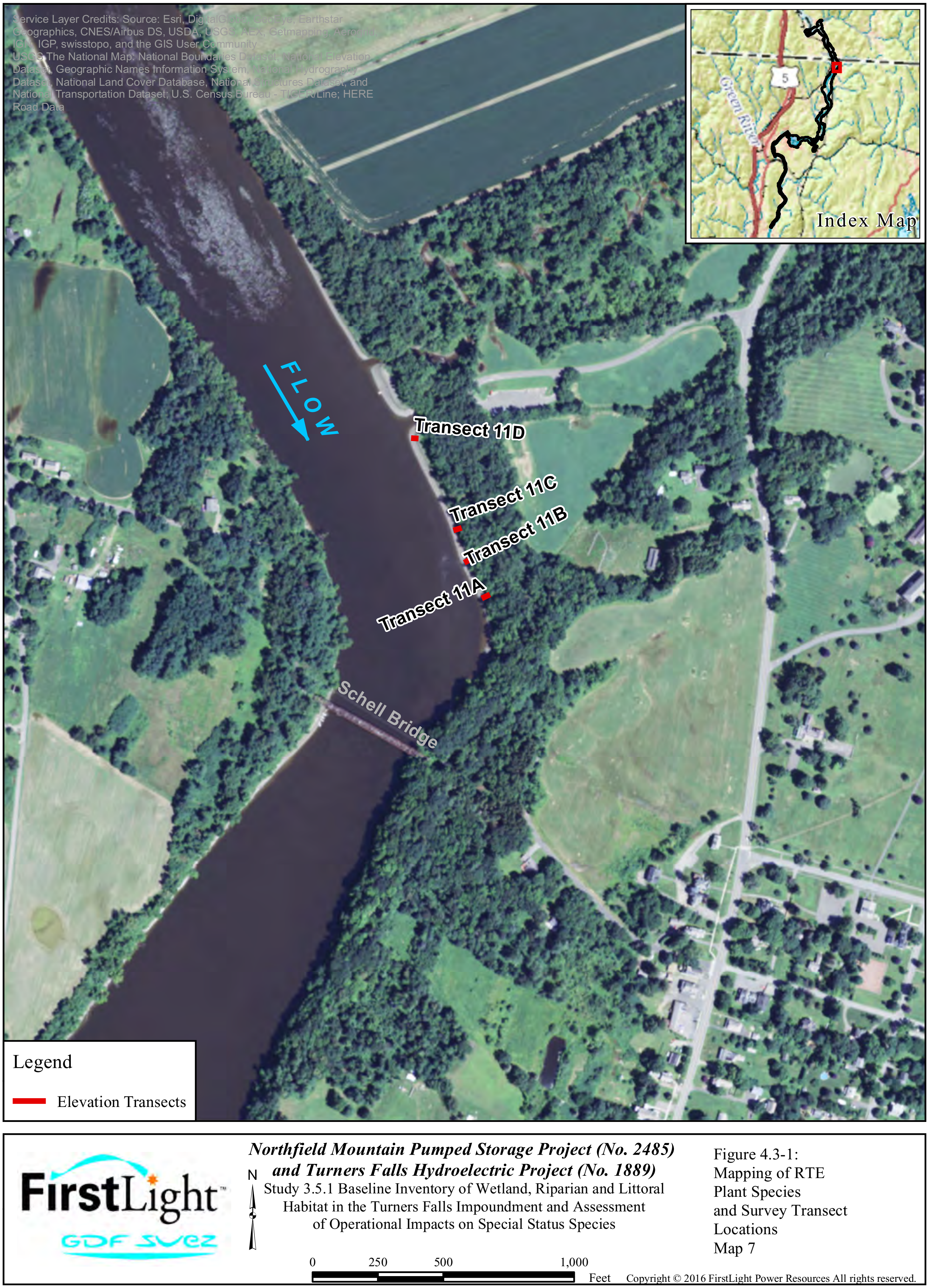

FirstLight GDF SUEZ

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

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

Figure 4.3-1:
Mapping of RTE Plant Species and Survey Transect Locations
Map 7

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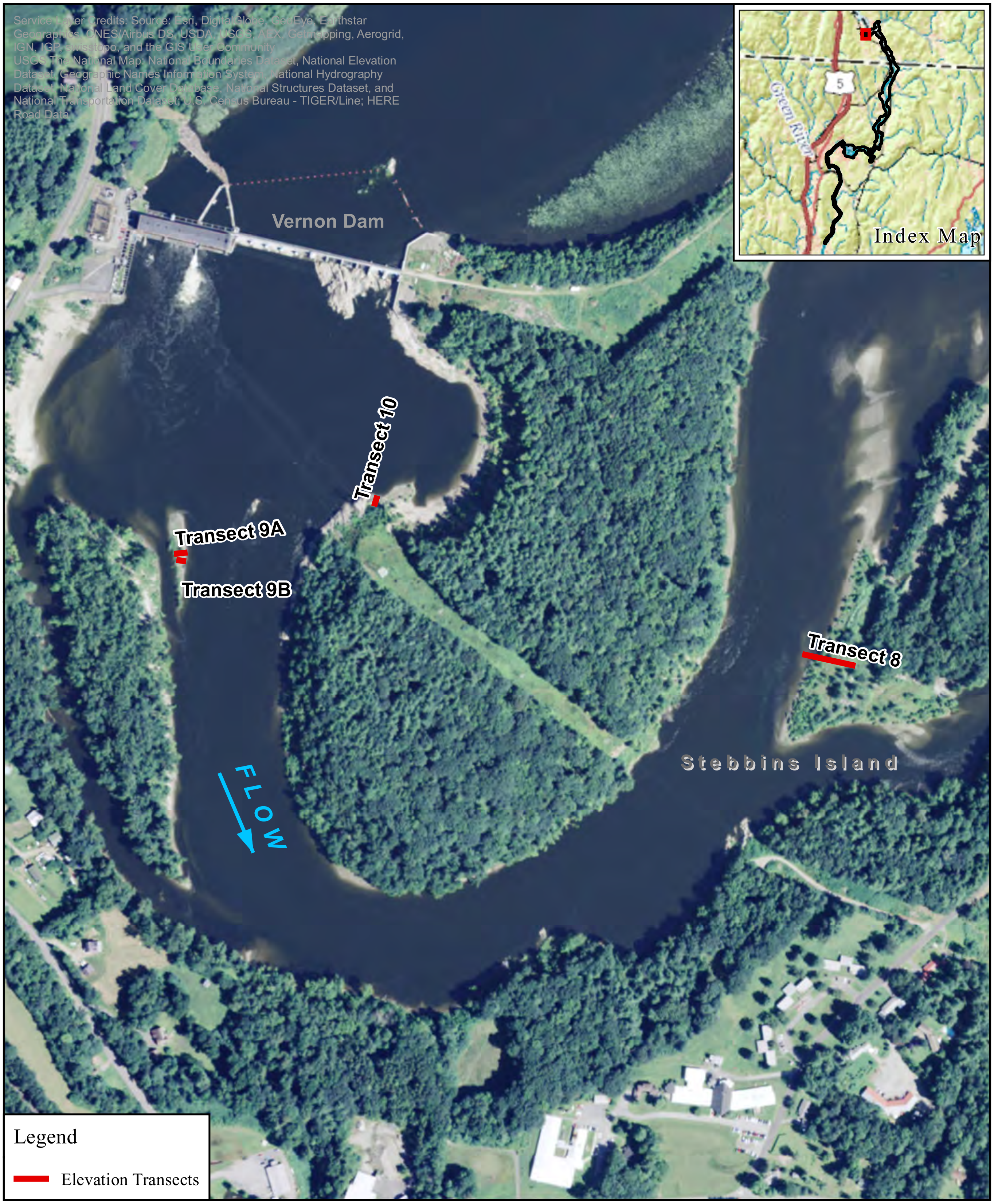


Northfield Mountain Pumped Storage Project (No. 2485)
and Turners Falls Hydroelectric Project (No. 1889)
Study 3.5.1 Baseline Inventory of Wetland, Riparian and Littoral Habitat in the Turners Falls Impoundment and Assessment of Operational Impacts on Special Status Species

N

0 250 500 1,000
Feet

Figure 4.3-1:
Mapping of RTE Plant Species and Survey Transect Locations
Map 8

Path: W:\gis\studies\3_5_1\maps\PUBLIC_Study_3_5_1_RTE_Transect_Figures.mxd

Figure 4.3-2: Typical Mountain Alder Habitat within the Bypass Reach

Figure 4.3-3: View of Typical Shoreline Habitat near the Pauchaug Boat Launch

Figure 4.3-4: Upland White Aster Identified Within the Bypass Reach in 2014

Figure 4.3-5: Typical Sandbar Cherry Located Within the Bypass Reach in 2014

Figure 4.3-6. View of Typical Habitat for the Sandbar Willow at First Island, near Sunderland Bridge

Figure 4.3-7. Typical Tradescant's Aster Habitat Identified within the Bypass Reach in 2014

Figure 4.3-8: View of Transect 1 Looking West

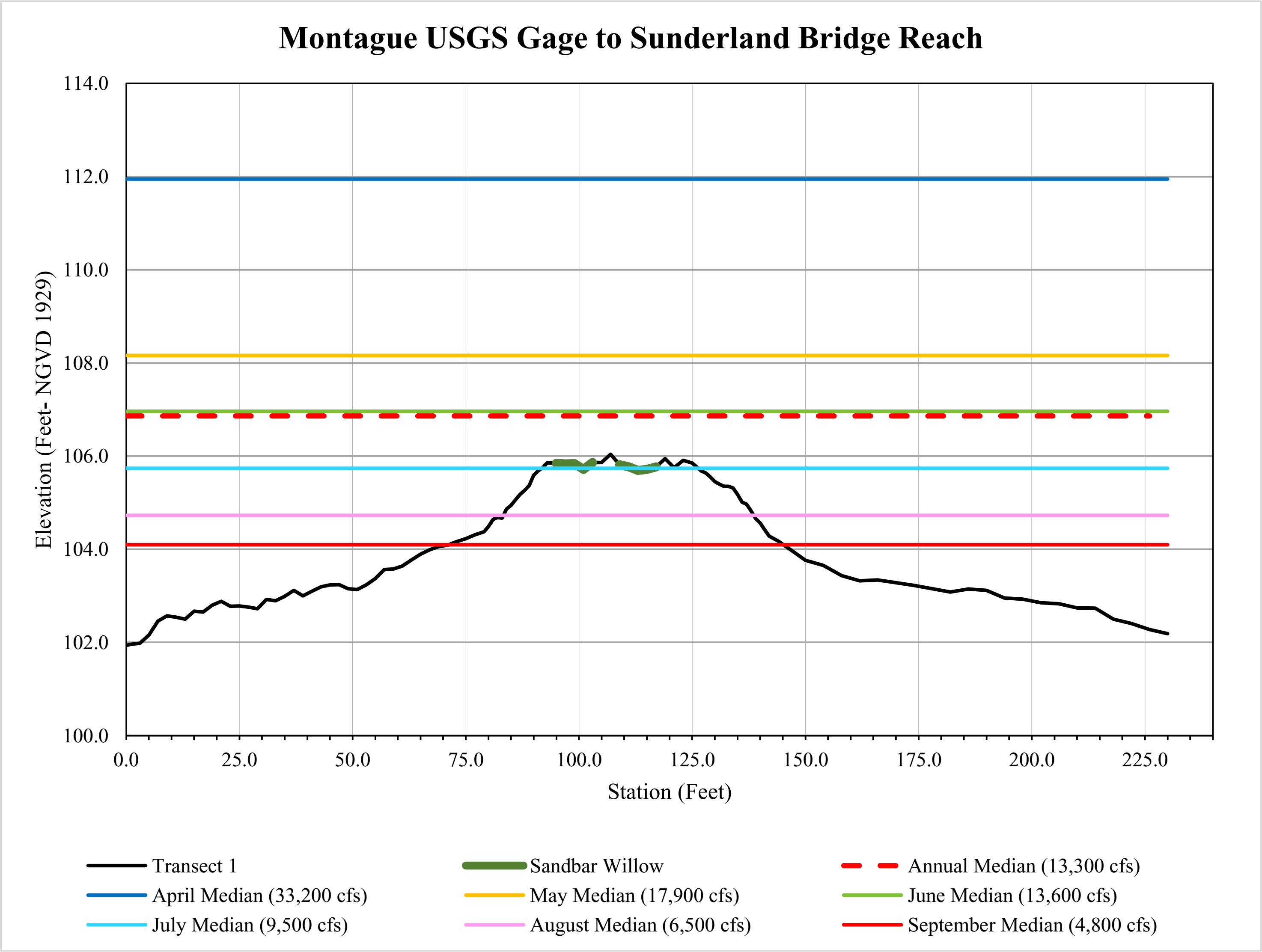


Figure 4.3-9: Transect 1 Elevation Survey, Distribution of Sandbar Willow, and Median Water Surface Elevations

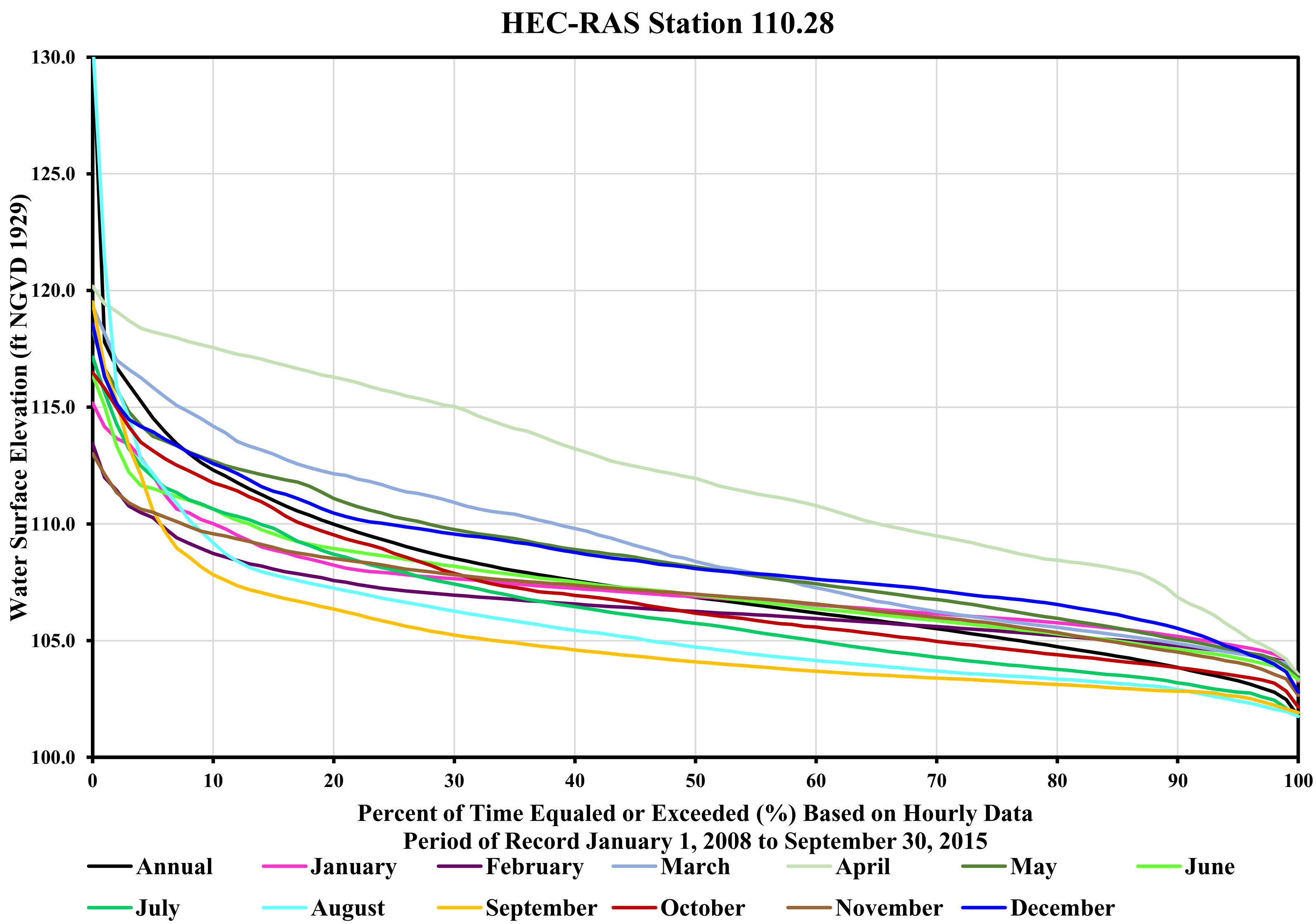


Figure 4.3.-10: Percent Exceedance Curves for the Transect 1 Location

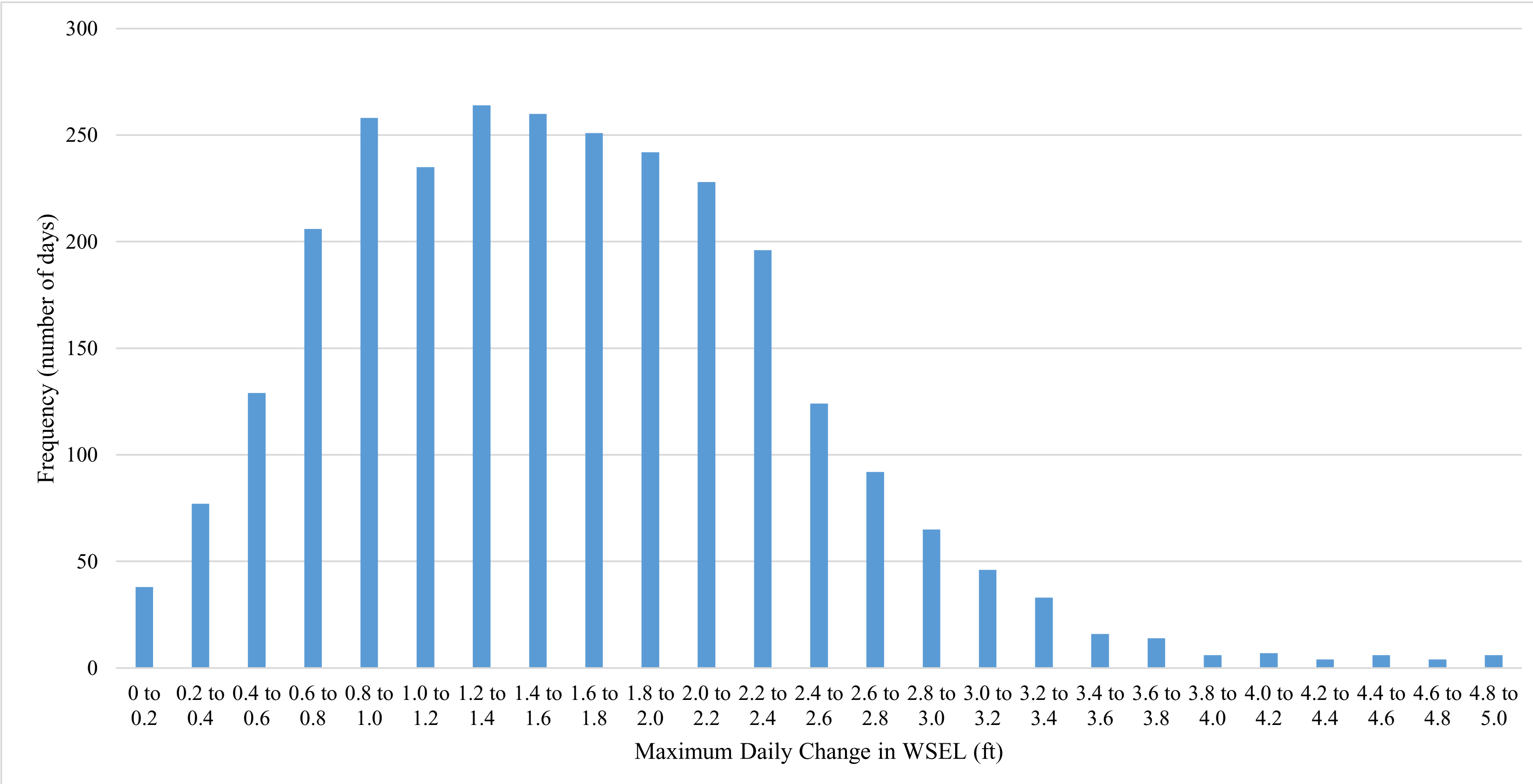


Figure 4.3-11: Annual Maximum Daily Change in Water Surface Elevation at the Transect 1 Location

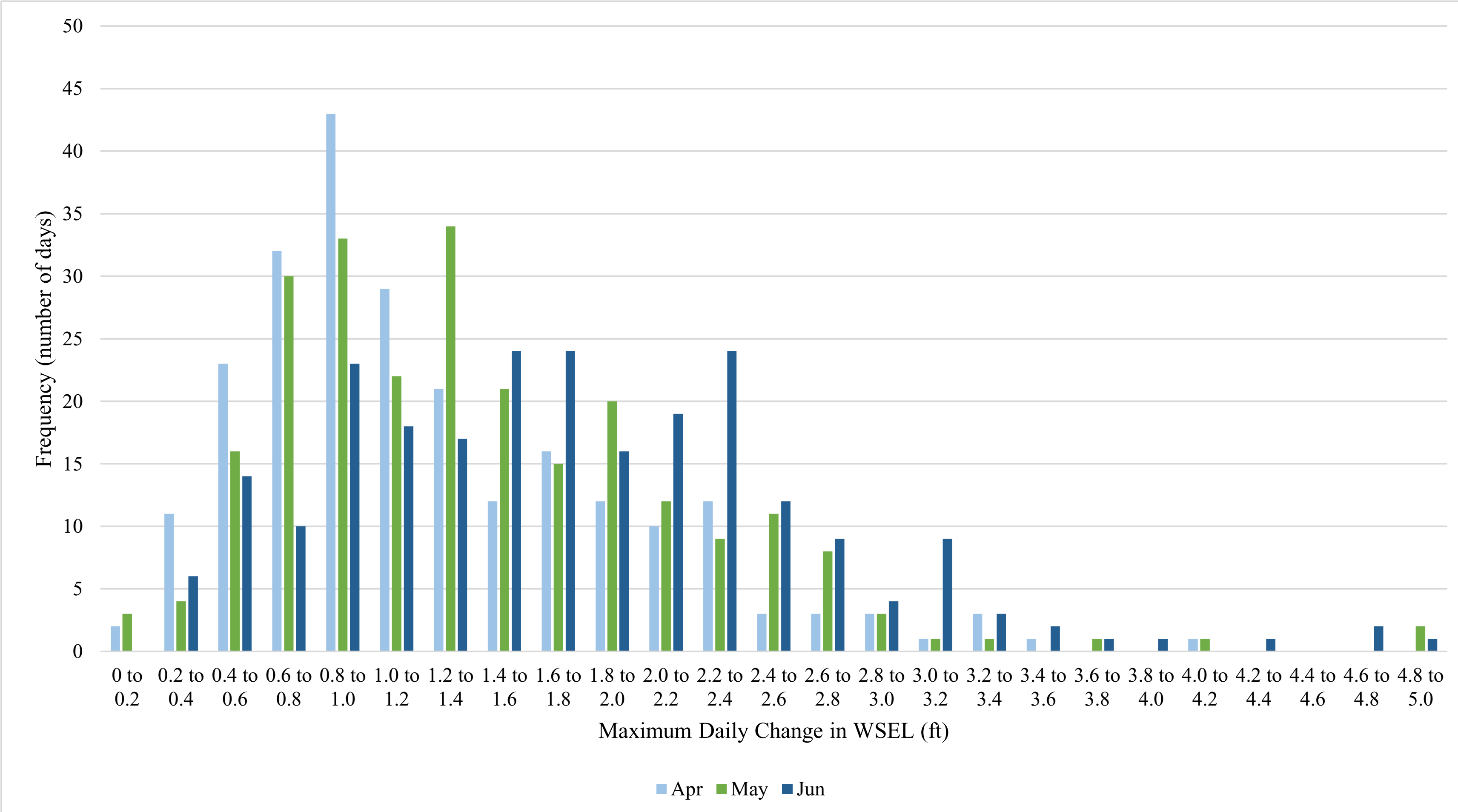


Figure 4.3-12: Spring Maximum Daily Change in Water Surface Elevation at the Transect 1 Location

Figure 4.3-13: View of Transect 2, Looking West

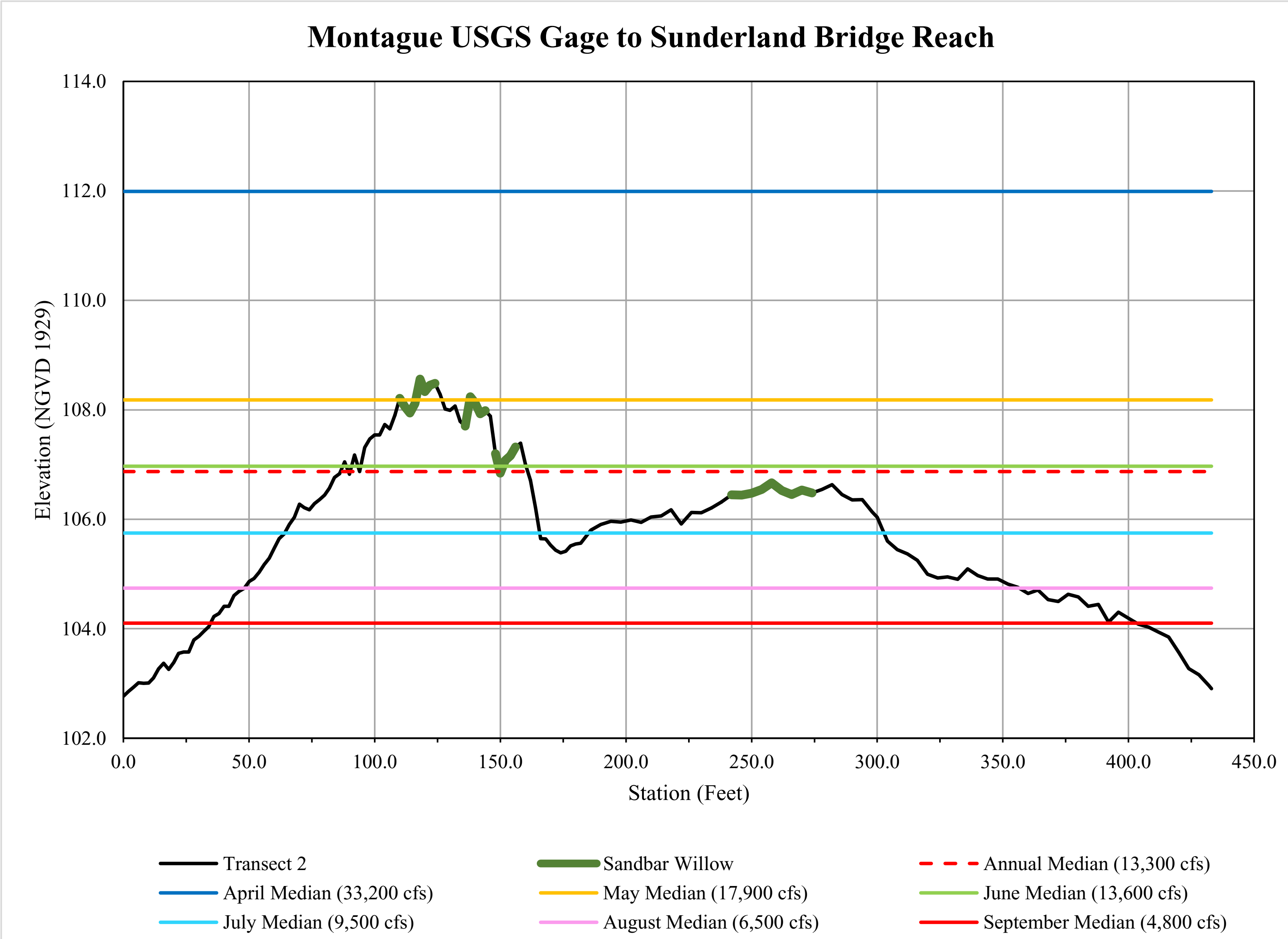


Figure 4.3-14: Transect 2 Elevation Survey, Distribution of Sandbar Willow, and Median Water Surface Elevations

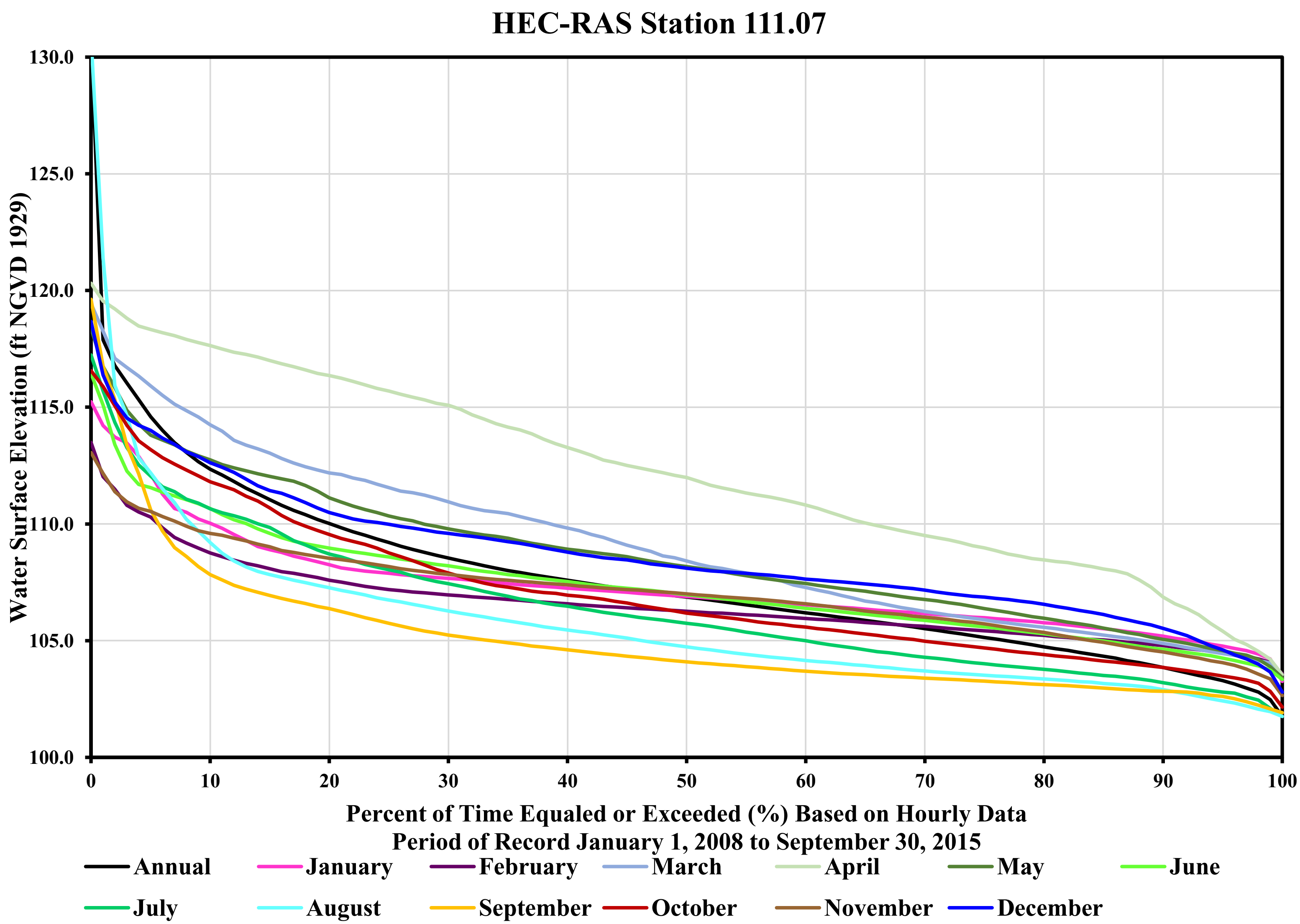


Figure 4.3-15: Percent Exceedance Curves for the Transect 2 Location.

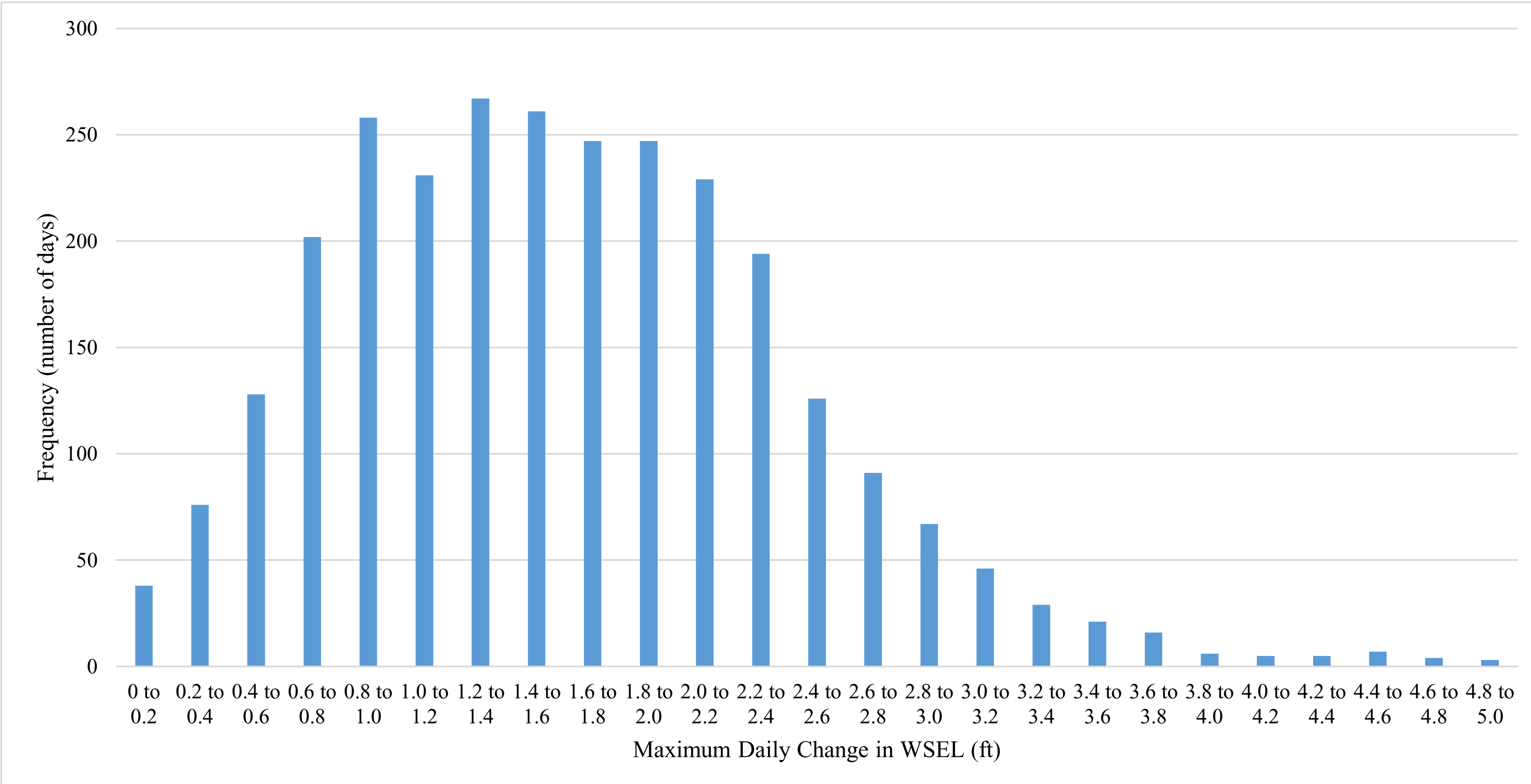


Figure 4.3-16: Annual Maximum Daily Change in Water Surface Elevation at the Transect 2 Location

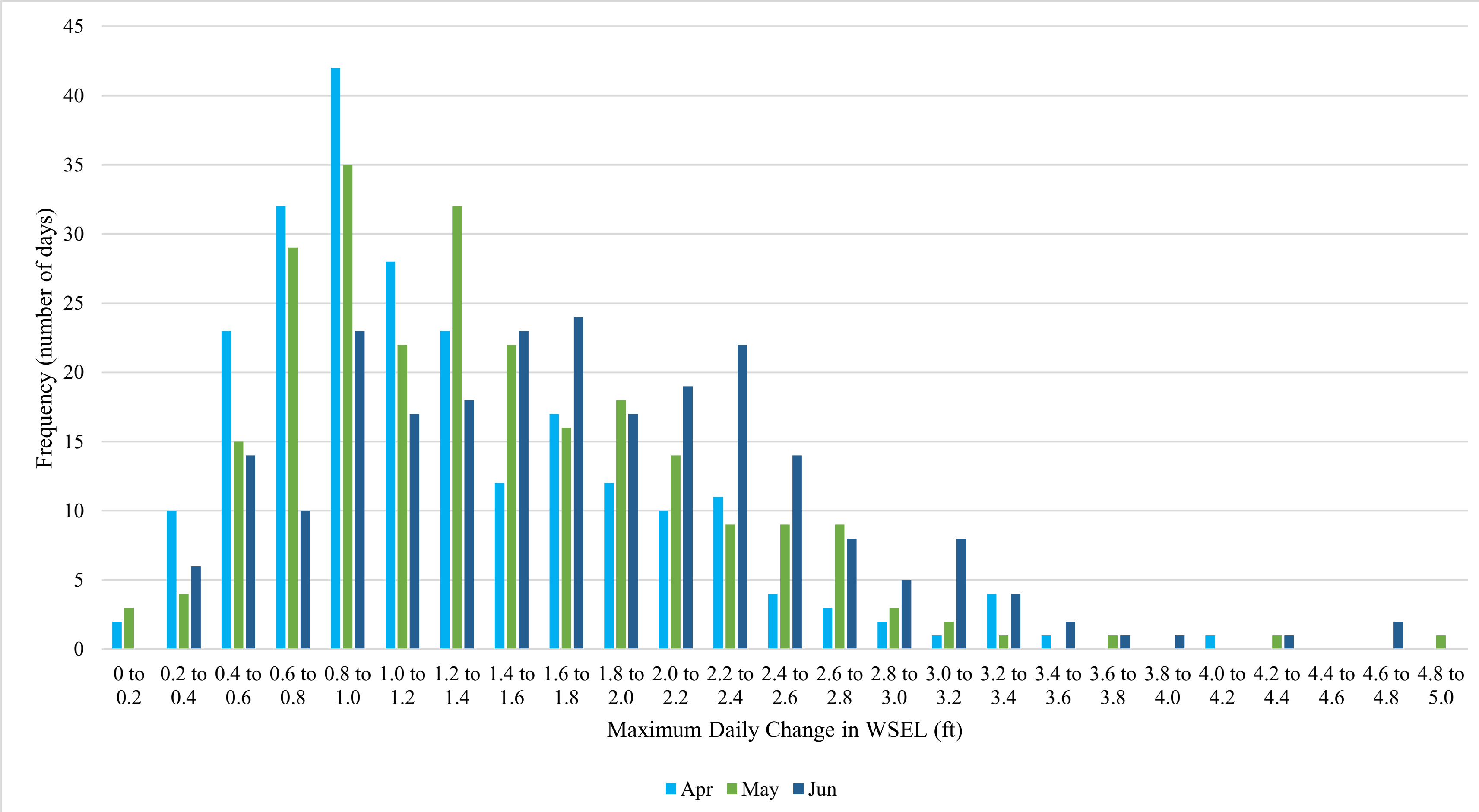


Figure 4.3-17: Spring Maximum Daily Change in Water Surface Elevation at the Transect 2 Location

Figure 4.3-18: Representative View of Habitat on Transect 3

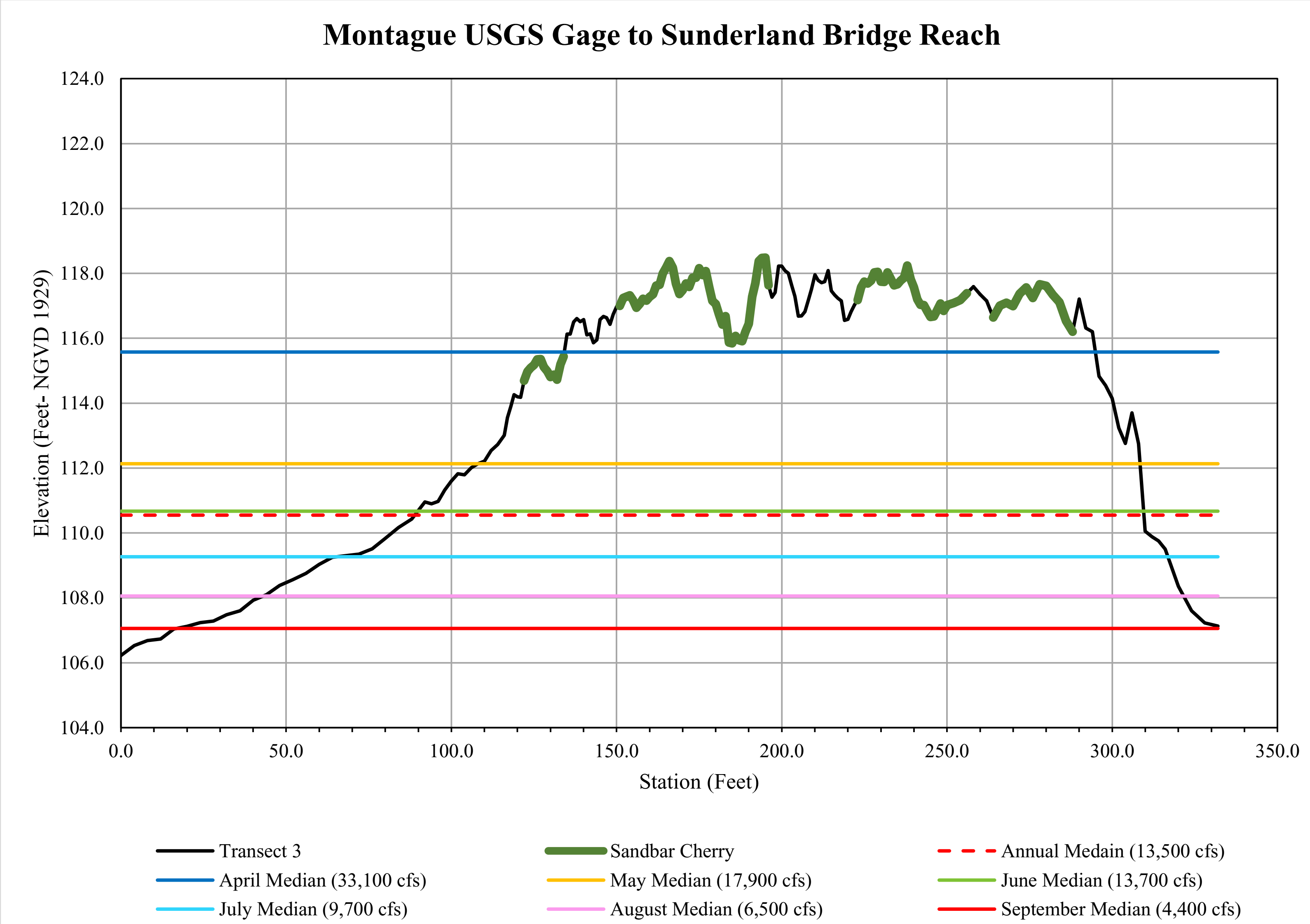


Figure 4.3-19: Transect 3 Elevation Survey, Distribution of Sandbar Cherry and Median Water Surface Elevations

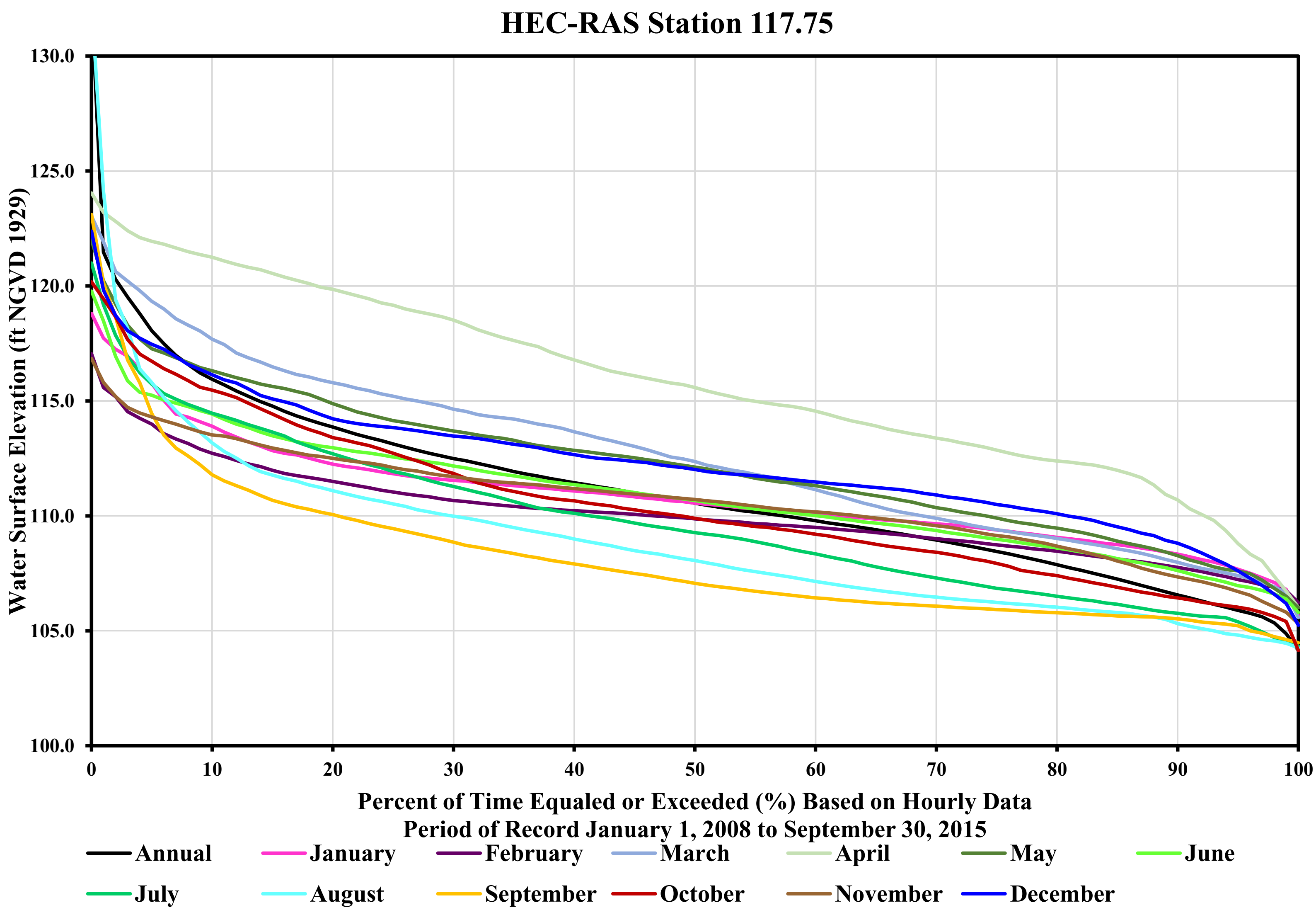


Figure 4.3-20: Percent Exceedance Curves for the Transect 3 Location

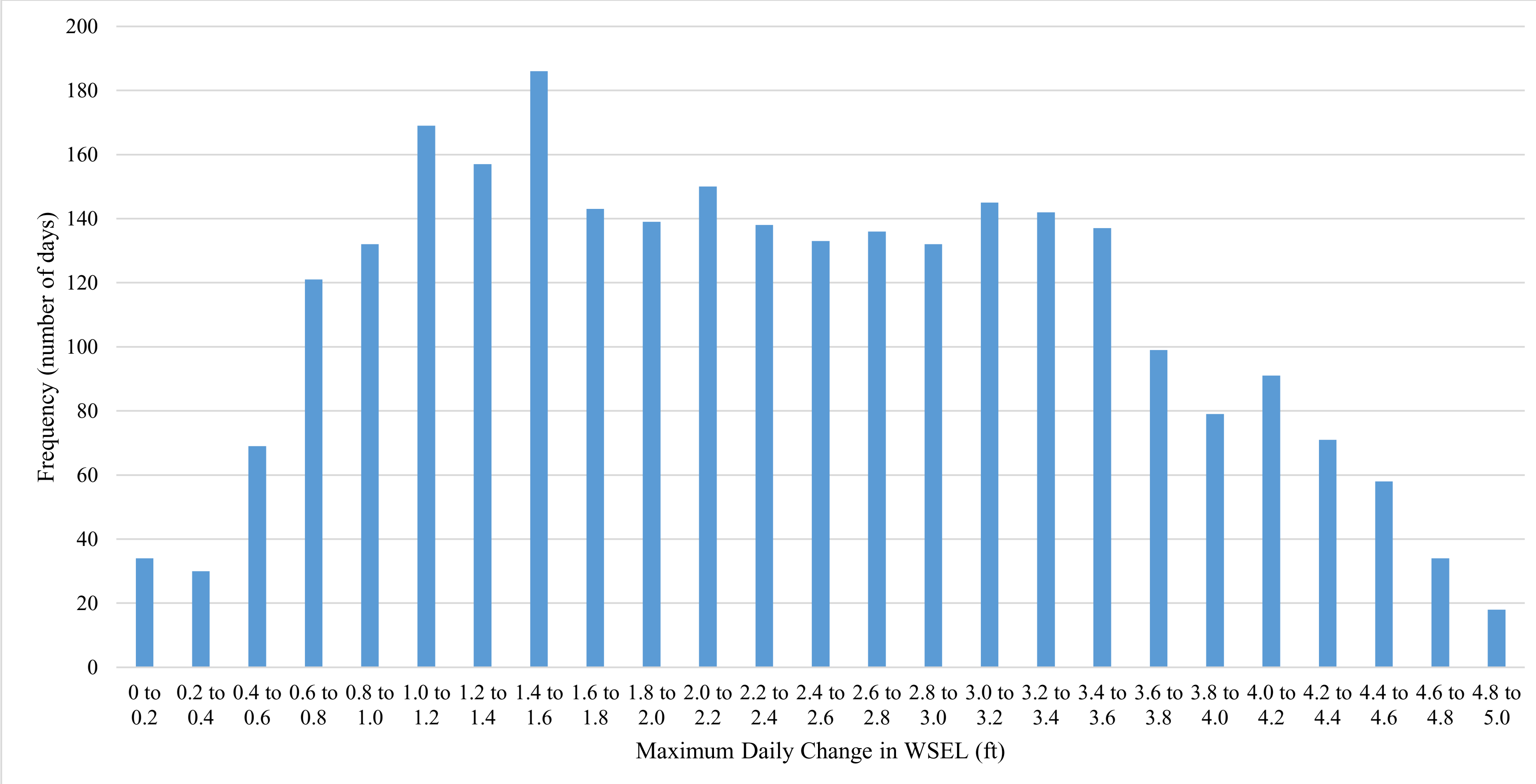


Figure 4.3-21: Annual Maximum Daily Change in Water Surface Elevation at the Transect 3 Location

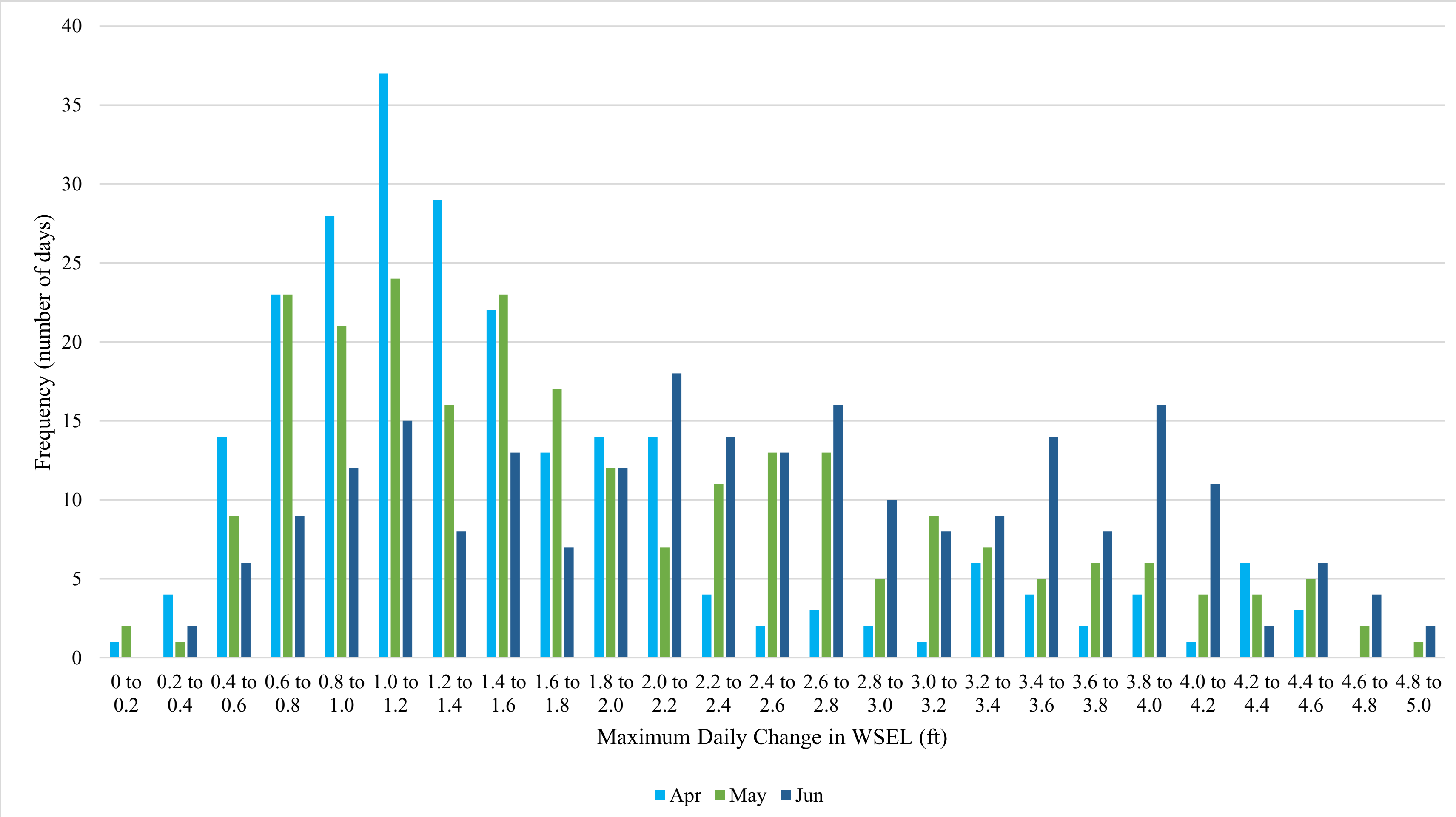


Figure 4.3-22: Spring Maximum Daily Change in Water Surface Elevation at the Transect 3 Location

Figure 4.3-23: View of Transect 4 Looking Downstream

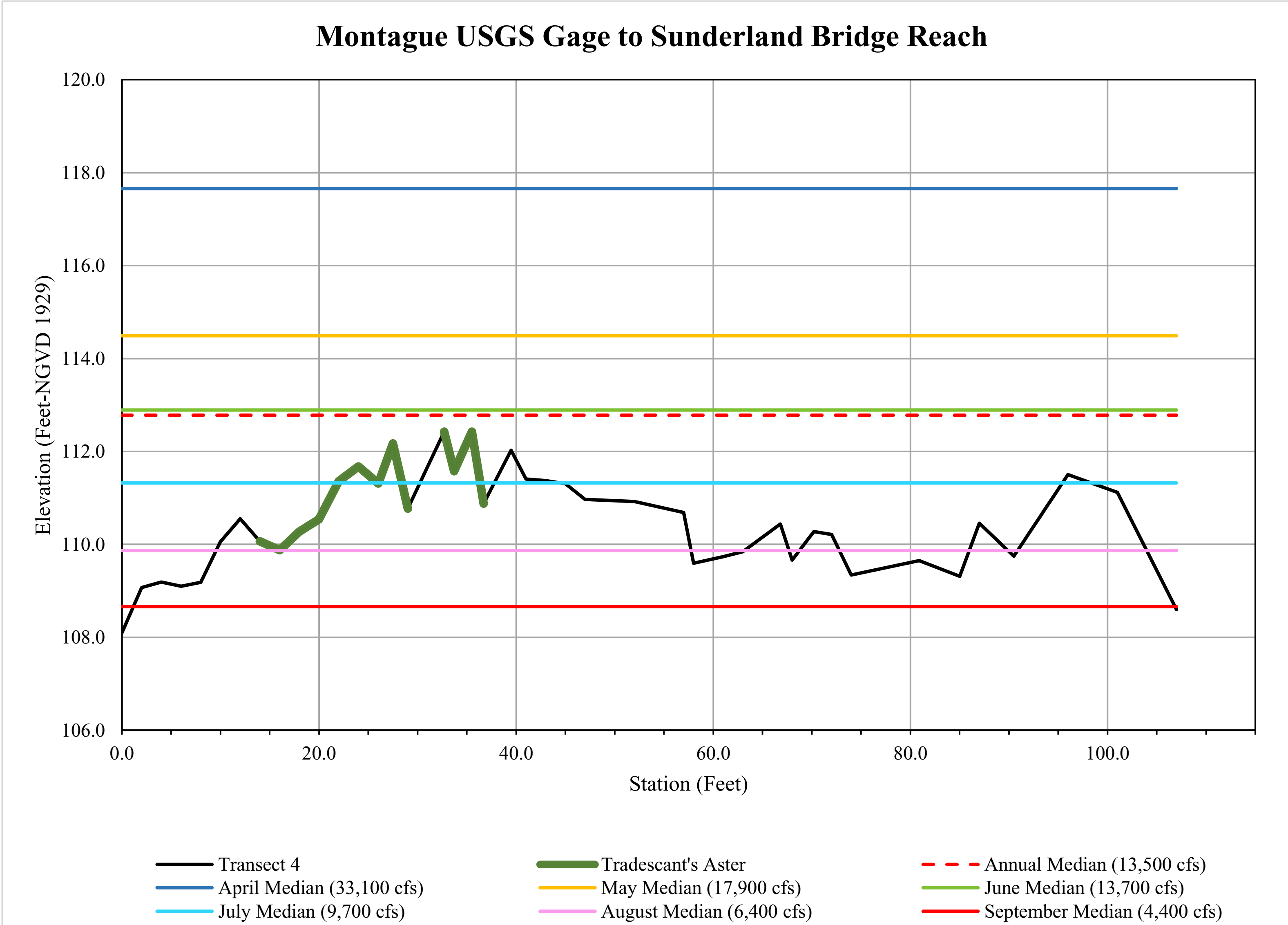


Figure 4.3-24: Transect 4 Elevation Survey, Distribution of Tradescant's Aster, and Median Water Surface Elevations

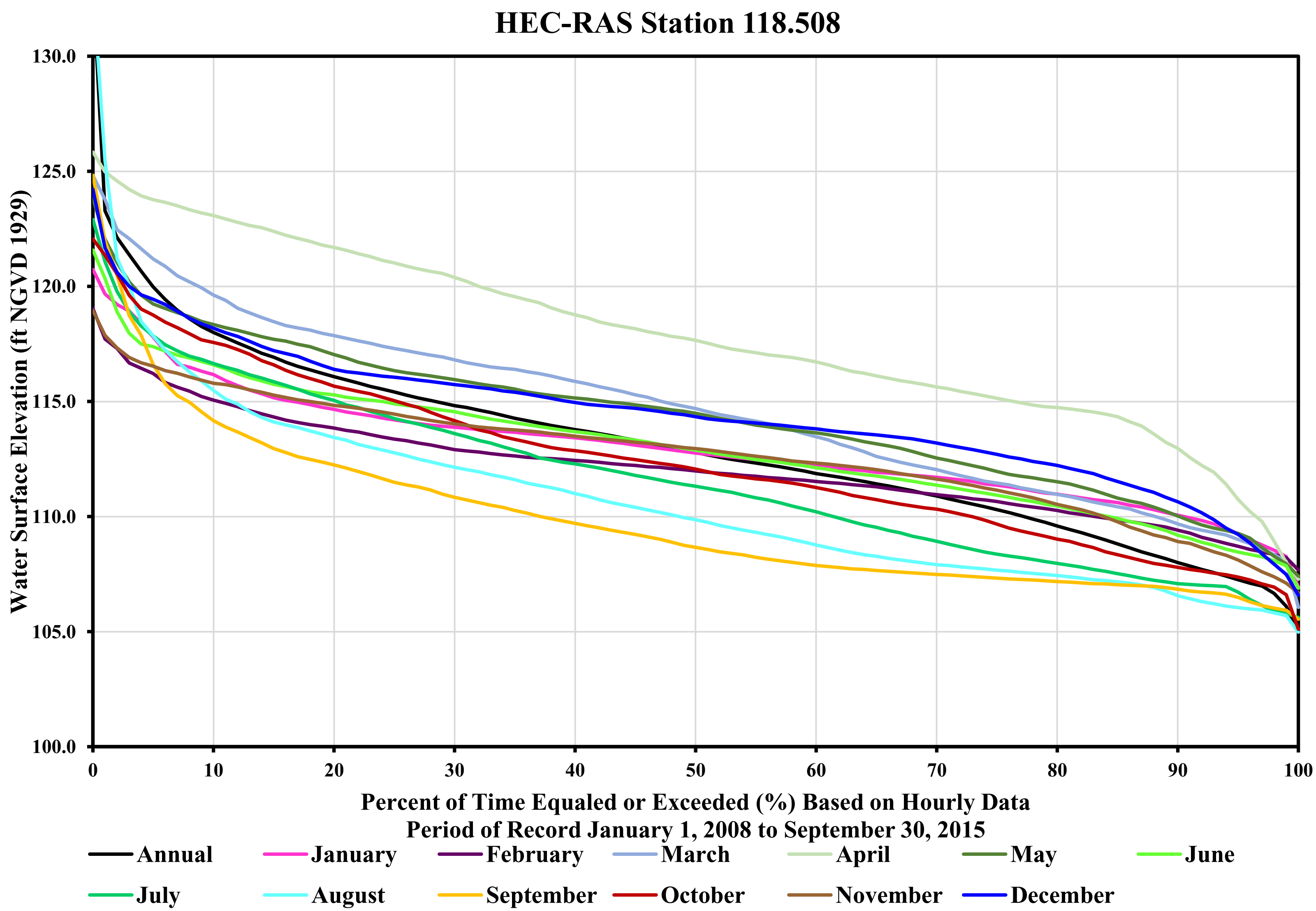


Figure 4.3-25: Percent Exceedance Curves for the Transect 4 Location

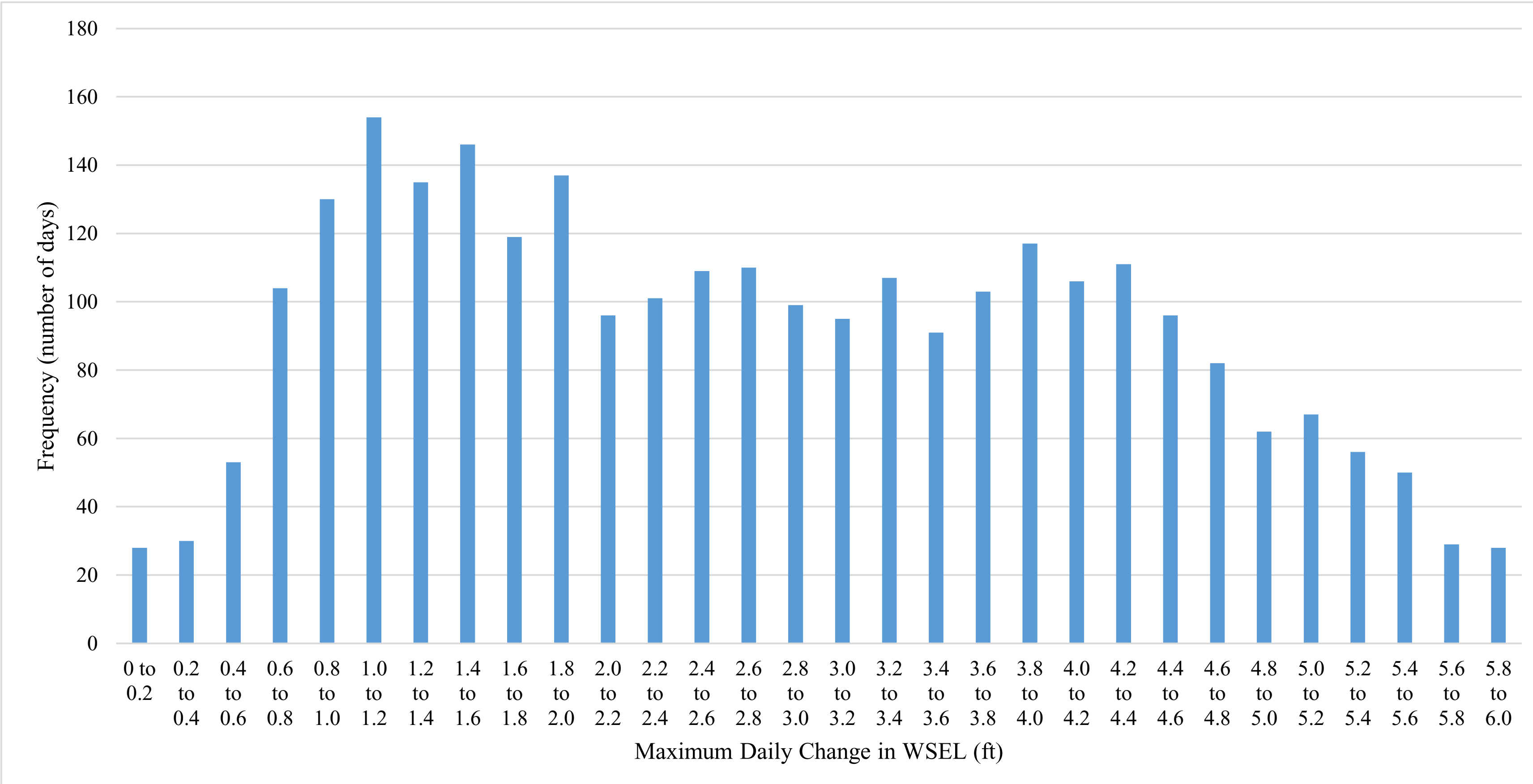


Figure 4.3-26: Annual Maximum Daily Change in Water Surface Elevation at the Transect 4 Location

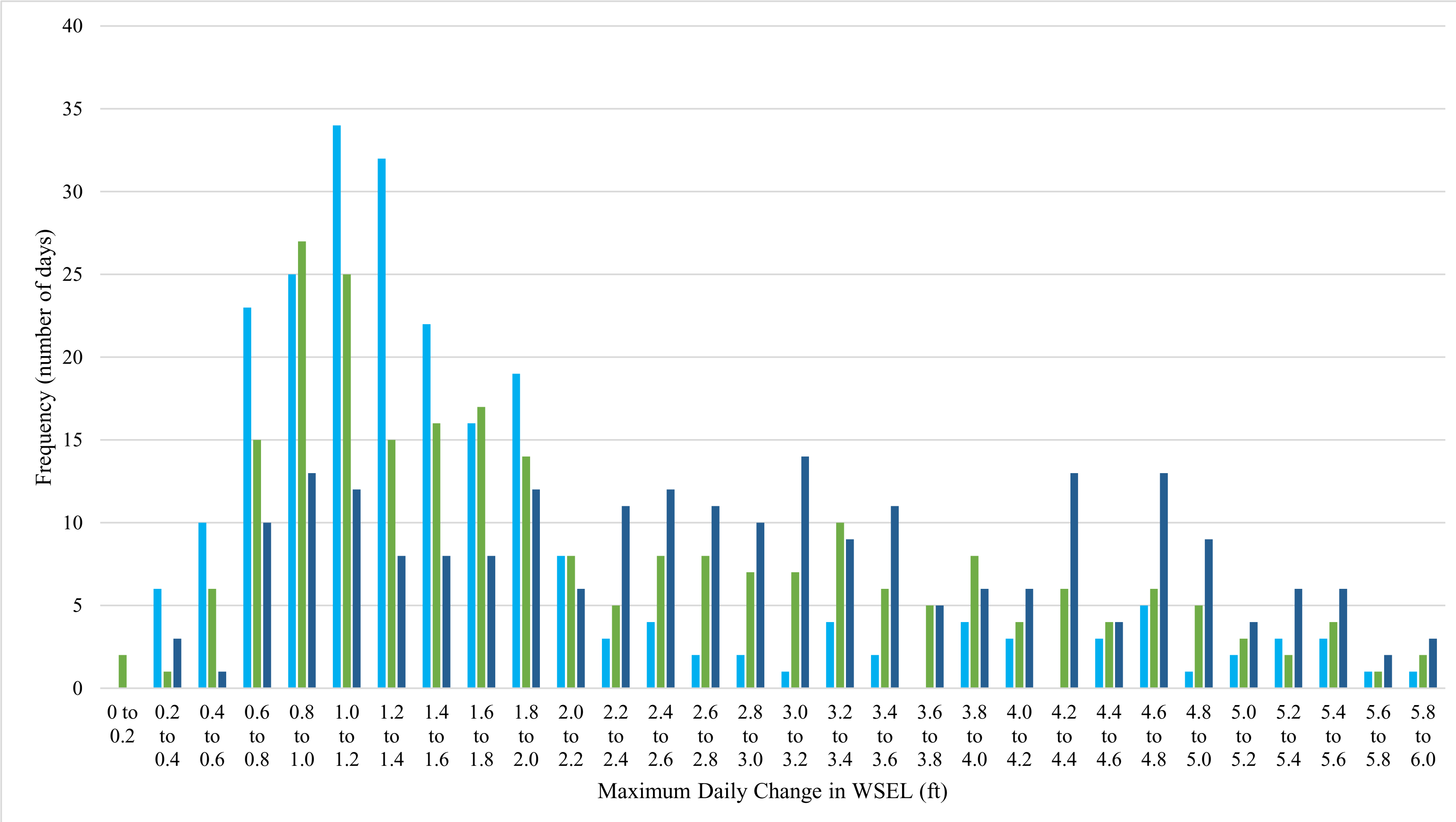


Figure 4.3-27: Spring Maximum Daily Change in Water Surface Elevation at the Transect 4 Location

Figure 4.3-28: View of IFIM Transect T-3 within the Bypass Reach, Looking West

Figure 4.3-29: View Upstream of IFIM Transect T-3, Looking North

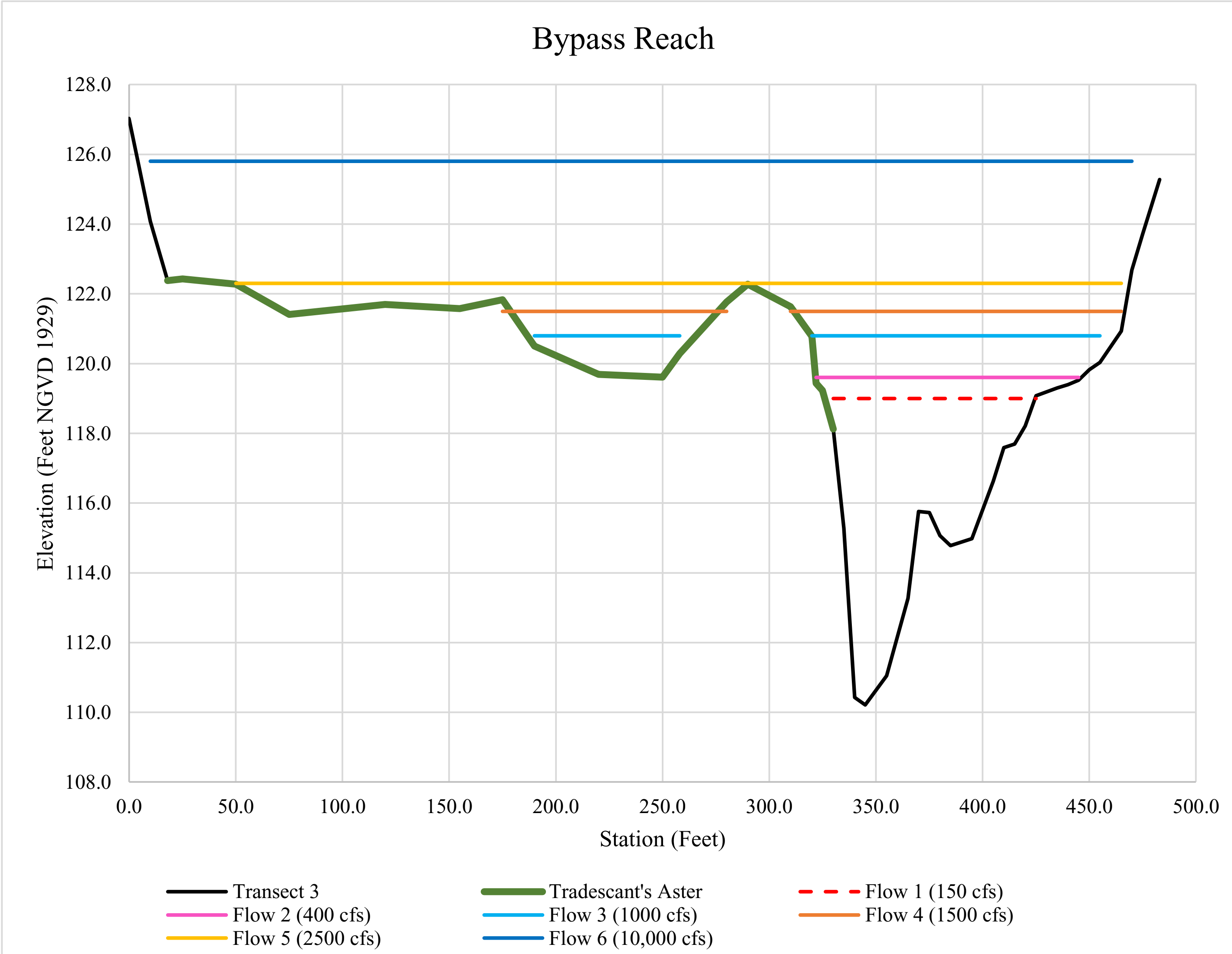


Figure 4.3-30: Transect T-3 Elevation Survey, Distribution of Tradescant's Aster, and Water Surface Elevations

Figure 4.3-31: View of Representative Habitat on Transect 5

Figure 4.3-32: View of Transect 5A, Looking East

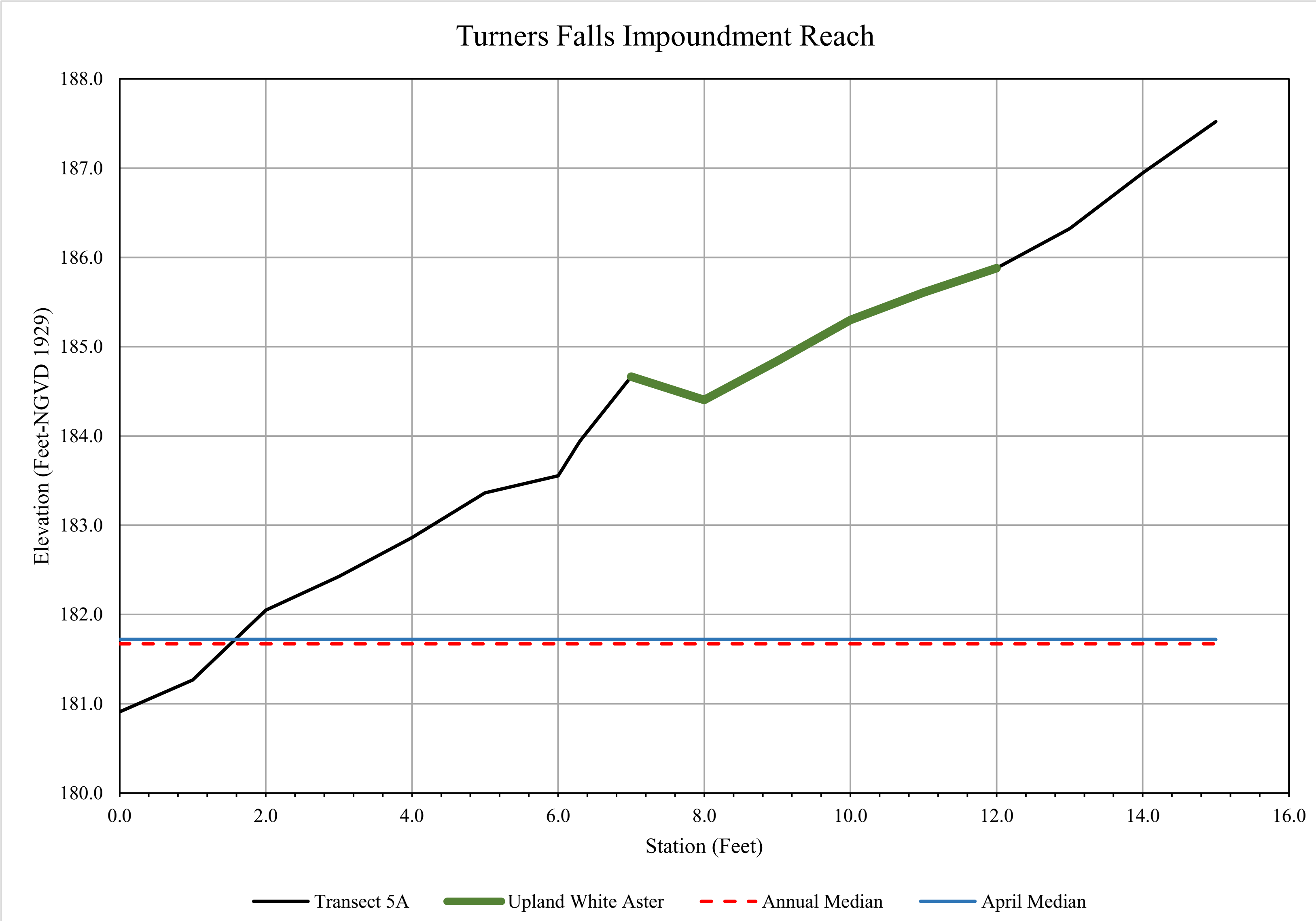


Figure 4.3-33: Transect 5A Elevation Survey, Distribution of Upland White Aster, and Median Water Surface Elevations

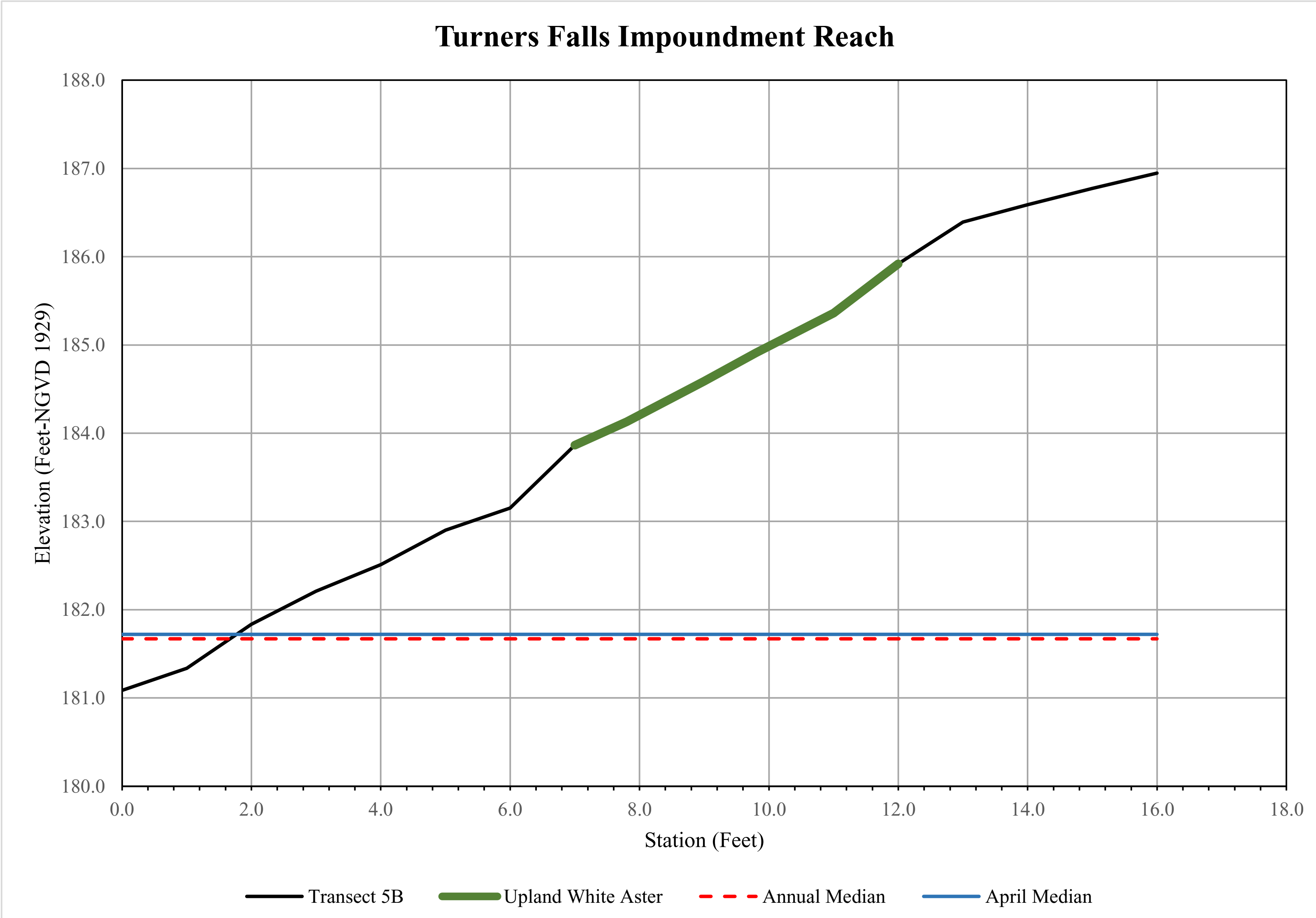


Figure 4.3-34: Transect 5B Elevation Survey, Distribution of Upland White Aster, and Median Water Surface Elevations

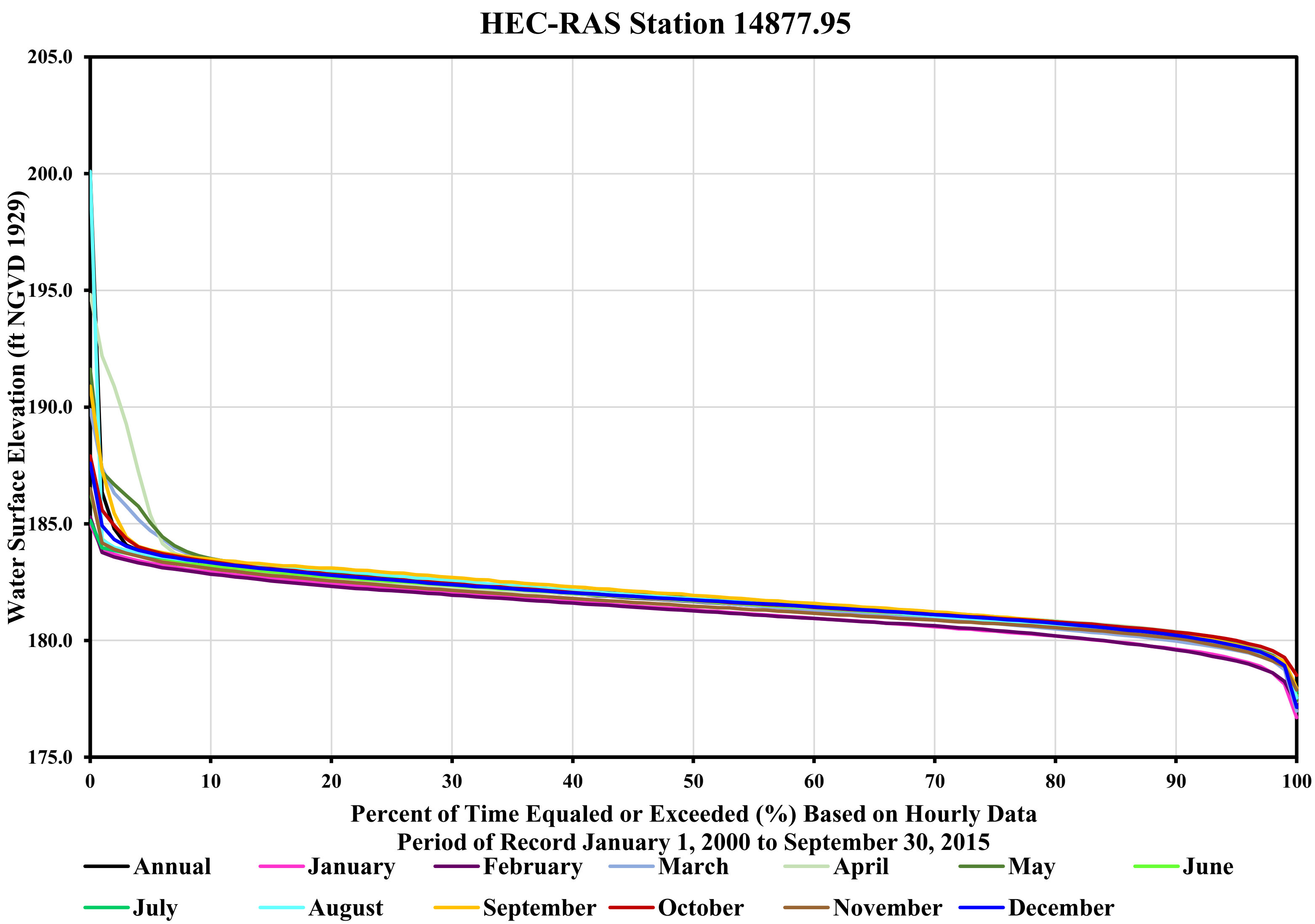


Figure 4.3-35: Percent Exceedance Curves for the Transect 5 Location

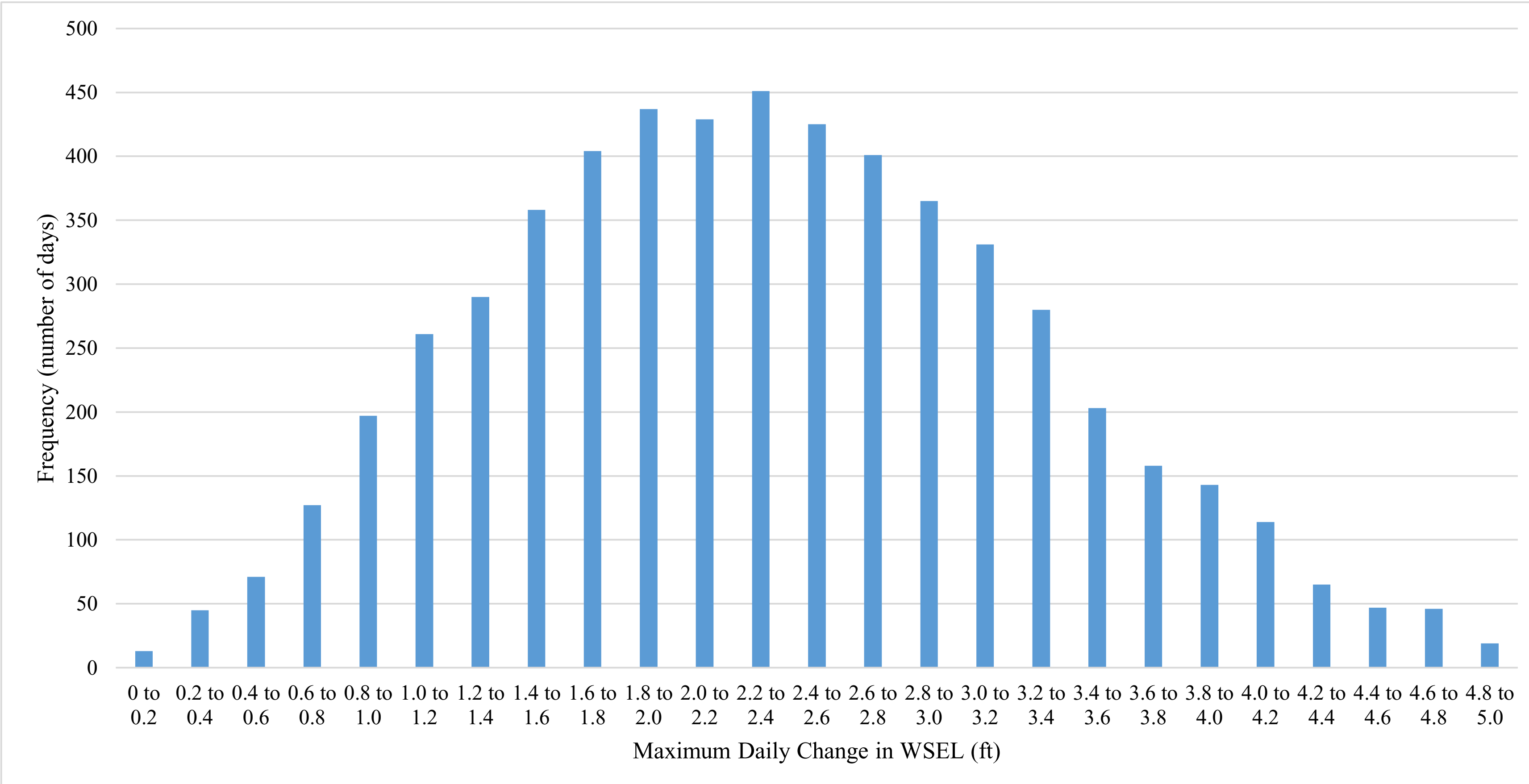


Figure 4.3-36: Annual Maximum Daily Change in Water Surface Elevation at the Transect 5 Location

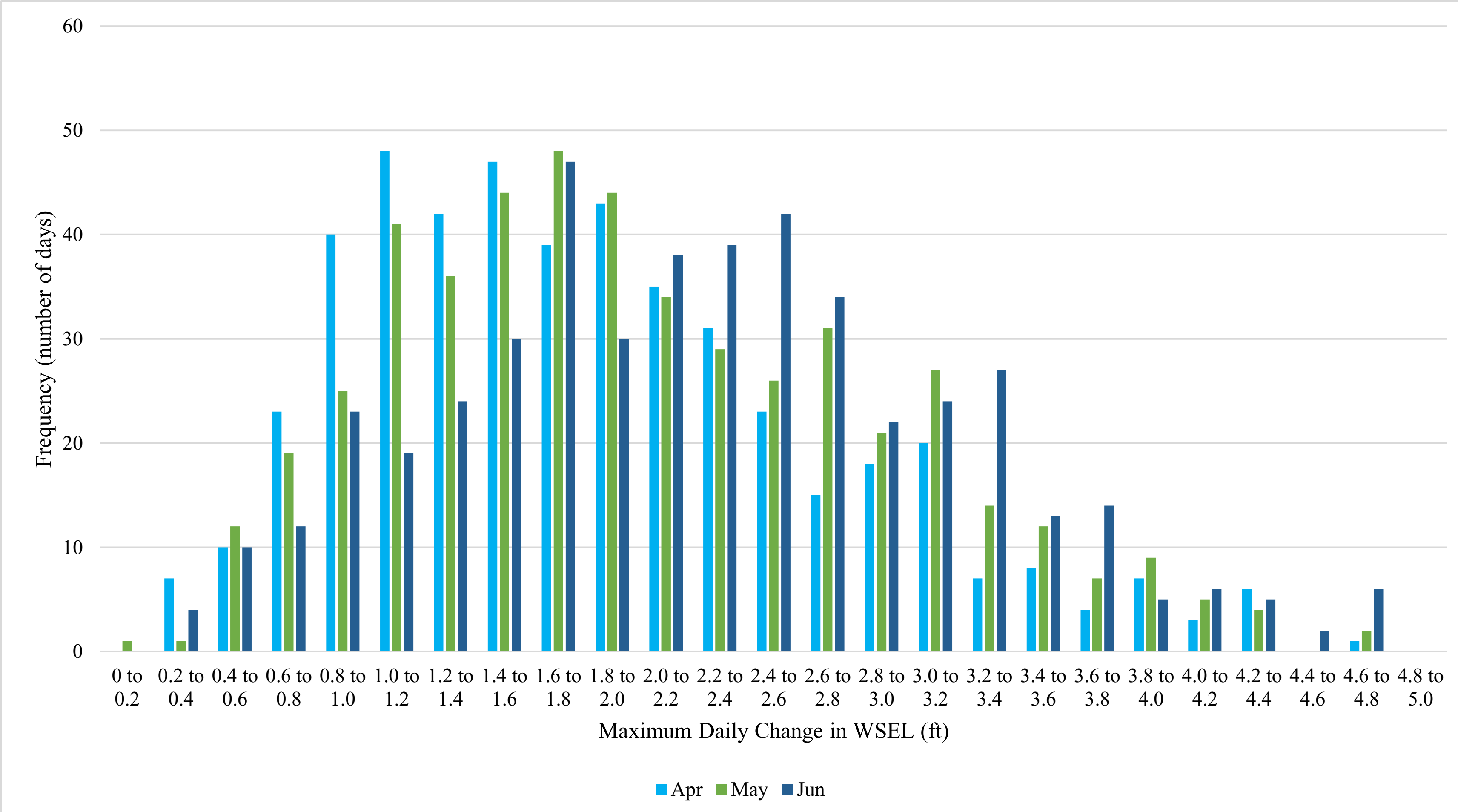


Figure 4.3-37: Spring Maximum Daily Change in Water Surface Elevation at the Transect 5 Location

Figure 4.3-38: View of Representative Habitat on Transect 6

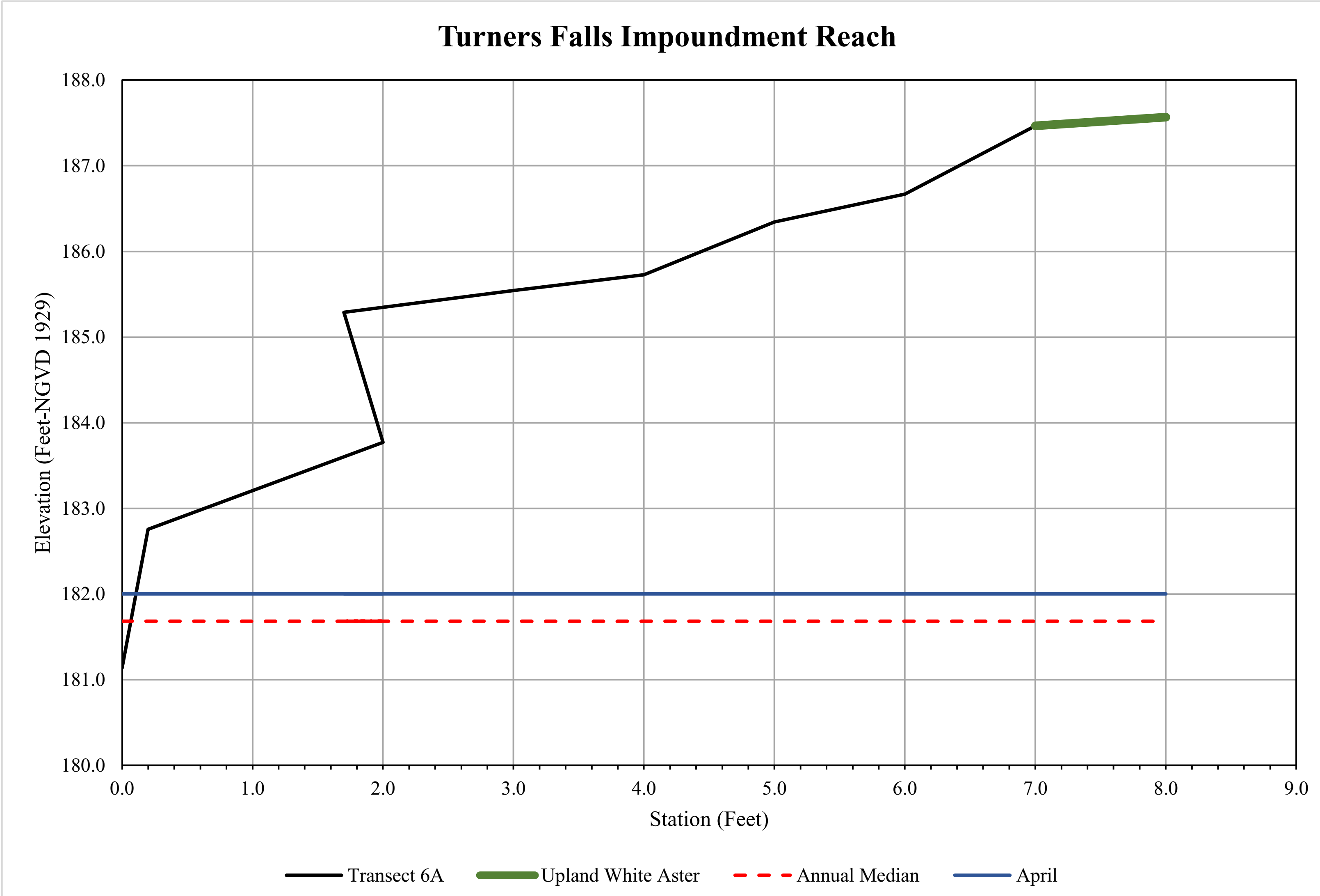


Figure 4.3-39: Transect 6A Elevation Survey, Distribution of Upland White Aster, and Median Water Surface Elevations

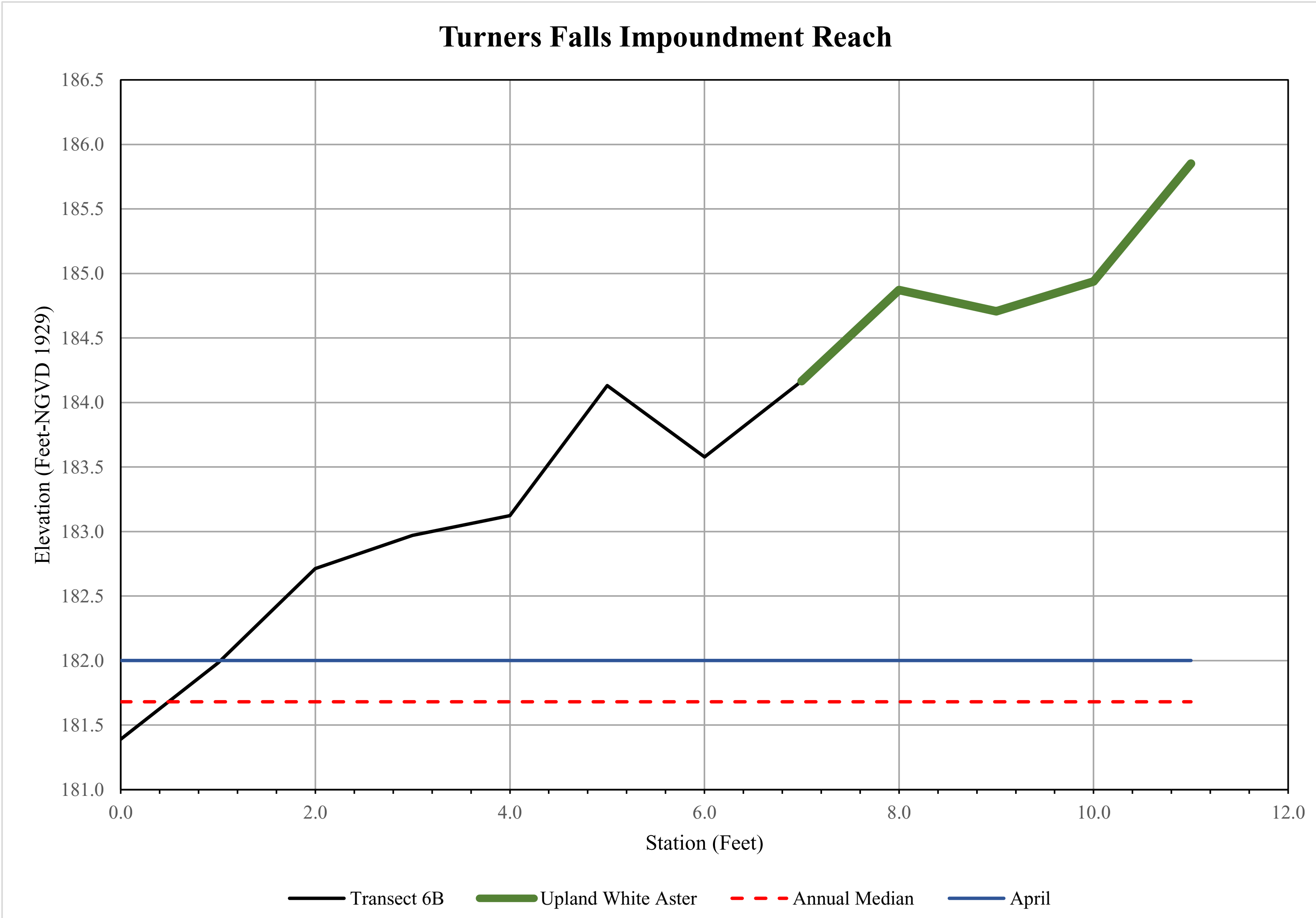


Figure 4.3-40: Transect 6B Elevation Survey, Distribution of Upland White Aster, and Median Water Surface Elevations

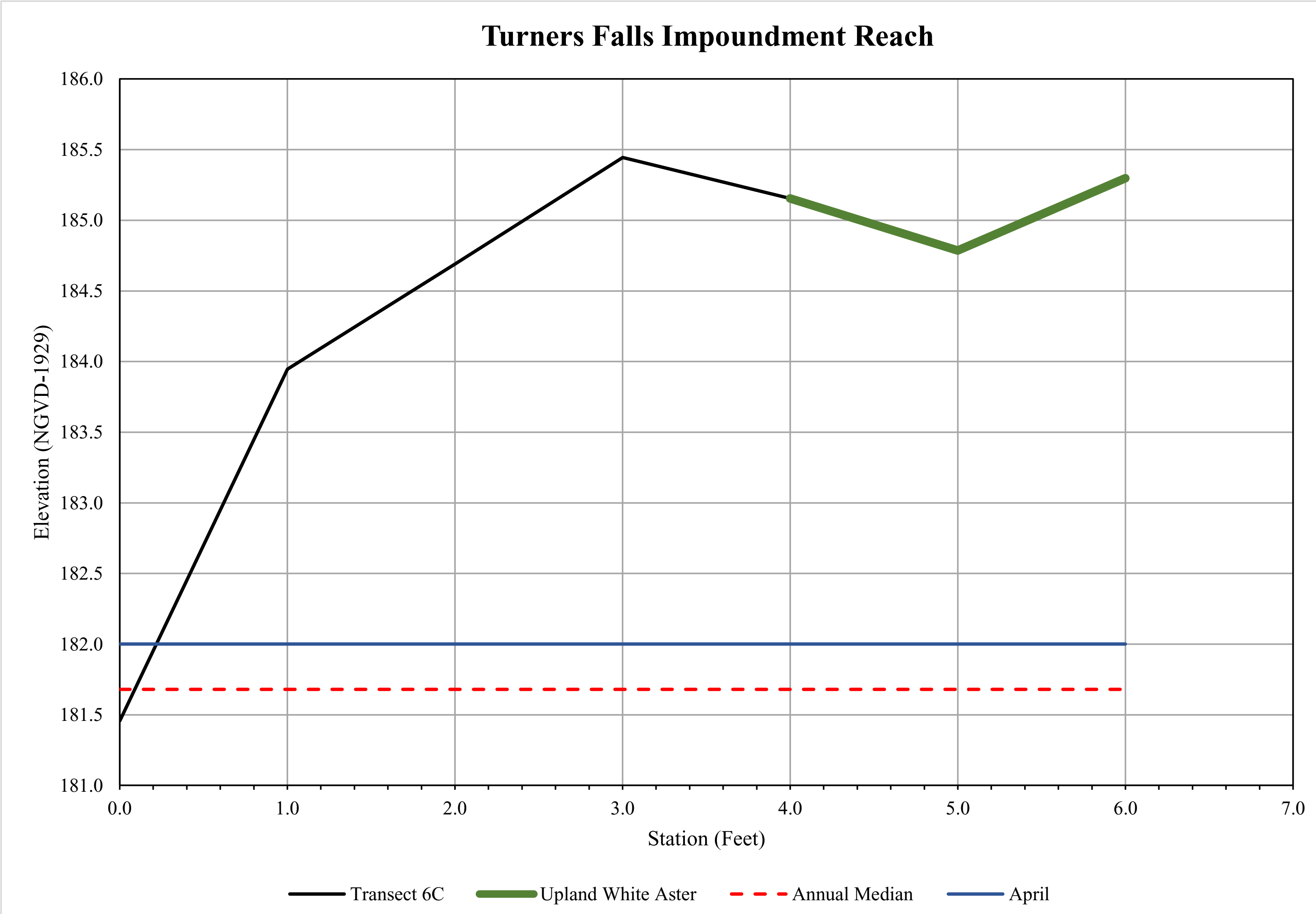


Figure 4.3-41: Transect 6C Elevation Survey, Distribution of Upland White Aster, and Median Water Surface Elevations

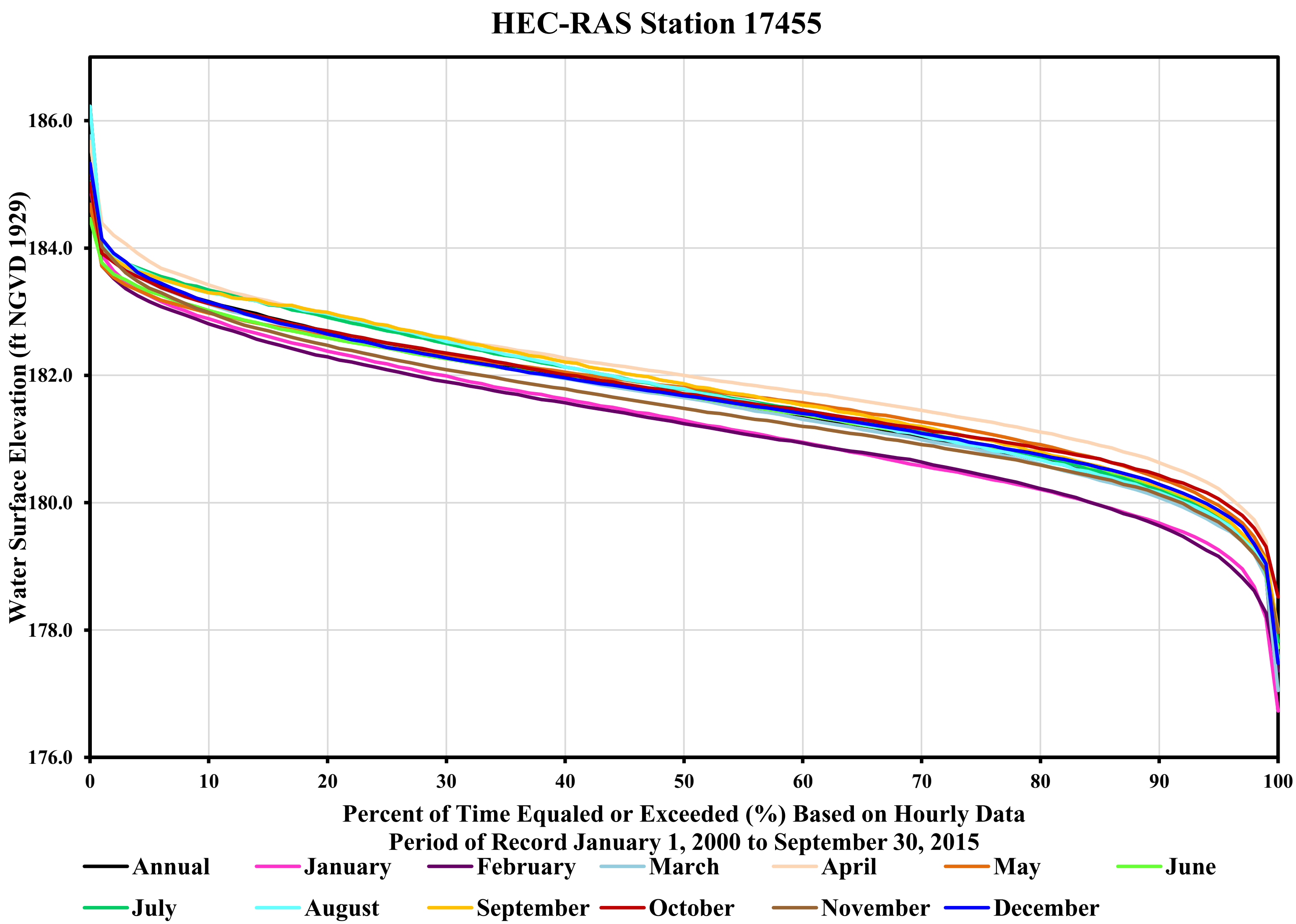


Figure 4.3-42: Percent Exceedance Curves for the Transect 6 Location

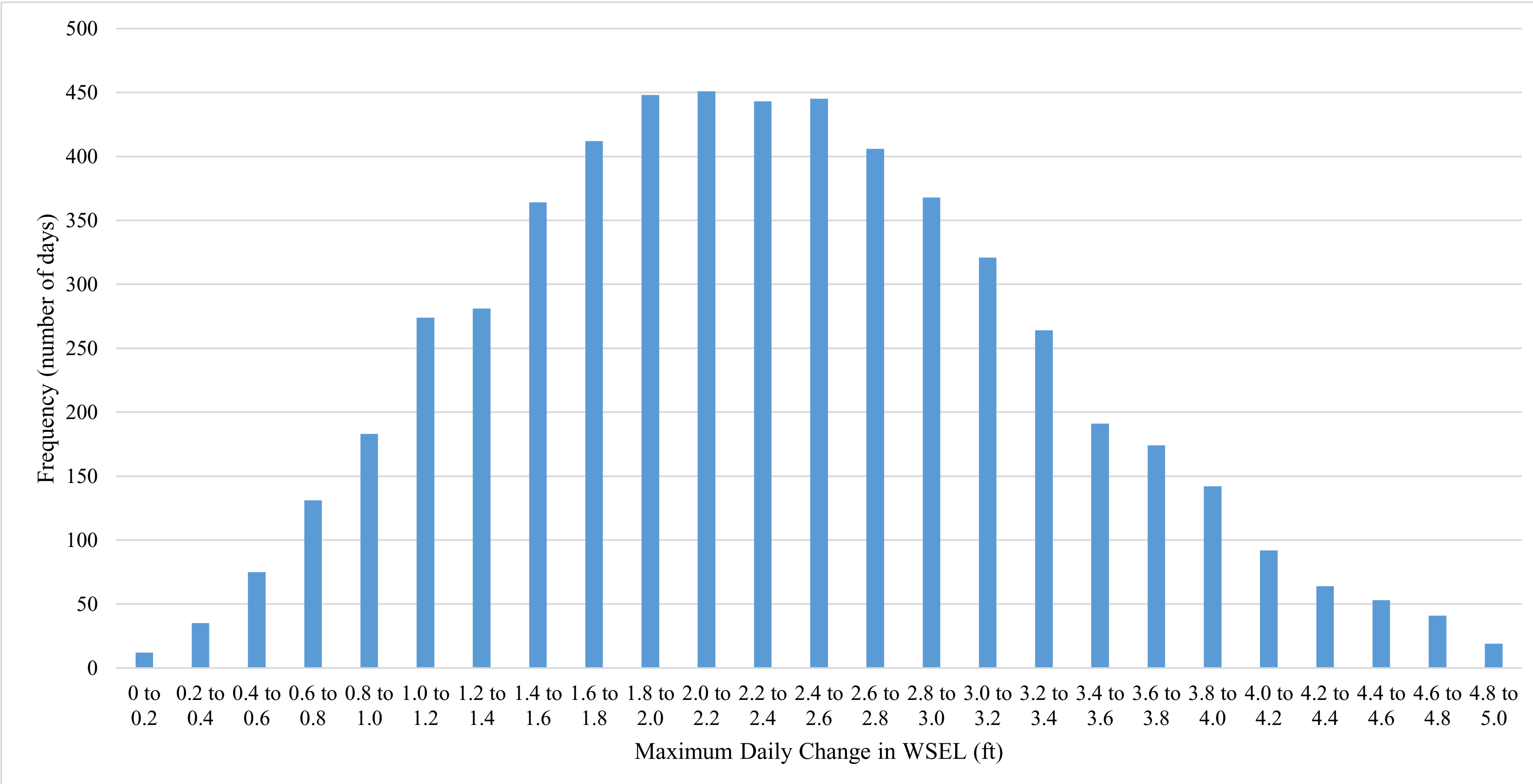


Figure 4.3-43: Annual Maximum Daily Change in Water Surface Elevation at the Transect 6 Location

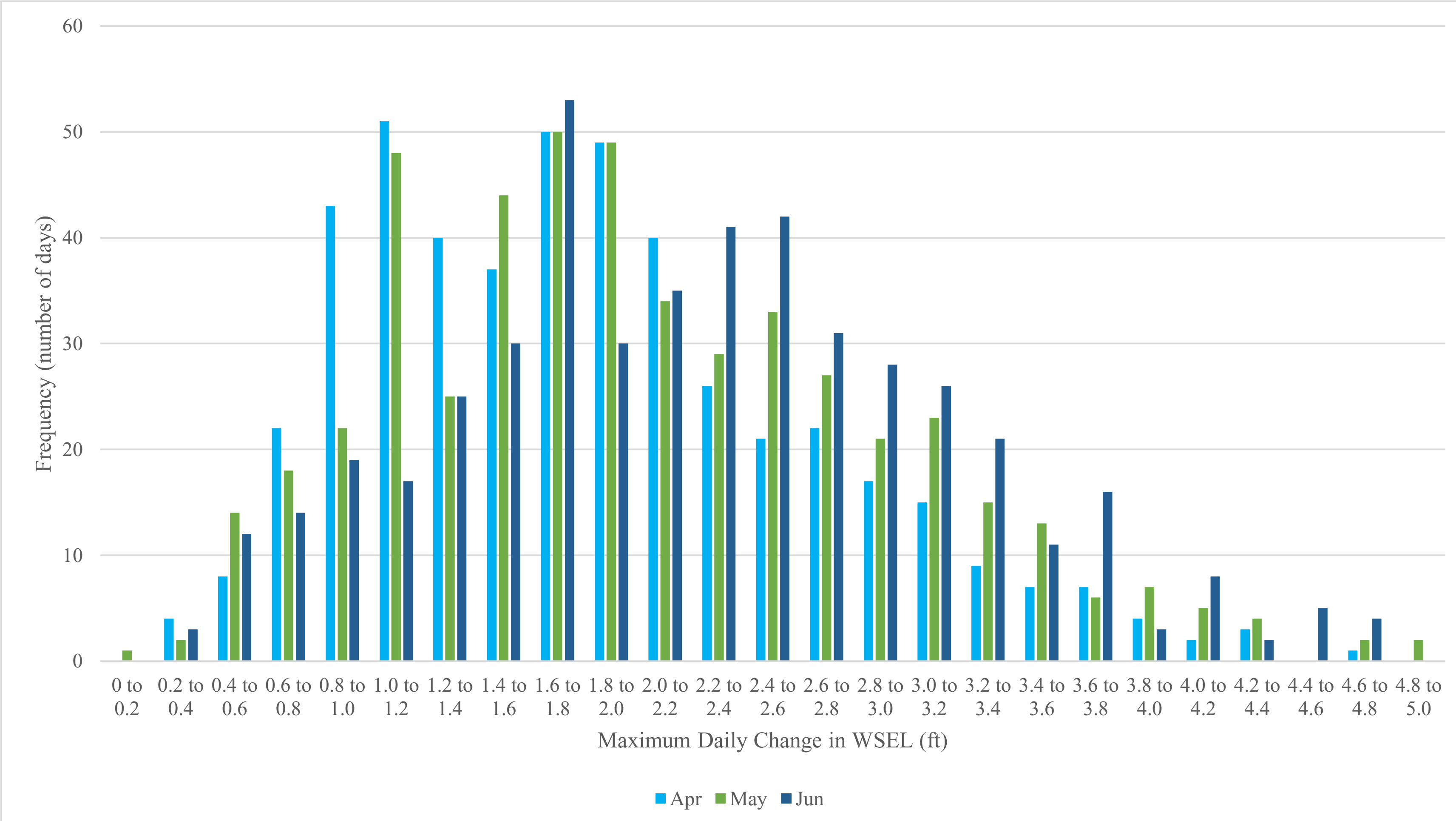


Figure 4.3-44: Spring Maximum Daily Change in Water Surface Elevation at the Transect 6 Location

Figure 4.3-45: View of Representative Habitat at the Transect 11 Location

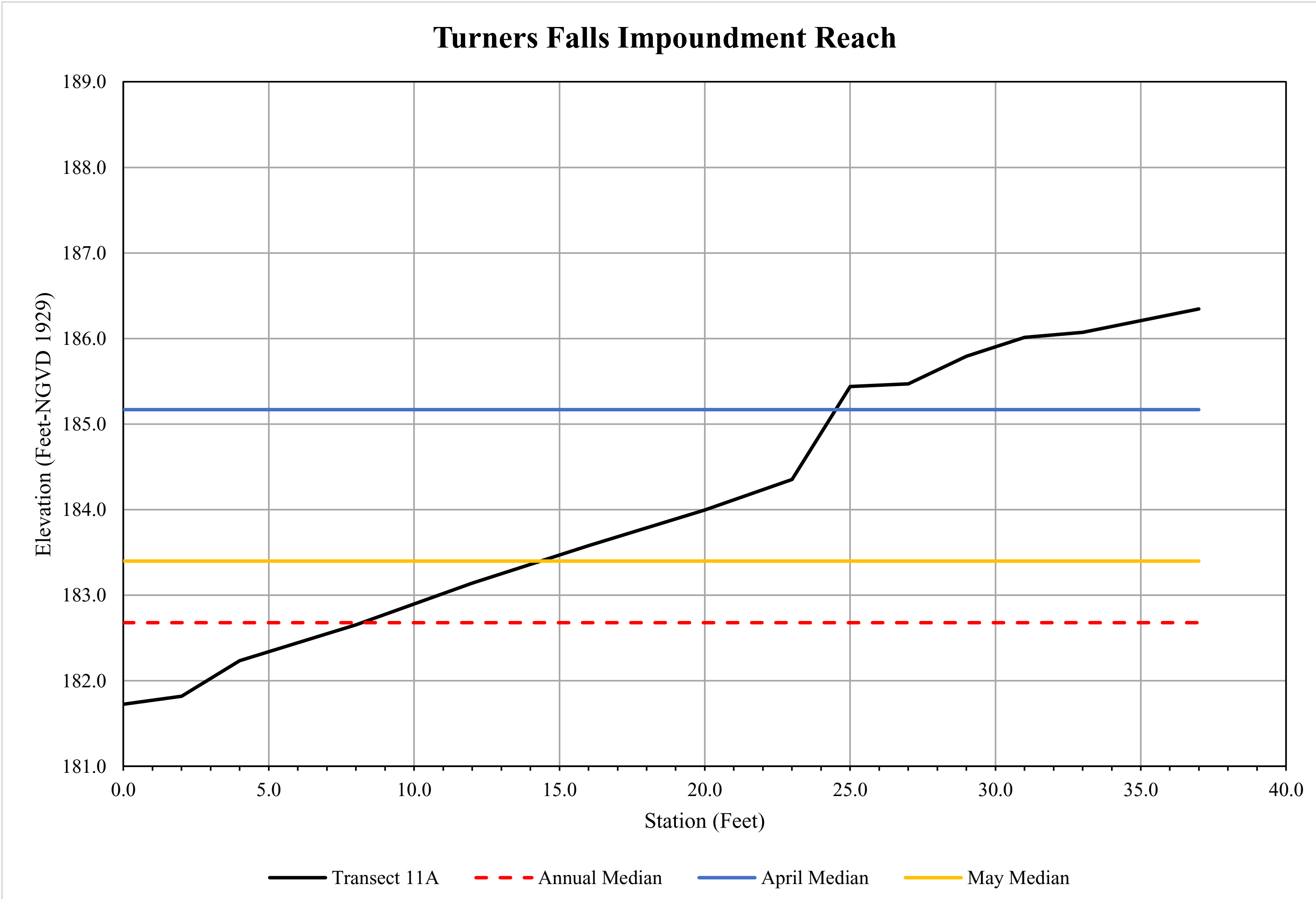


Figure 4.3-46: Transect 11A Elevation Survey, Distribution of Potential Spike Sedge Habitat, and Median Water Surface Elevations

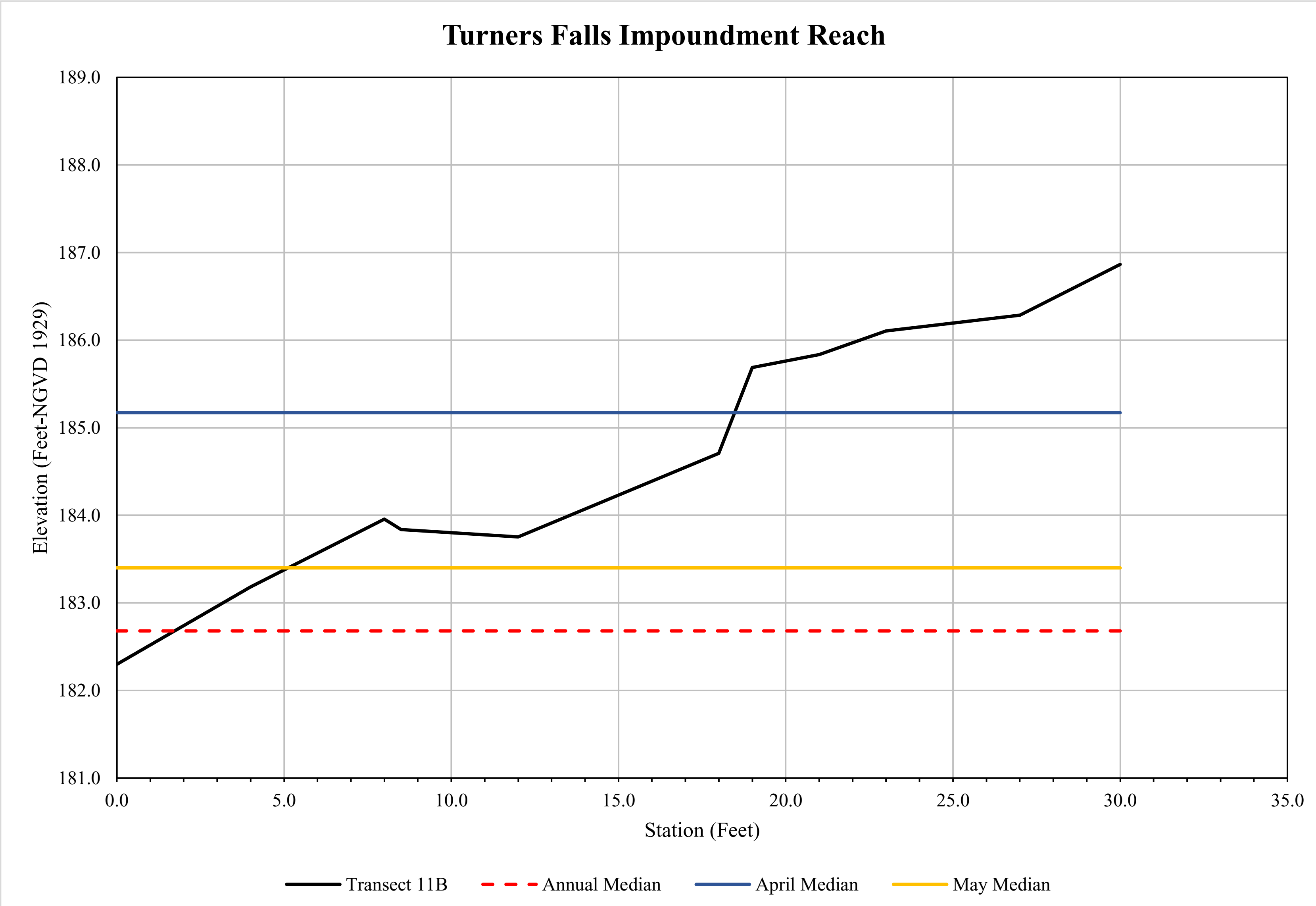


Figure 4.3-47: Transect 11B Elevation Survey, Distribution of potential Spike Sedge Habitat, and Median Water Surface Elevations

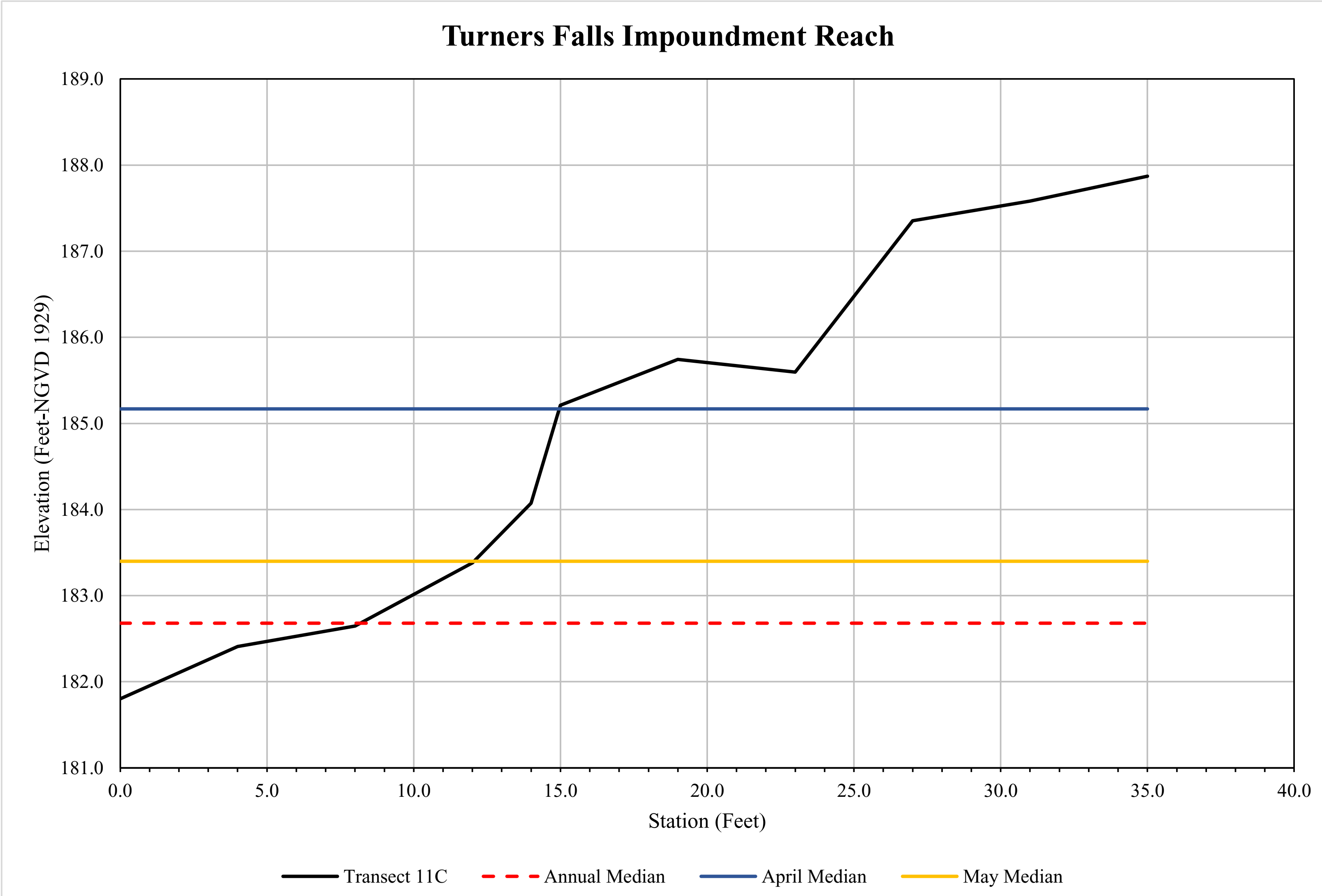


Figure 4.3-48: Transect 11C Elevation Survey, Distribution of potential Spike Sedge Habitat, and Median Water Surface Elevations

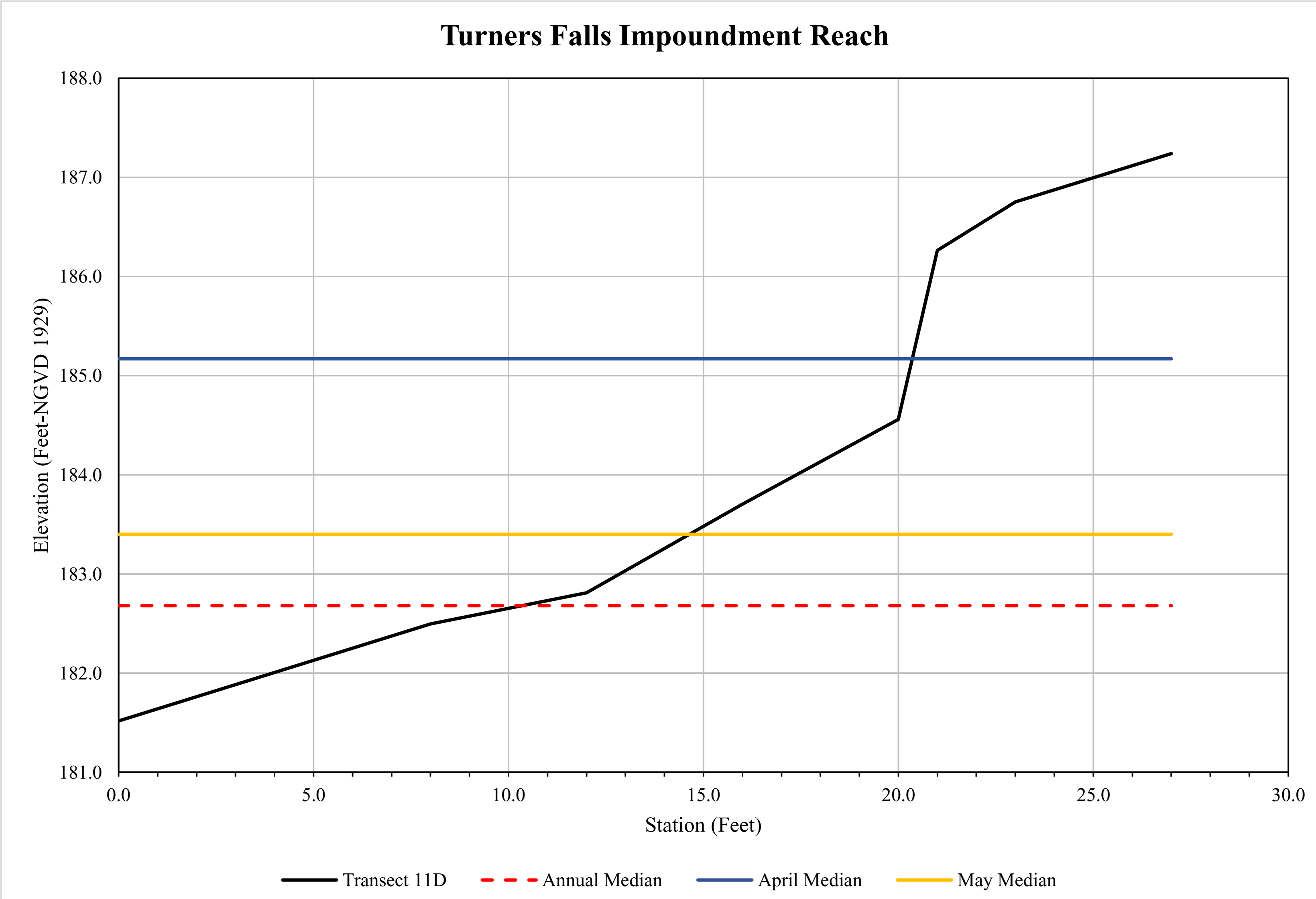


Figure 4.3-49: Transect 11D Elevation Survey, Distribution of Potential Spike Sedge Habitat, and Median Water Surface Elevations

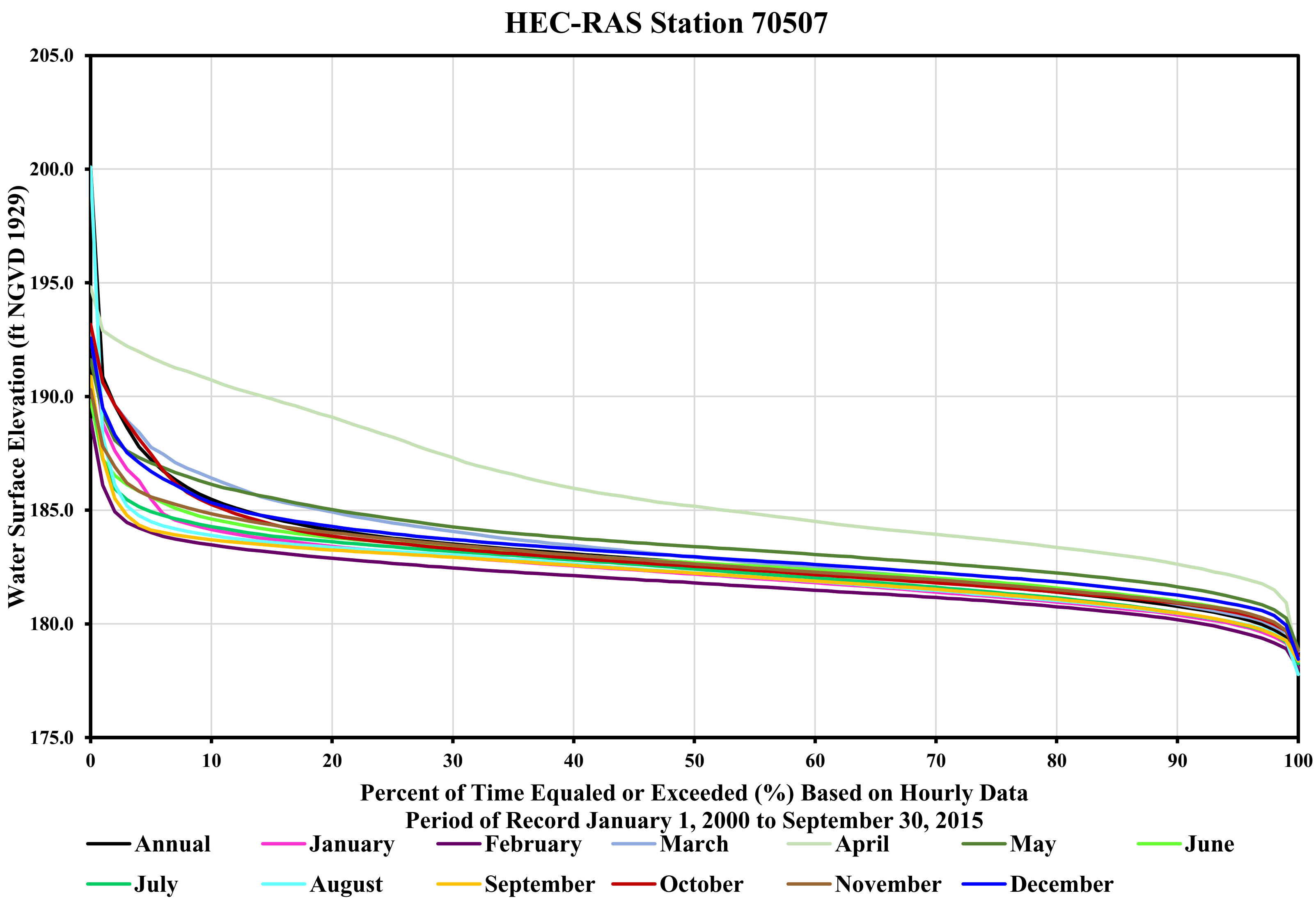


Figure 4.3-50: Percent Exceedance Curves for the Transect 11 Location

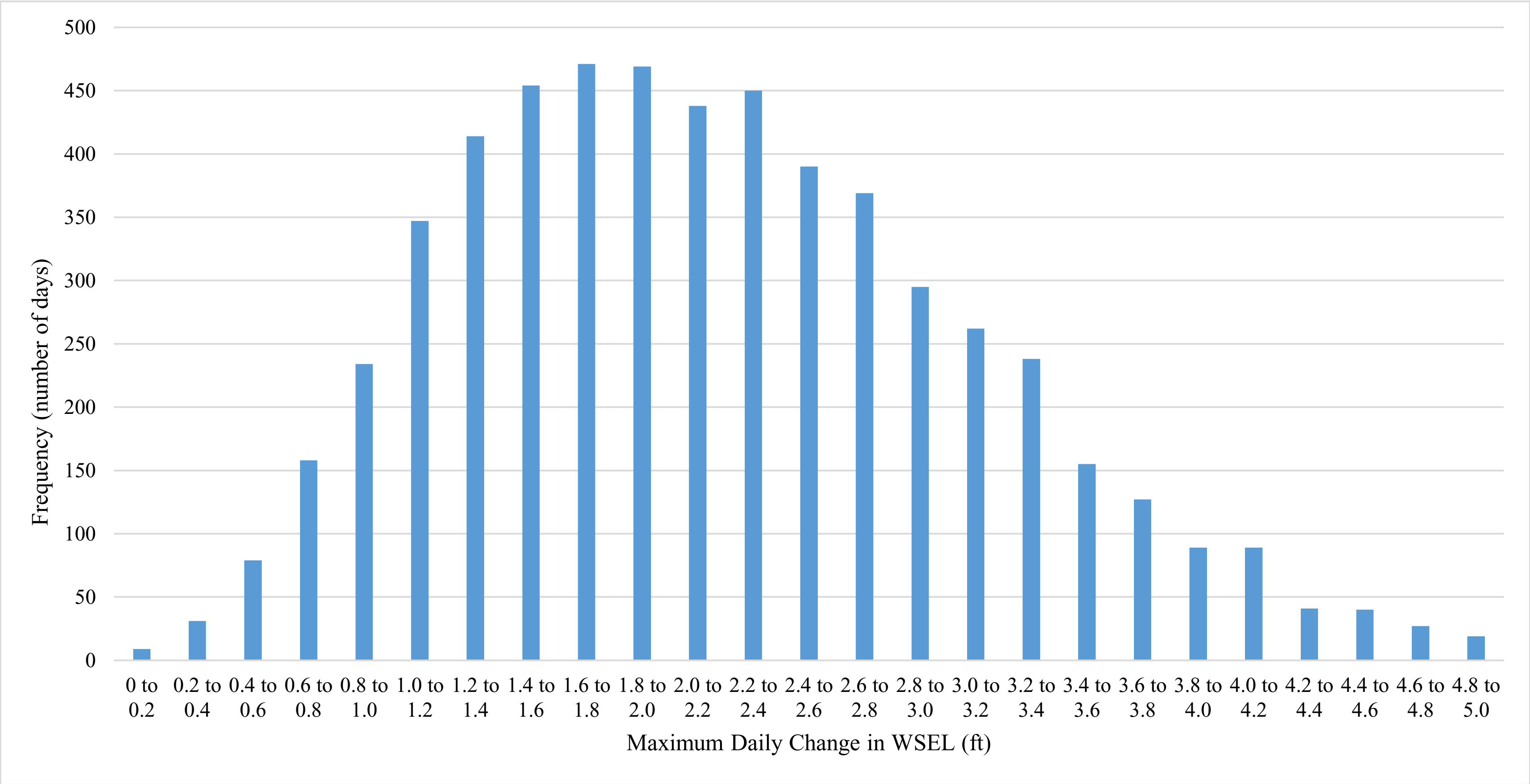


Figure 4.3-51: Annual Maximum Daily Change in Water Surface Elevation at the Transect 11 Location

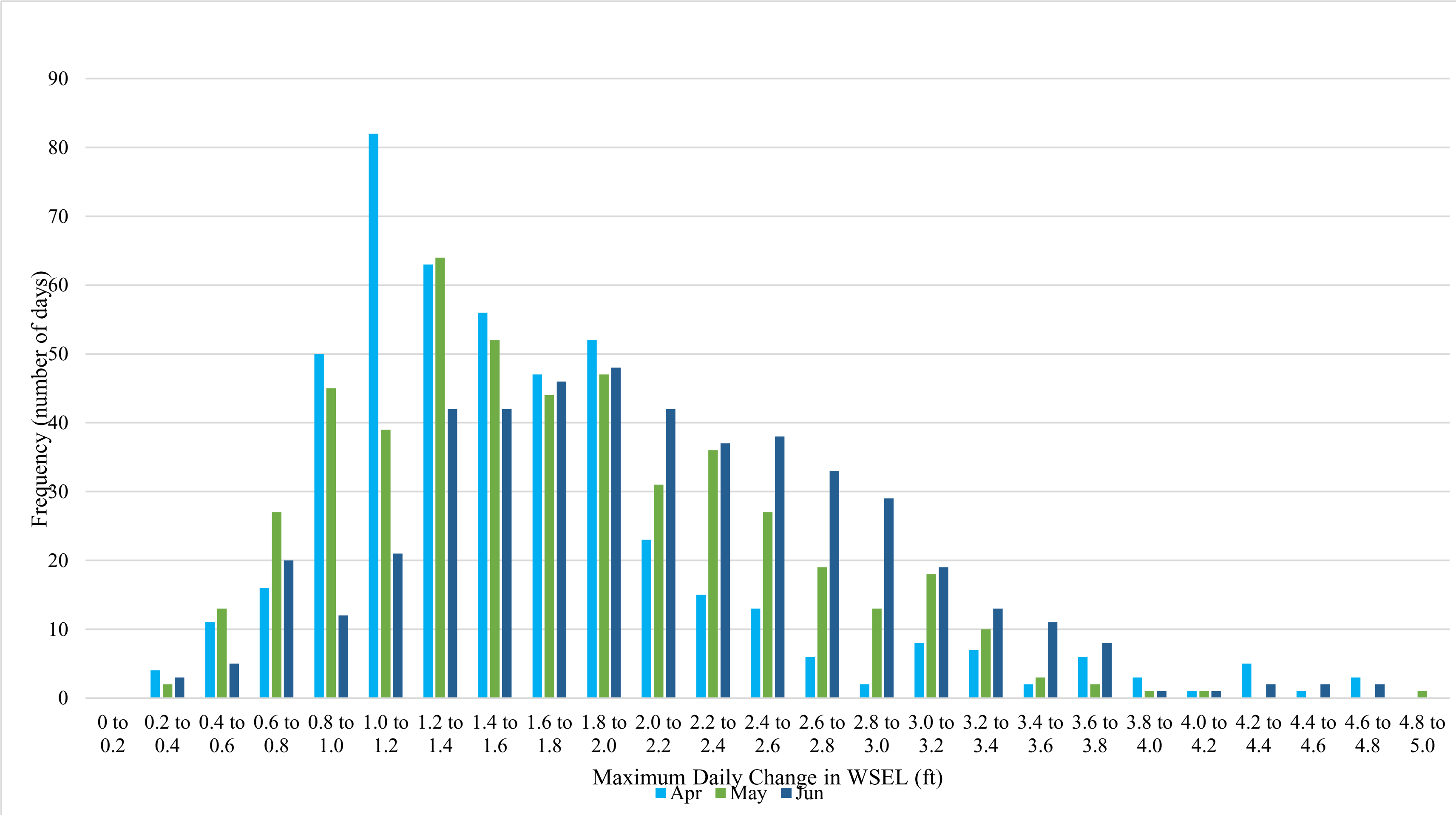


Figure 4.3-52: Spring Maximum Daily Change in Water Surface Elevation at the Transect 11 Location

Figure 4.3-53: Representative View of Transect 8 Habitat

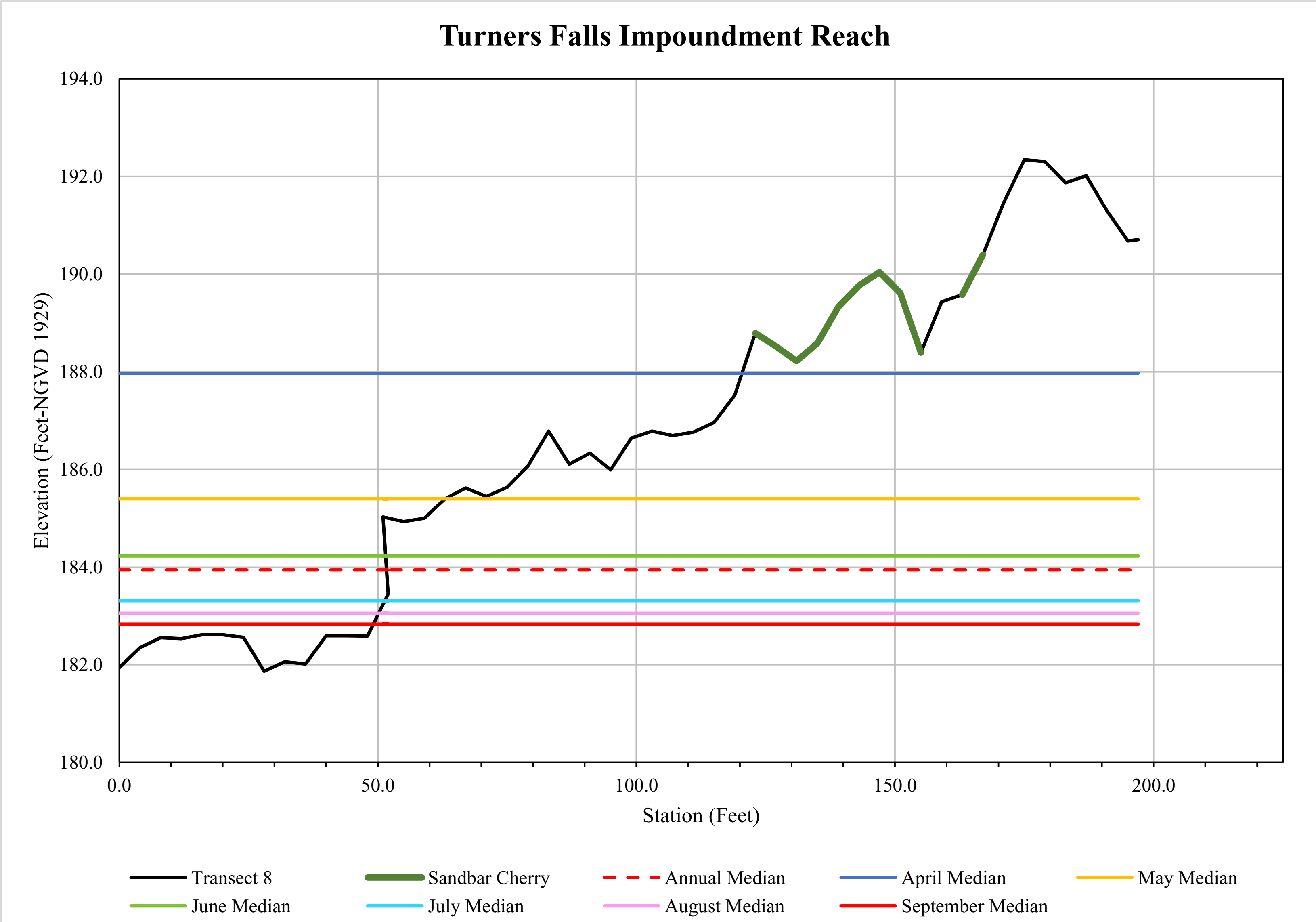


Figure 4.3-54: Transect 8 Elevation Survey, Distribution of Sandbar Cherry, and Median Water Surface Elevations

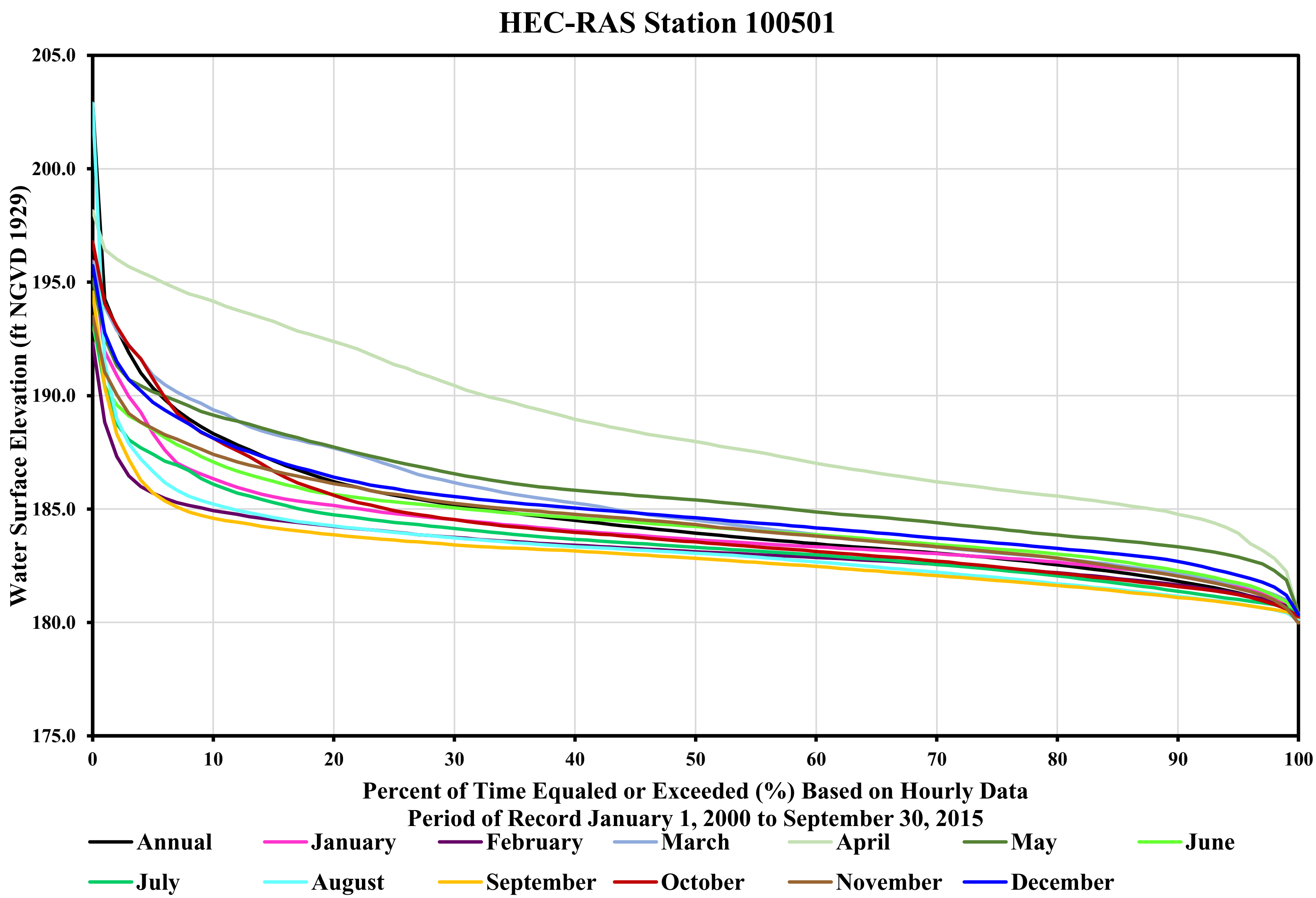


Figure 4.3-55: Percent Exceedance Curves for the Transect 8 Location

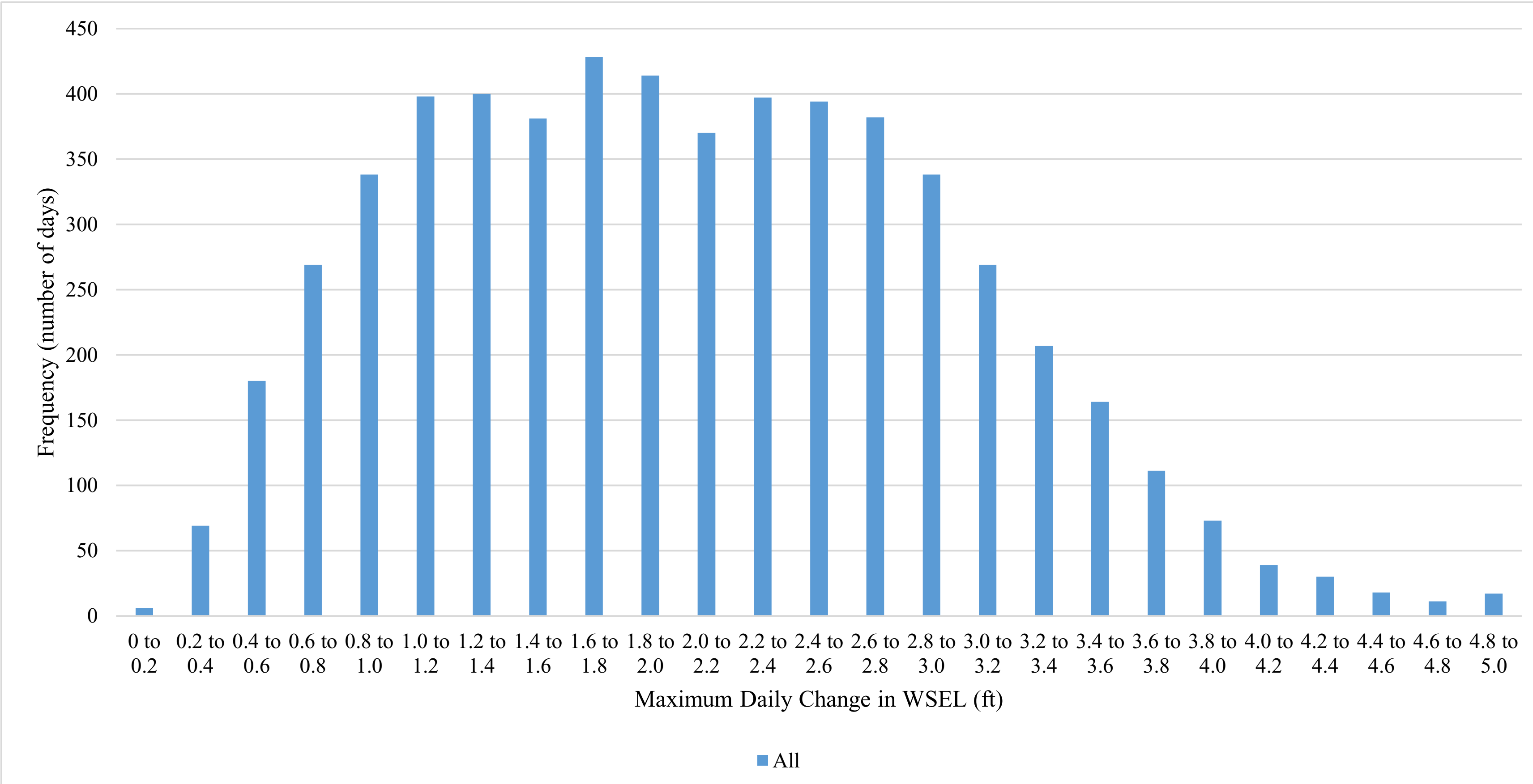


Figure 4.3-56: Annual Maximum Daily Change in Water Surface Elevation at the Transect 8 Location

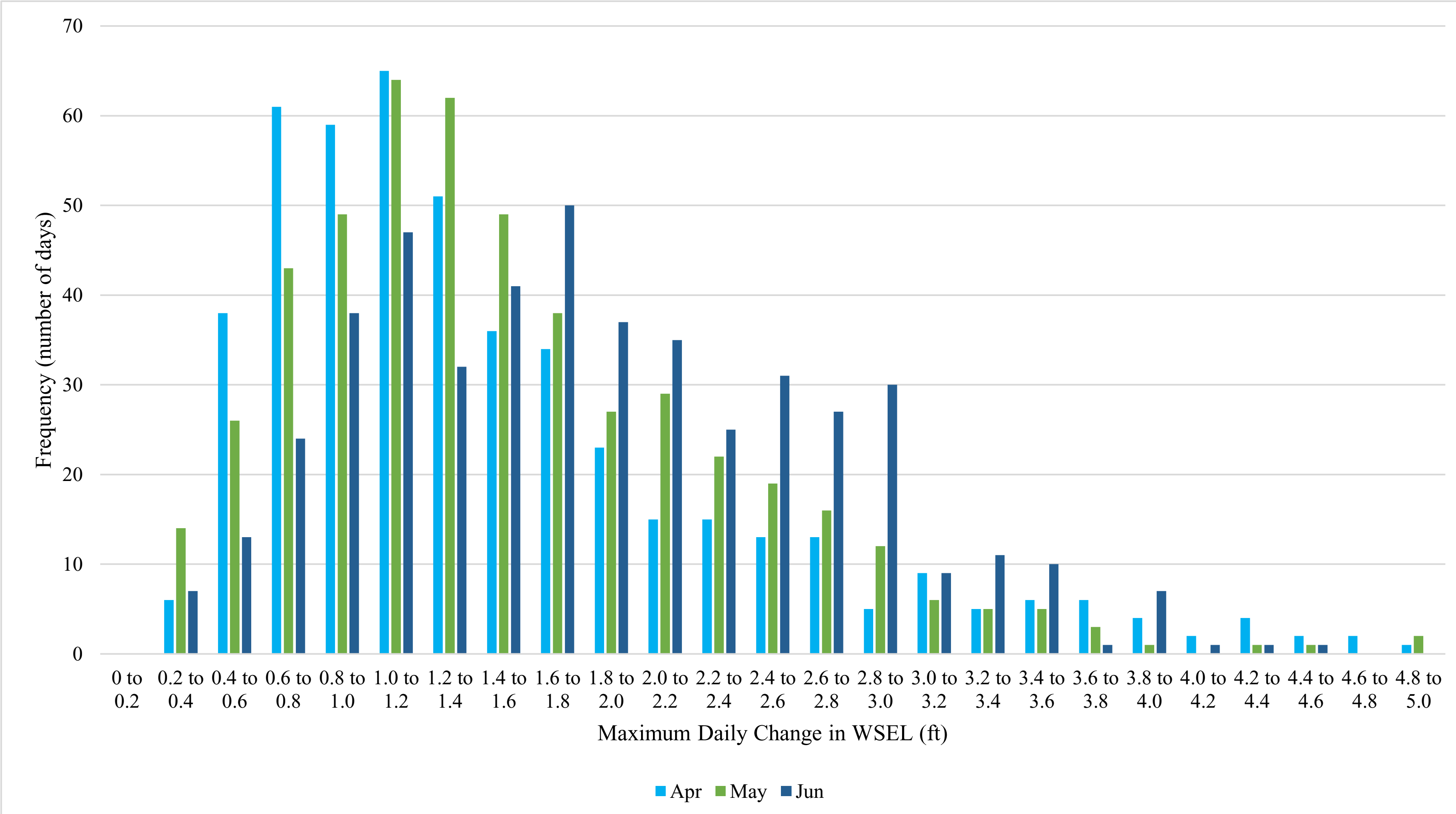


Figure 4.3-57: Spring Maximum Daily Change in Water Surface Elevation at the Transect 8 Location

Figure 4.3-58: Representative Habitat at the Transect 9 Location

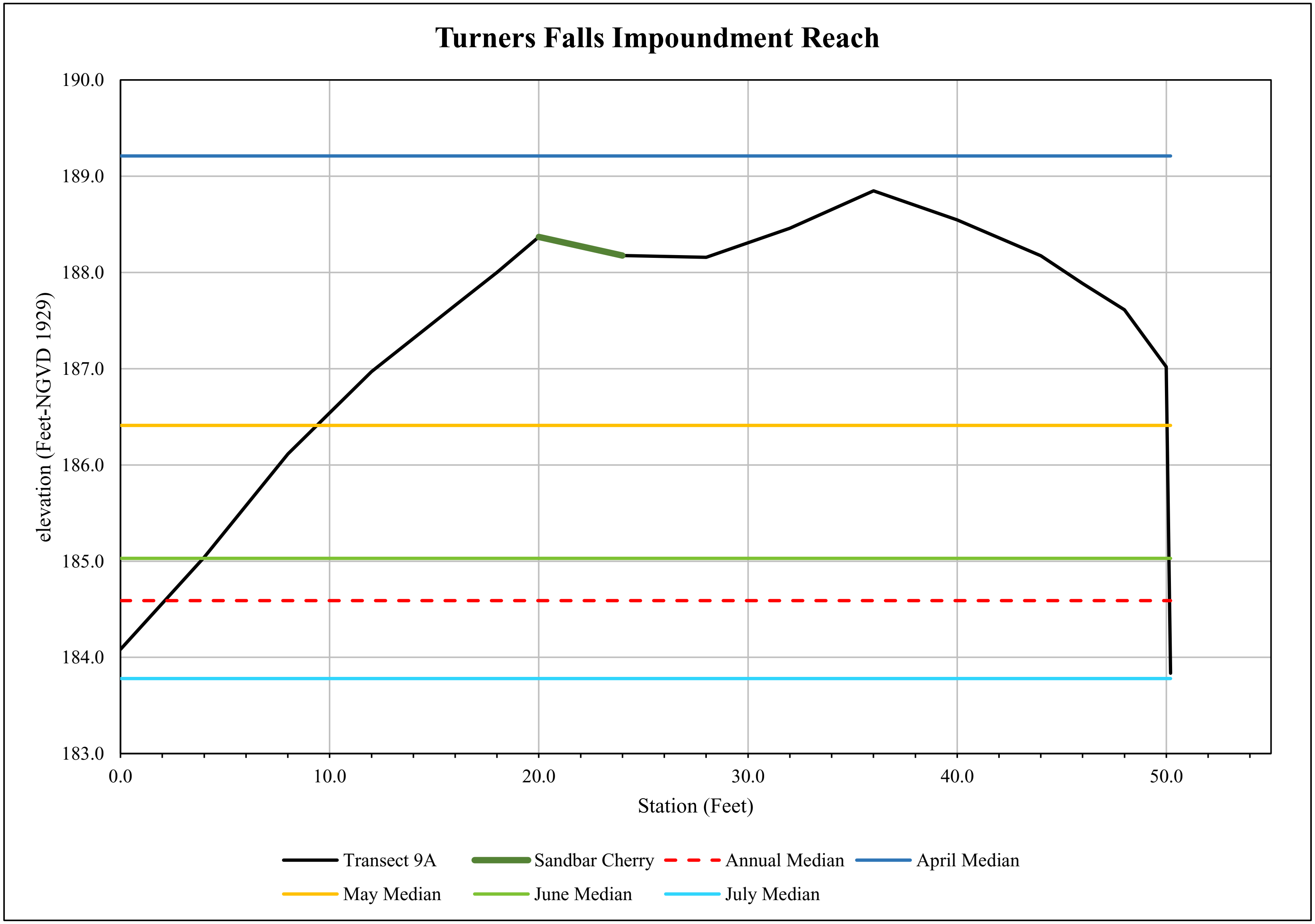


Figure 4.3-59: Transect 9A Elevation Survey, Distribution of Sandbar Cherry, and Median Water Surface Elevations

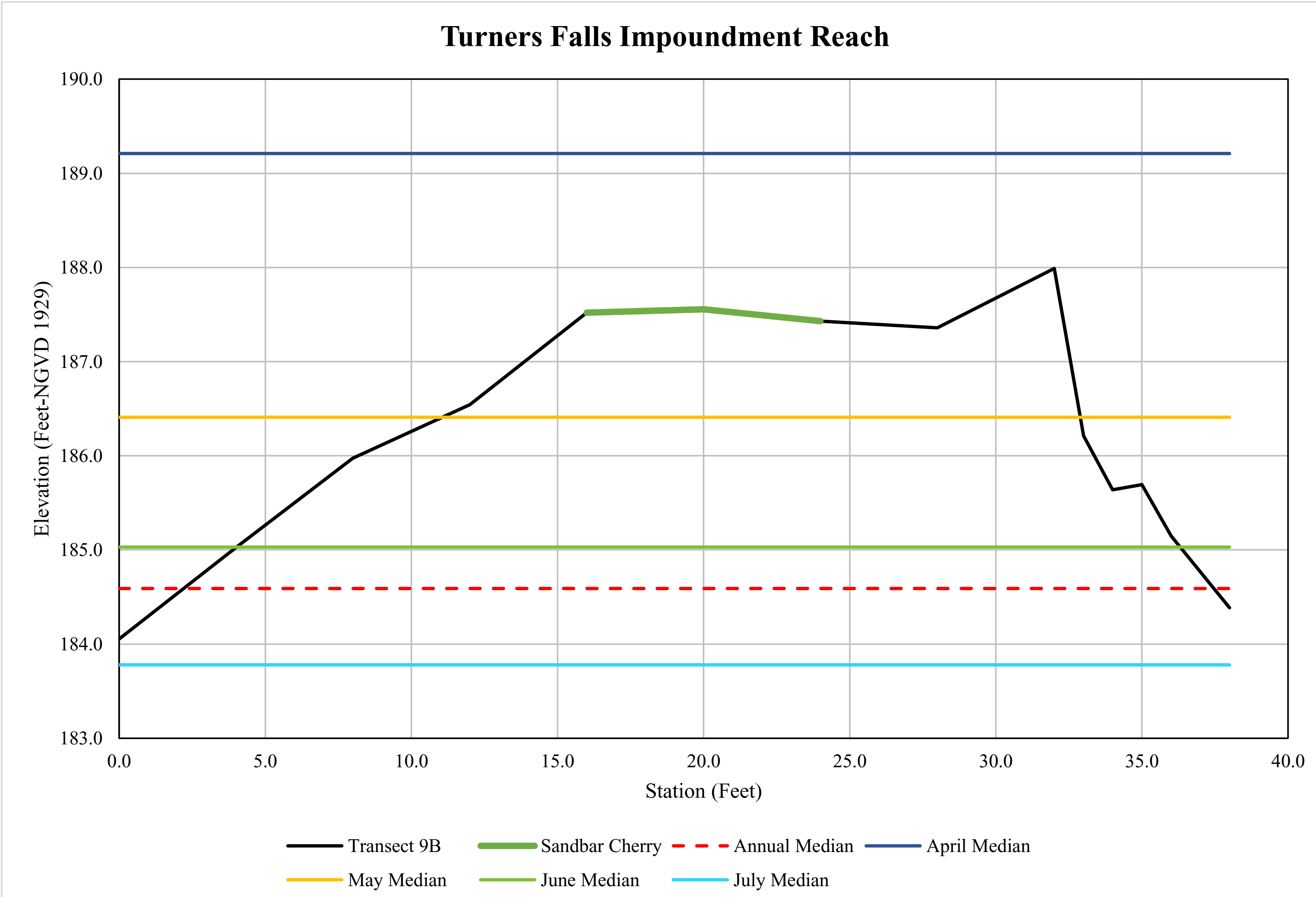


Figure 4.3-60: Transect 9B Elevation Survey, Distribution of Sandbar Cherry, and Median Water Surface Elevations

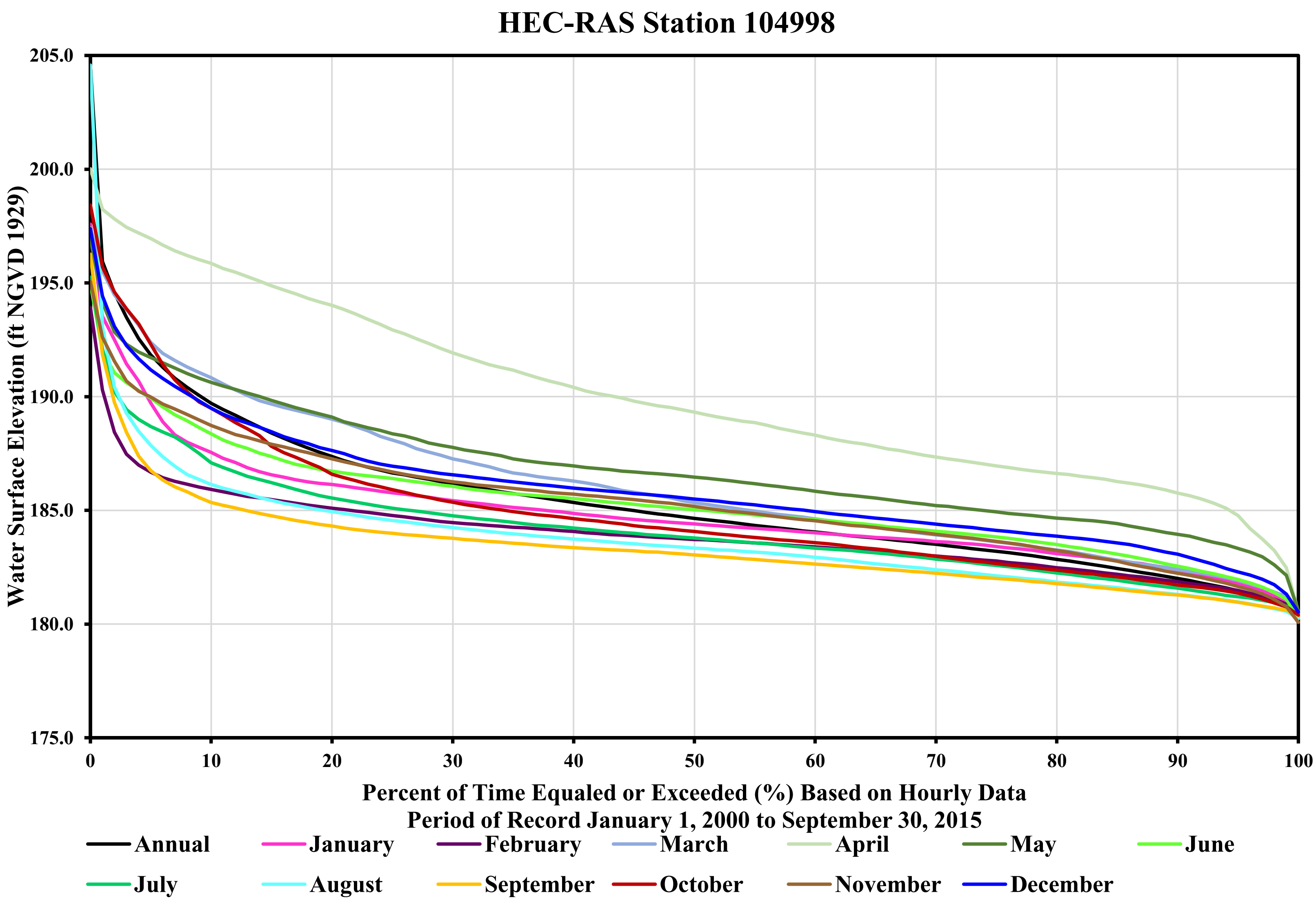


Figure 4.3-61: Percent Exceedance Curves for the Transect 9 Location

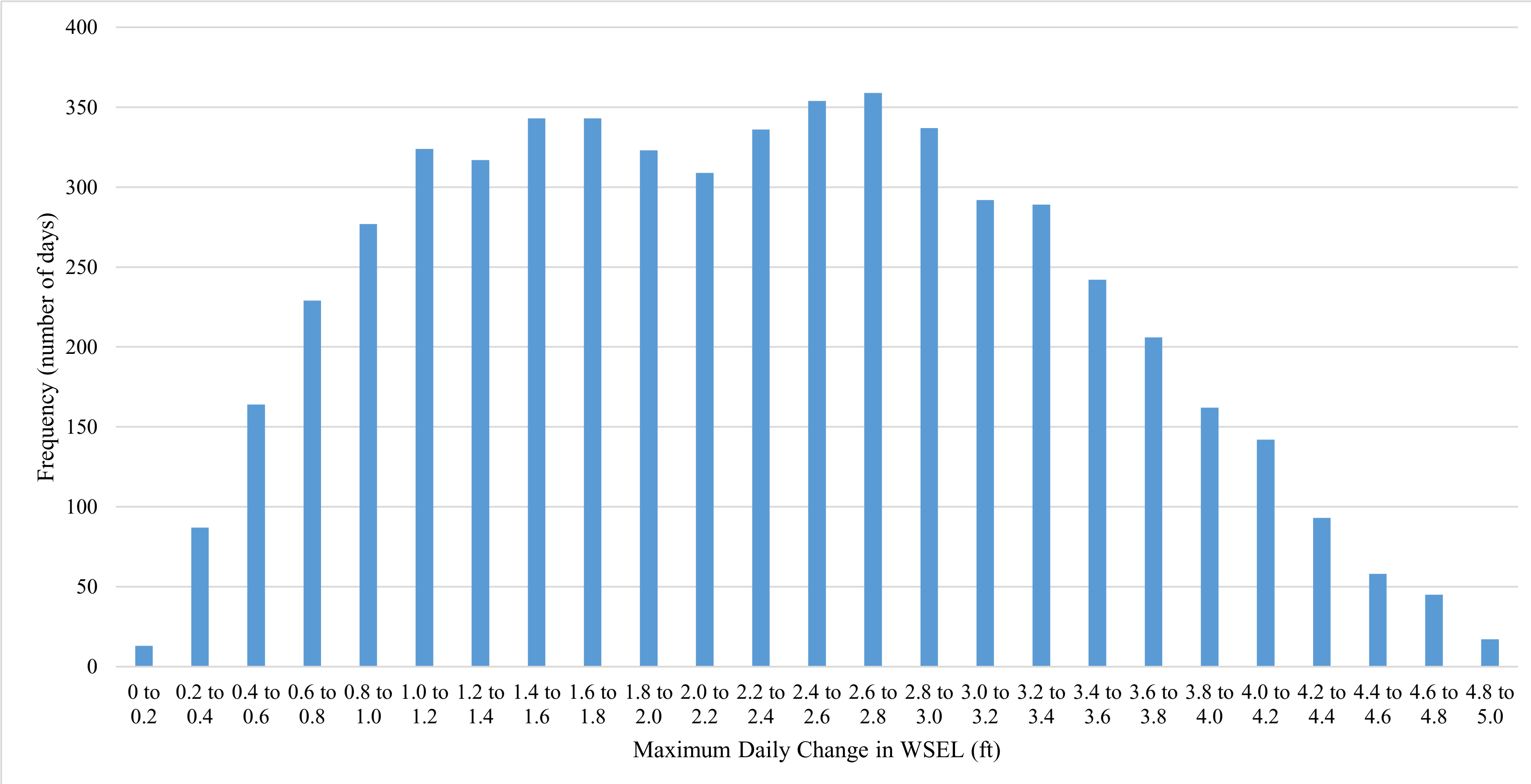


Figure 4.3-62: Annual Maximum Daily Change in Water Surface Elevation at the Transect 9 Location

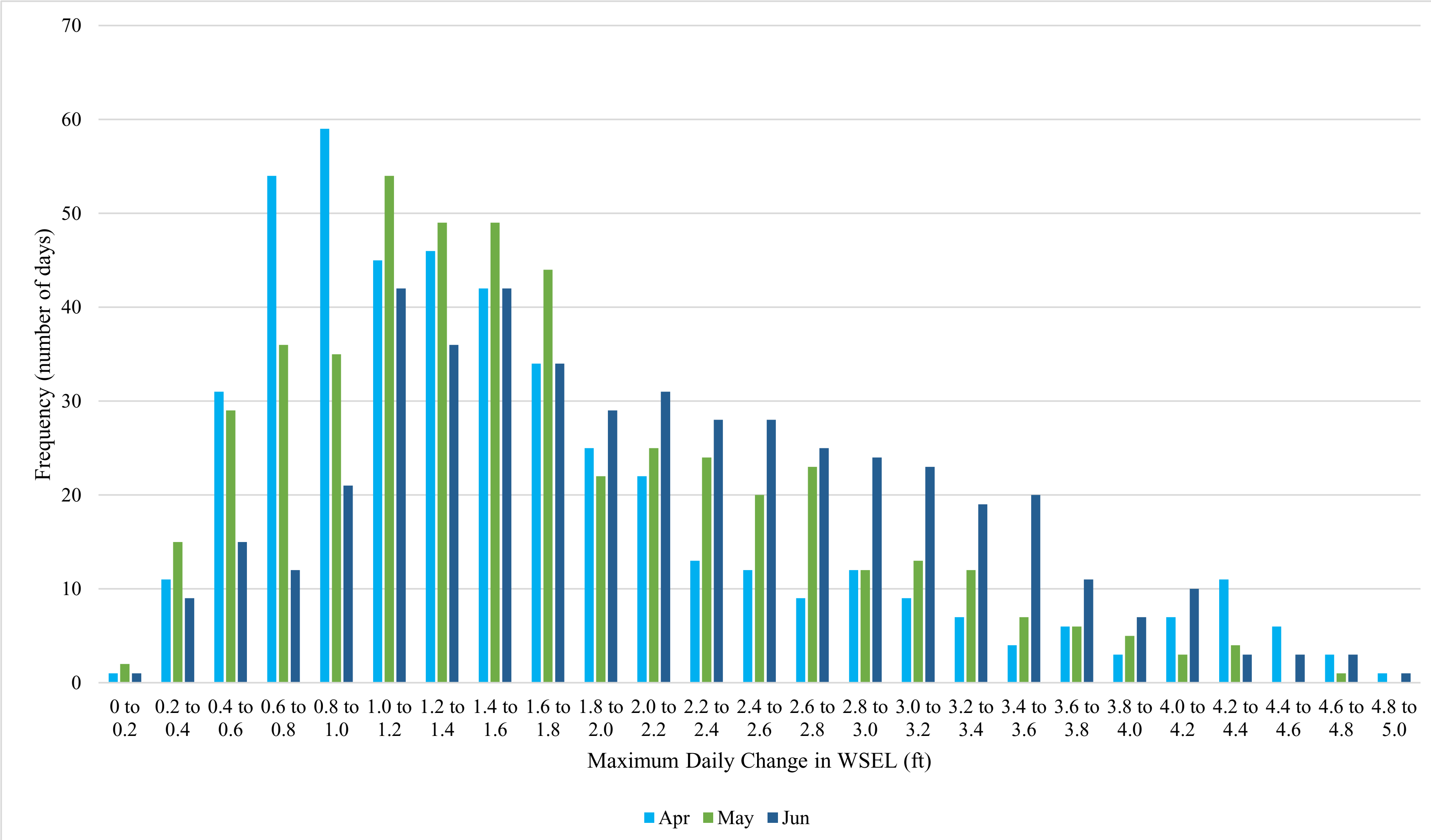


Figure 4.3-63: Spring Maximum Daily Change in Water Surface Elevation at the Transect 9 Location

Figure 4.3-64: View of Survey Transect 10, Looking North toward Vernon Dam

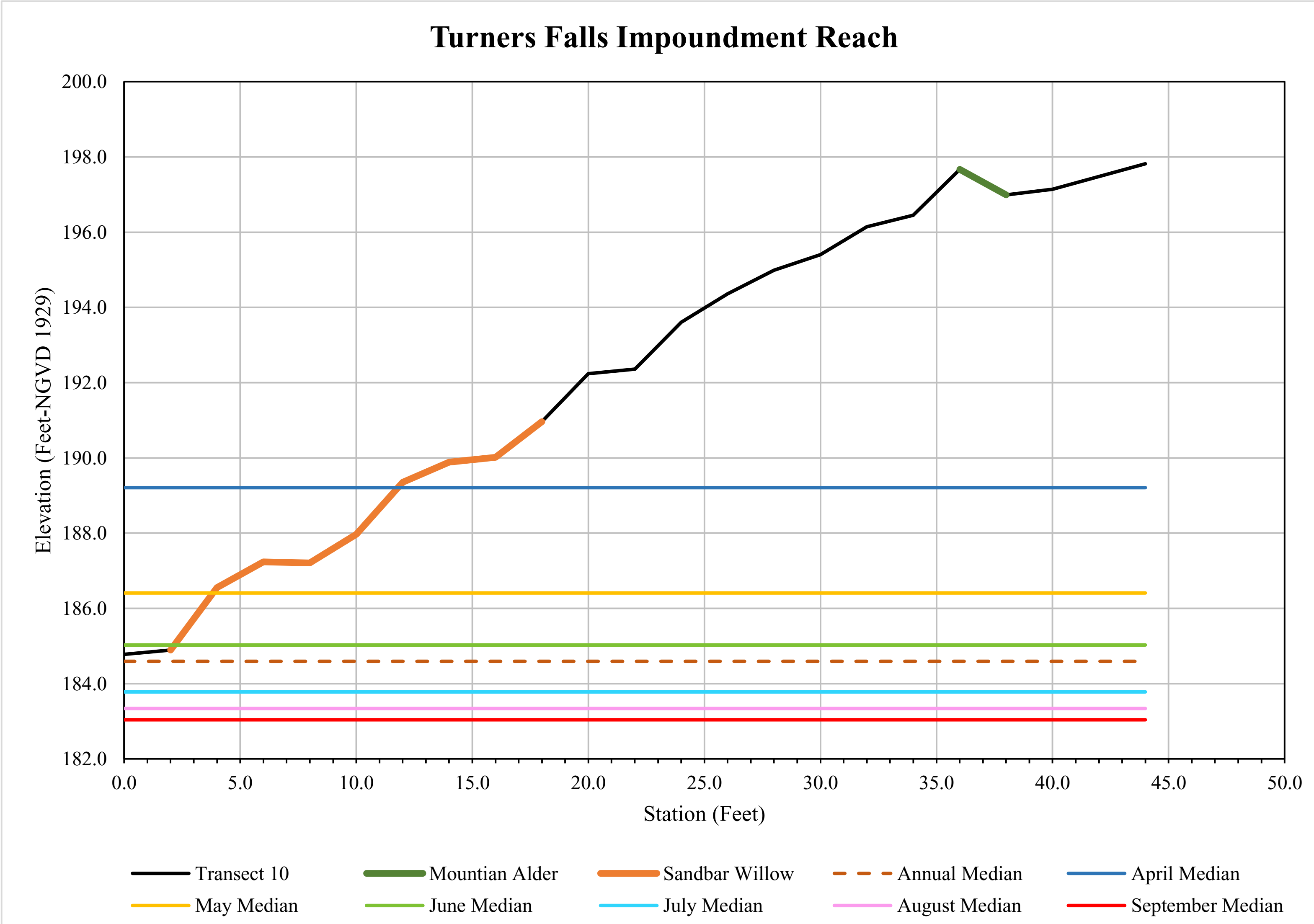


Figure 4.3-65: Transect 10 Elevation Survey, Distribution of Mountain Alder and Sandbar Willow, and Median Water Surface Elevations

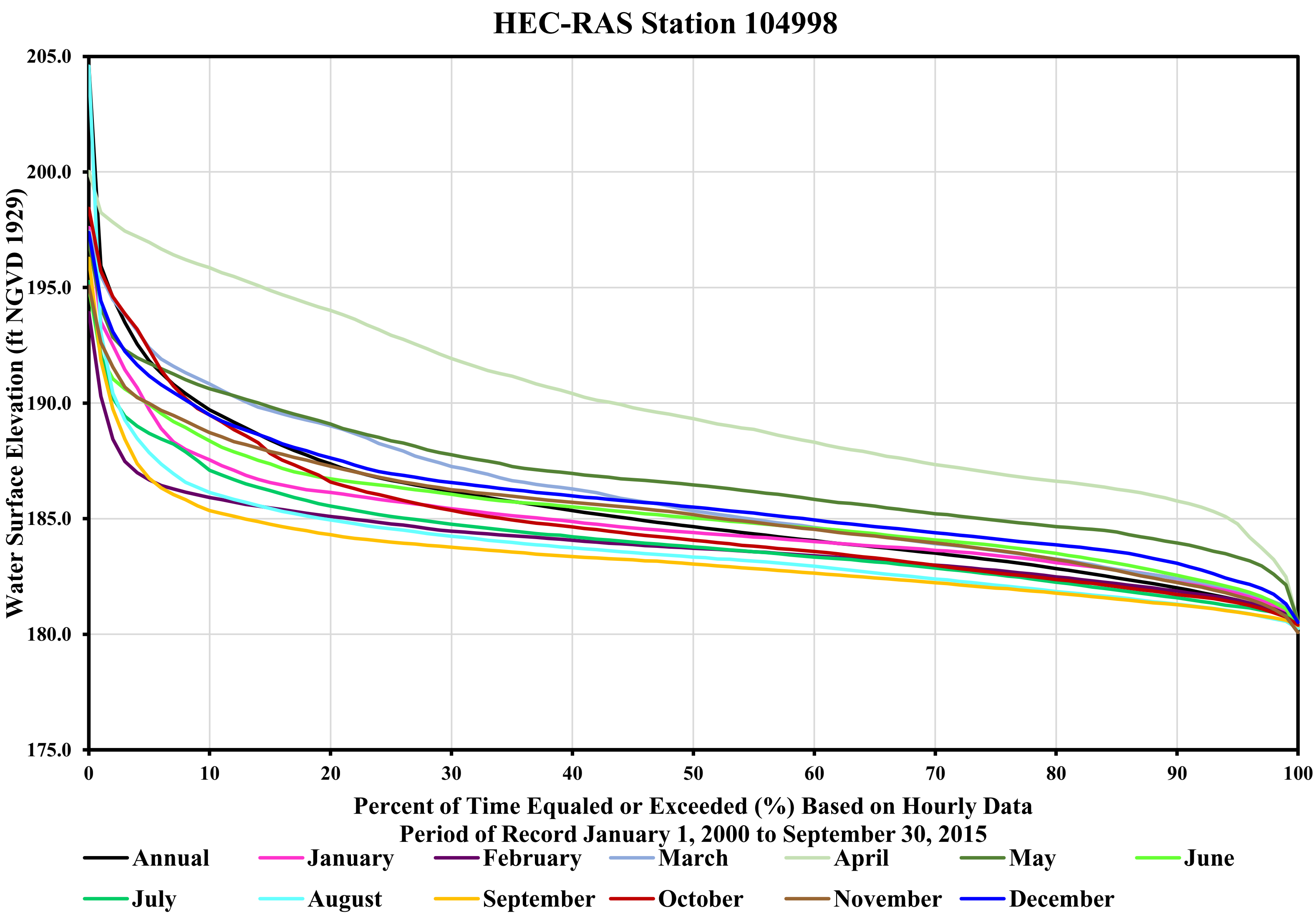


Figure 4.3-66: Percent Exceedance Curves for the Transect 10 Location

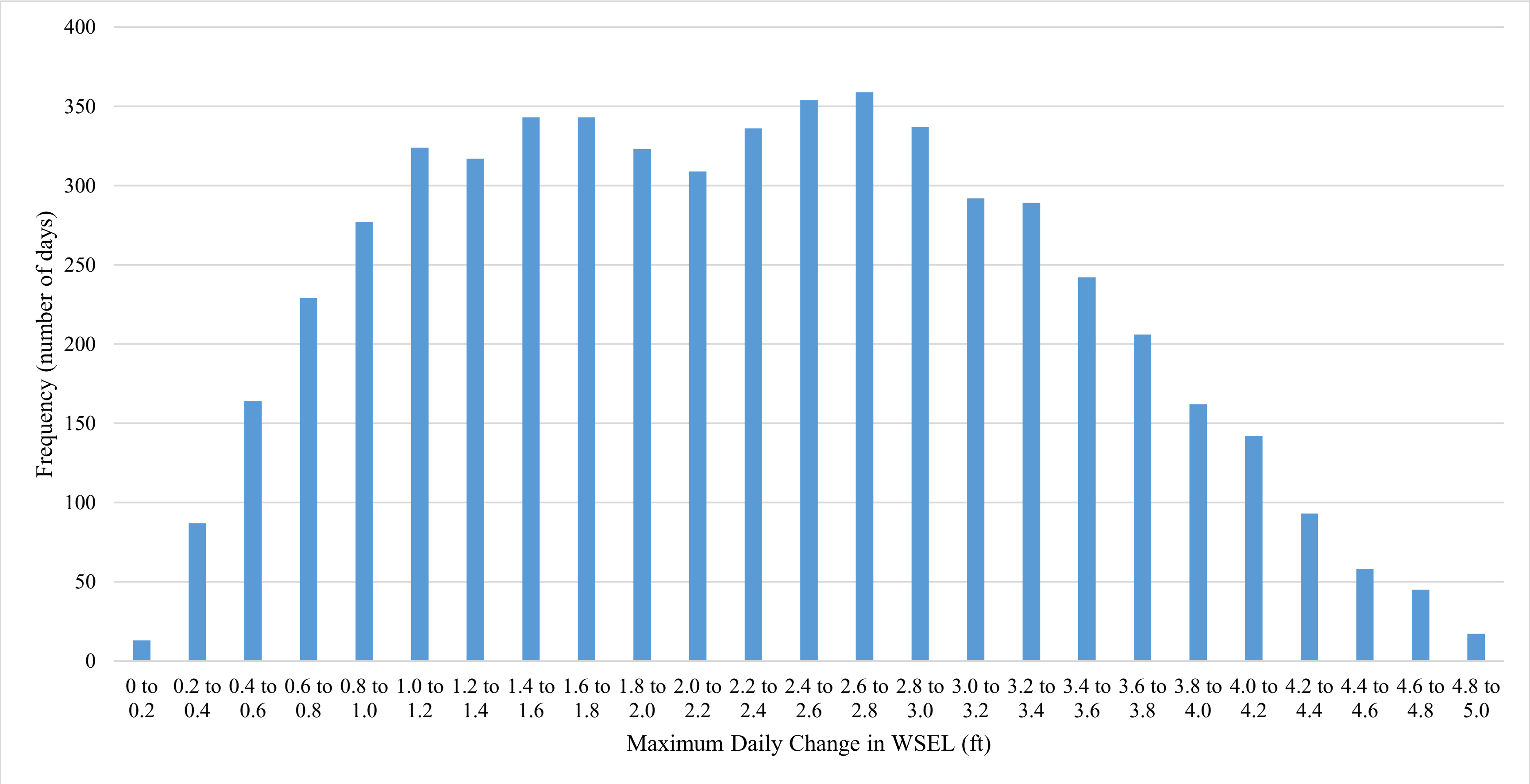


Figure 4.3-67: Annual Maximum Daily Change in Water Surface Elevation at the Transect 10 Location

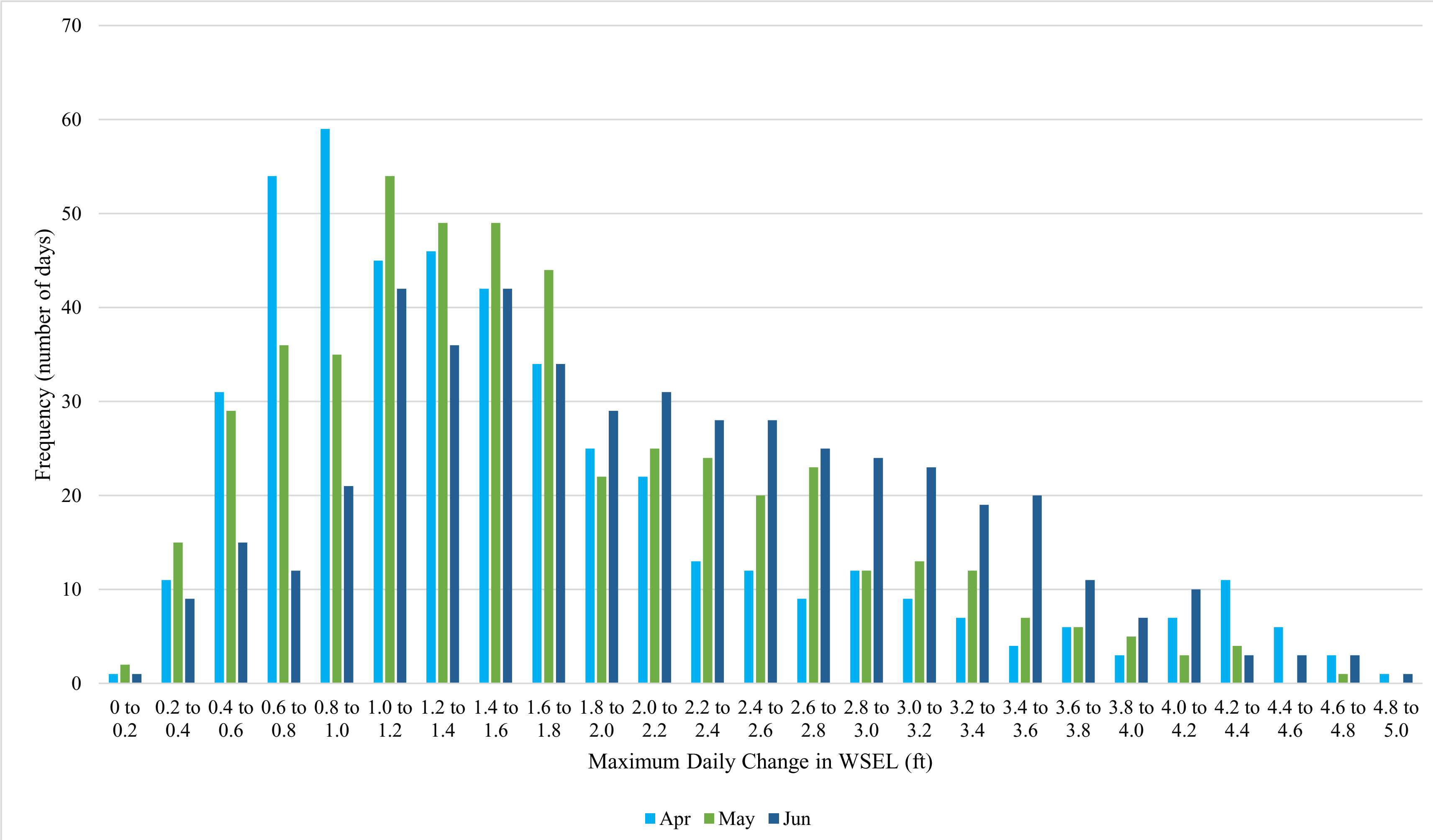


Figure 4.3-68: Spring Maximum Daily Change in Water Surface Elevation at the Transect 10 Location

4.4 Invasive Plant Survey

During fieldwork completed in 2014 and 2015, invasive plant species were identified and mapped within the study area (Table 4.4-1). In general, invasive species are not widespread throughout the study area. In particular, species such as common reed and purple loosestrife, which can occupy and form large monocultures along river banks, have not done so along much of the study area. Based on qualitative observations within the study area, oriental bittersweet, black swallowwort, and Japanese knotweed are the most commonly occurring species along much of the shoreline and islands. Species such as yellow iris (*Iris pseudoacrus*) and Japanese barberry (*Berberis thunbergii*) occur, but generally as discrete plants or small patches along the shoreline and islands. Figures included in Study Report 3.4.1 *Baseline Inventory of Terrestrial, Wildlife and Botanical Resources* (GSE, 2015b) show the distribution of invasive plant species within the TFI. The more commonly observed species are described below.

Black swallowwort

Black swallowwort is native to Europe, and the species was introduced in North America sometime in the late 1800s and escaped cultivation. Most concentrations of this species occur in the northeastern United States and eastern Canadian provinces. The species is a clonal, rhizomatous species and can form dense mats, often with a single plant appearing to be several individual plants. Within the study area, black swallowwort occurs primarily on islands and occasionally on the shoreline. While wide-spread monocultures were not observed within the study area, several patches of this species do occur.

Japanese knotweed

Japanese knotweed was introduced initially in the United Kingdom sometime after 1830 and became popular in landscaping. By the 1900s, Japanese knotweed had been introduced to the United States and was widespread throughout the country. Japanese knotweed inhabits a variety of habitats and thrives in riparian areas and the edges of wetlands. The species exhibits rapid growth, and, if left un-checked, can outcompete and exclude most other vegetation. Within the study area, stands of Japanese knotweed are most common along riparian areas and on islands. Several large patches are also located in areas along Barton Cove. While not widespread throughout the study area, occasional mono-cultures of Japanese knotweed do occur in discrete locations.

Oriental bittersweet

Oriental bittersweet is native to Korea, China, and Japan. In North America, bittersweet was likely introduced around 1860 as an ornamental plant and is now sporadically distributed. In the eastern United States, Oriental bittersweet occupies mesic, mixed hardwood forests and edge habitat. Oriental bittersweet is a deciduous liana with the woody stems reaching up to 66 feet in length. In open habitat, it assumes a sprawling growth form, often forming impenetrable thickets. Rapid growth and smothering of native vegetation are the primary threats of Oriental bittersweet. Within the study area, it is the most common and widely distributed invasive species. It is found along most of the shoreline of the study area, and forms dense thickets and blankets native vegetation in some locations.

Table 4.4-1: Terrestrial Invasive Species Identified within the Study Area

Scientific Name	Common Name
Berberis thunbergii	Japanese Barberry
Celastrus orbiculatus	Oriental Bittersweet
Centaurea stoebe	Spotted Knapweed
Cynanchum louiseae	Black Swallowwort
Elaeagnus umbellata	Autumn Olive
Euonymus alatus	Burning Bush
Fallopia japonica	Japanese Knotweed
Frangula alnus	Glossy Buckthorn
Ipomoea cairica	Mile-a-minute Vine
Iris pseudacorus	Yellow Iris
Lythrum salicaria	Purple Loosestrife
Phalaris arundinacea	Reed Canary Grass
Phragmites australis	Common Reed

4.5 Mapping Wetlands and Waters of the United States

In 2014 and 2015, NWI wetlands with the study area were verified. If new wetlands (not occurring in the mapped NWI data) were located, the approximate boundaries were identified. Verified wetlands account for approximately 1,382 acres of wetland and include emergent, scrub-shrub, and forested wetland types (Table 4.5-1). In addition, biologists identified an additional 55.7 acres of wetlands that were not captured in current NWI wetland mapping (Table 4.5-2). In total, the study area includes approximately 1,438 acres of wetland habitat with shrub dominated wetlands and freshwater ponds being most common. Figure 4.5-1 shows the location of verified wetlands and newly identified wetlands within the study area. In general, the principle functions and services of wetlands within the study area are flood attenuation, wildlife habitat, shoreline stabilization, fish and shellfish habitat, visual quality, and recreation.

Palustrine Emergent Wetlands

Palustrine emergent wetlands within the study area occur, primarily, as fringe wetlands along the shoreline (Figure 4.5-2). The largest examples of these wetlands occur near Turners Falls Dam and the Barton Cove area. Large expanses of emergent and deep emergent marshes occur in these areas. Dominant species within these wetlands include American bulrush (*Schoenoplectus acutus*), sweet flag (*Acorus americanus*), soft-stem bulrush (*Schoenoplectus tabernaemontani*), arrowhead (*Sagittaria latifolia*), pickerelweed (*Pontederia cordata*), bur-reed (*Sparganium sp.*), and cattail (*Typha sp.*). Palustrine emergent wetlands within the study area provide several functions, primarily as wildlife habitat and also through sediment and toxicant retention.

Palustrine Scrub-Shrub Wetlands

Palustrine scrub-shrub wetlands are the least abundant wetland type observed within the study area. Generally these wetland types occur in association with larger emergent or forested wetland complexes. The shrub wetlands occur along the fringes of emergent wetlands or intermixed in open canopy areas adjacent to or within forested communities. Dominant shrub vegetation within these wetlands includes alder (*Alnus incana*), button bush (*Cephalanthus occidentalis*), winterberry (*Ilex verticillata*), red-osier dogwood (*Cornus sericea*), elderberry (*Sambucus canadensis*), silky dogwood (*Cornus amomum*), high bush blueberry (*Vaccinium corymbosum*), and saplings of over story species. Herbaceous vegetation varies depending on light penetration, but may include sensitive fern (*Onoclea sensibilis*), horsetails (*Equisetum spp.*), jewelweed (*Impatiens sp.*), ostrich fern (*Matteuccia struthiopteris*), royal fern (*Osmunda regalis*), cinnamon fern (*Osmundastrum cinnamomeum*), and interrupted fern (*Osmunda claytonia*). Functionally these wetland provide primarily wildlife habitat. Depending upon landscape position, these wetlands may also aid in flood storage, shoreline stabilization, and sediment retention.

Palustrine Forested Wetlands

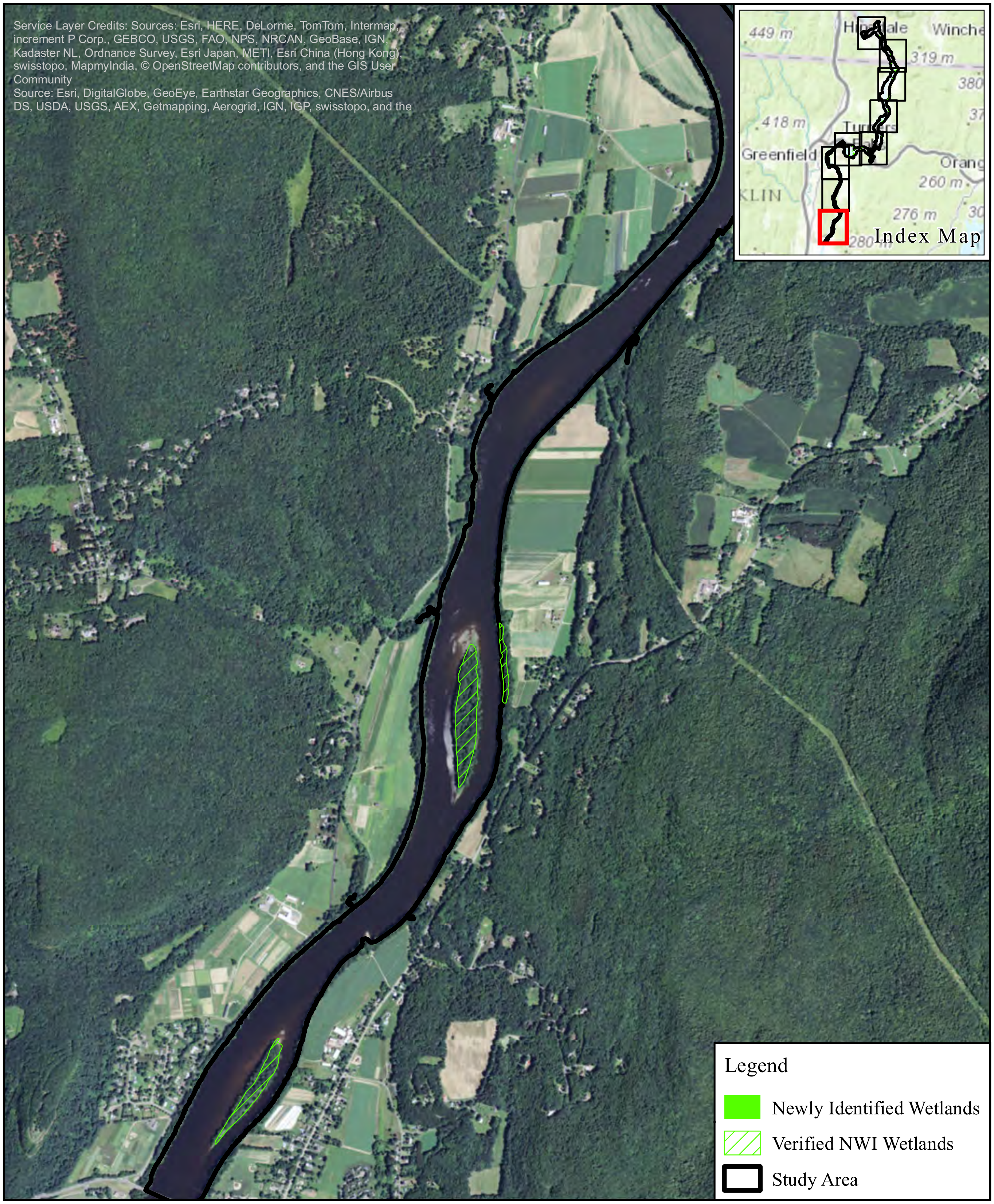
Palustrine forested wetlands within the study area are primarily hardwood forested floodplains. These areas are often inundated during the spring by high water (Figure 4.5-3). Excellent examples of these forested wetland systems are present near the Pauchuag boat launch (Figure 4.5-4). Dominant overstory species include silver maple (*Acer saccharinum)*, red maple (*Acer rubrum*), American basswood (*Tilia Americana*), American elm (*Ulmus americana*), willow, and cottonwood. The shrub layer in these systems is limited, but occasional alders and dogwoods occur. Herbaceous vegetation includes sensitive fern, ostrich fern, skunk cabbage (*Symplocarpus foetidus*), blue flag iris (*Iris versicolor*), clearweed (*Pilea pumila*), false nettle (*Boehmeria cylindrica*), and stinging nettle (*Urtica dioica*). Several islands within the study area also contain similar forested floodplains. In some cases, Japanese knotweed has invaded the understory of these systems. Forested wetland systems within the study area provide several important functions and services, most importantly flood storage, wildlife habitat, shoreline stabilization, and sediment retention.

Table 4.5-1: NWI Wetlands Verified as Occurring Within the Study Area

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**

Table 4.5-2: Newly Identified Wetlands Mapped Within the Study Area

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



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

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

Figure 4.5- 1: Wetland Mapping within the Study Area Map 1

N

0 0.125 0.25 0.5 Miles

FirstLight GDF SUEZ

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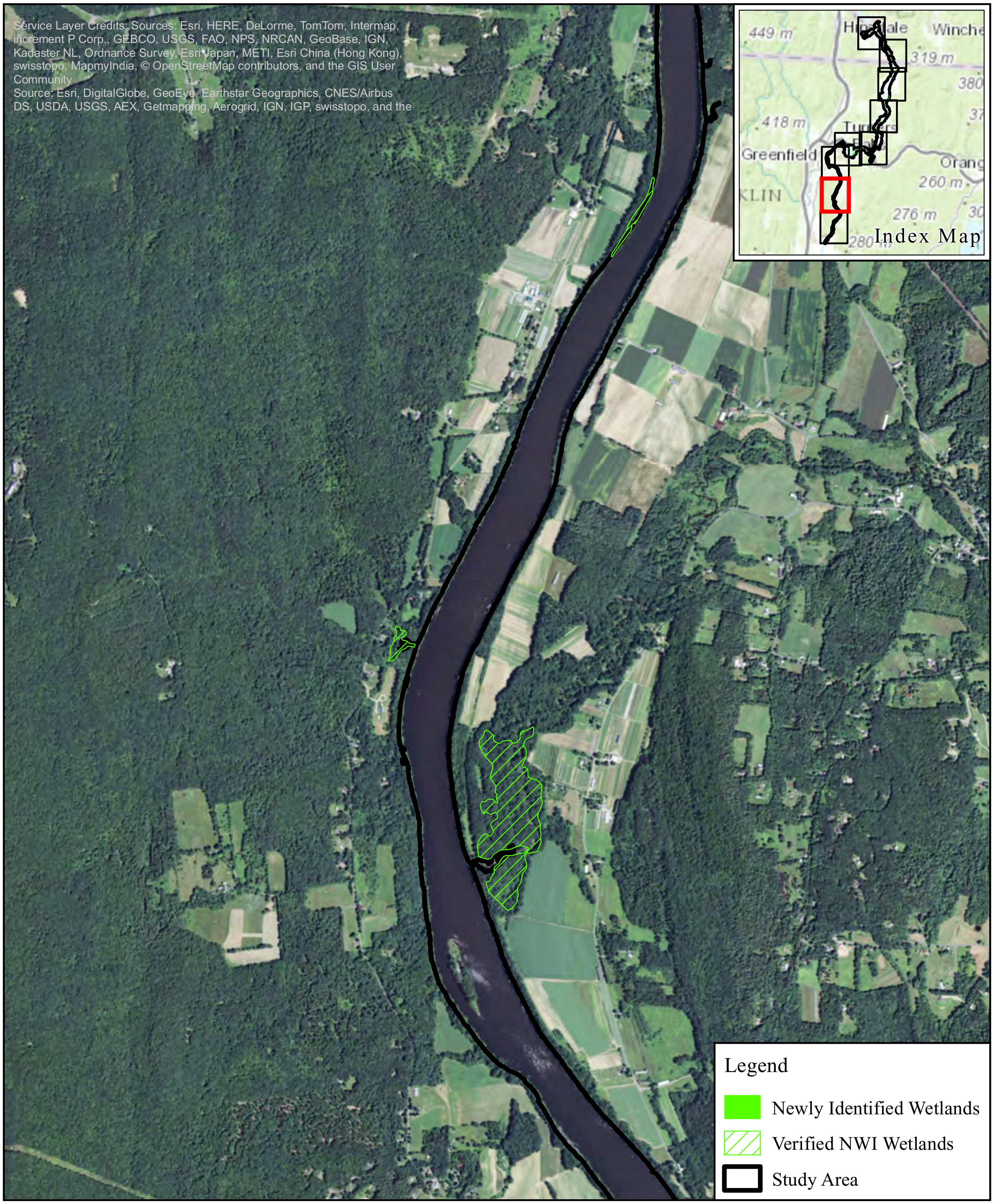

Northfield Mountain Pumped Storage Project (No. 2485)
and Turners Falls Hydroelectric Project (No. 1889)
Study 3.5.1 Baseline Inventory of Wetland, Riparian and Littoral Habitat in the Turners Falls Impoundment and Assessment of Operational Impacts on Special Status Species

Figure 4.5- 1: Wetland Mapping within the Study Area
Map 2

FirstLight GDF SUEZ

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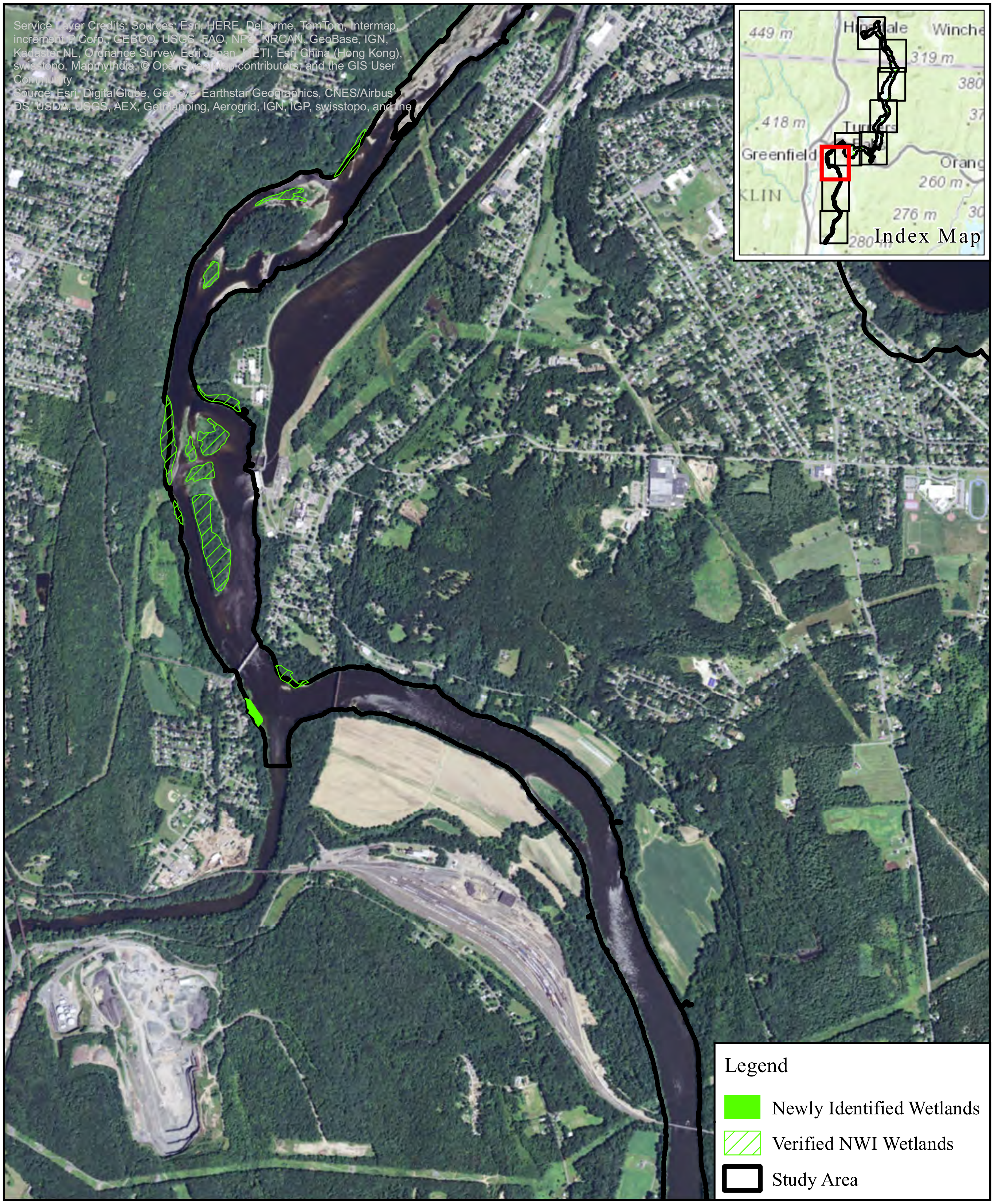

Northfield Mountain Pumped Storage Project (No. 2485) and Turners Falls Hydroelectric Project (No. 1889)

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

N

0 0.125 0.25 0.5 Miles

Figure 4.5- 1: Wetland Mapping within the Study Area Map 3

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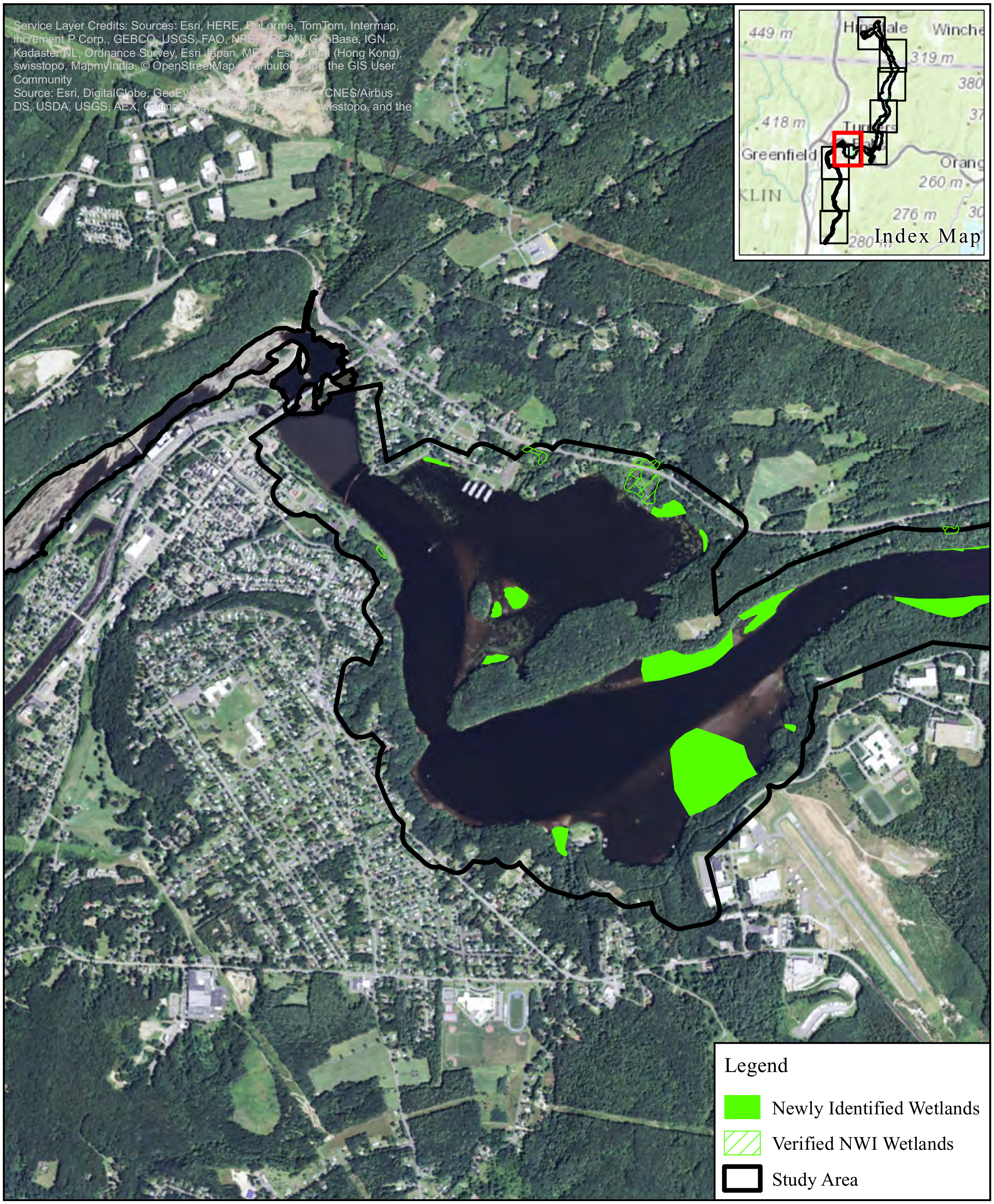

Northfield Mountain Pumped Storage Project (No. 2485) and Turners Falls Hydroelectric Project (No. 1889)

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

N

0 0.125 0.25 0.5 Miles

Figure 4.5- 1: Wetland Mapping within the Study Area Map 4

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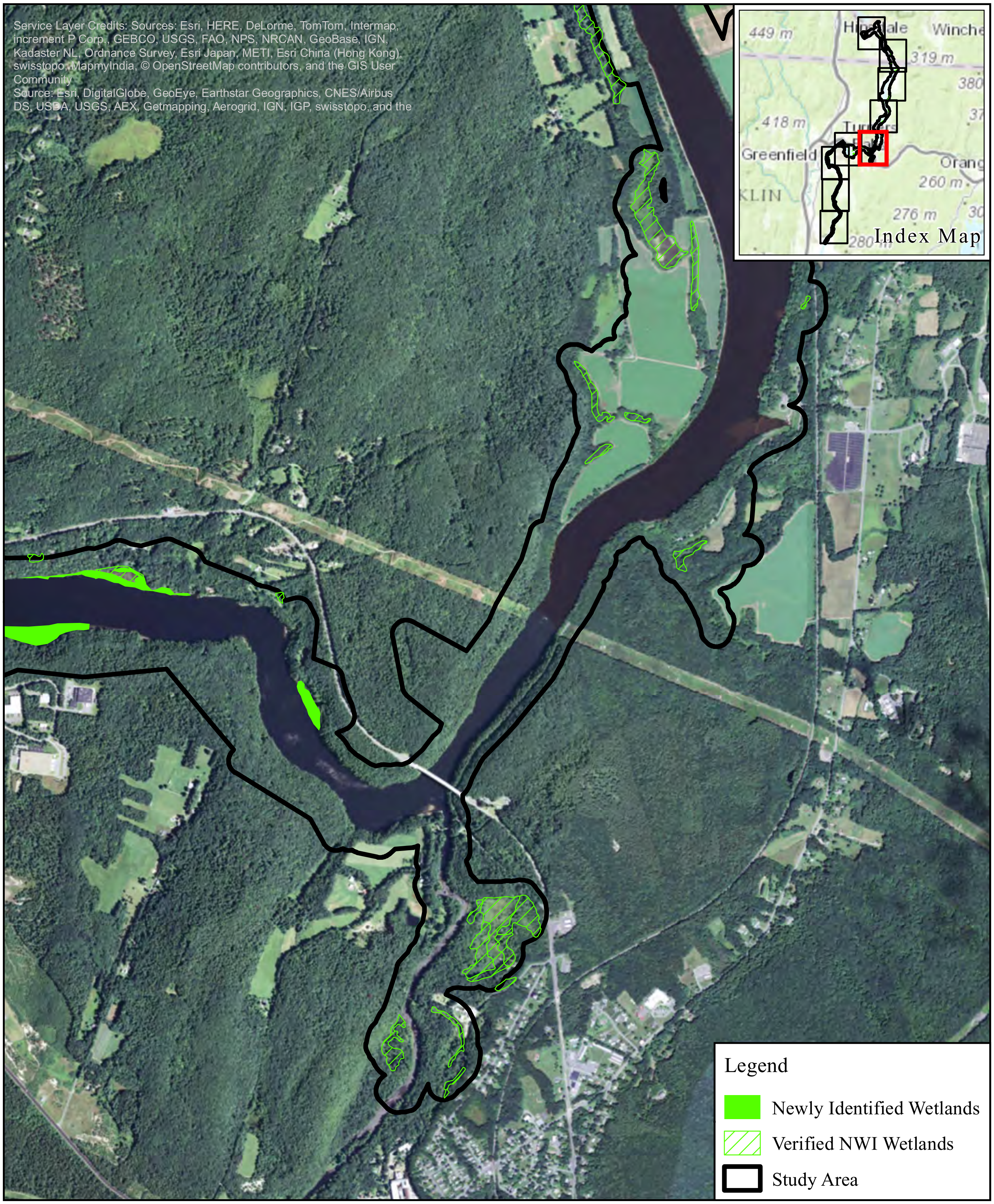

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Northfield Mountain Pumped Storage Project (No. 2485) and Turners Falls Hydroelectric Project (No. 1889)

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

N

0 0.125 0.25 0.5 Miles

Figure 4.5- 1: Wetland Mapping within the Study Area Map 5

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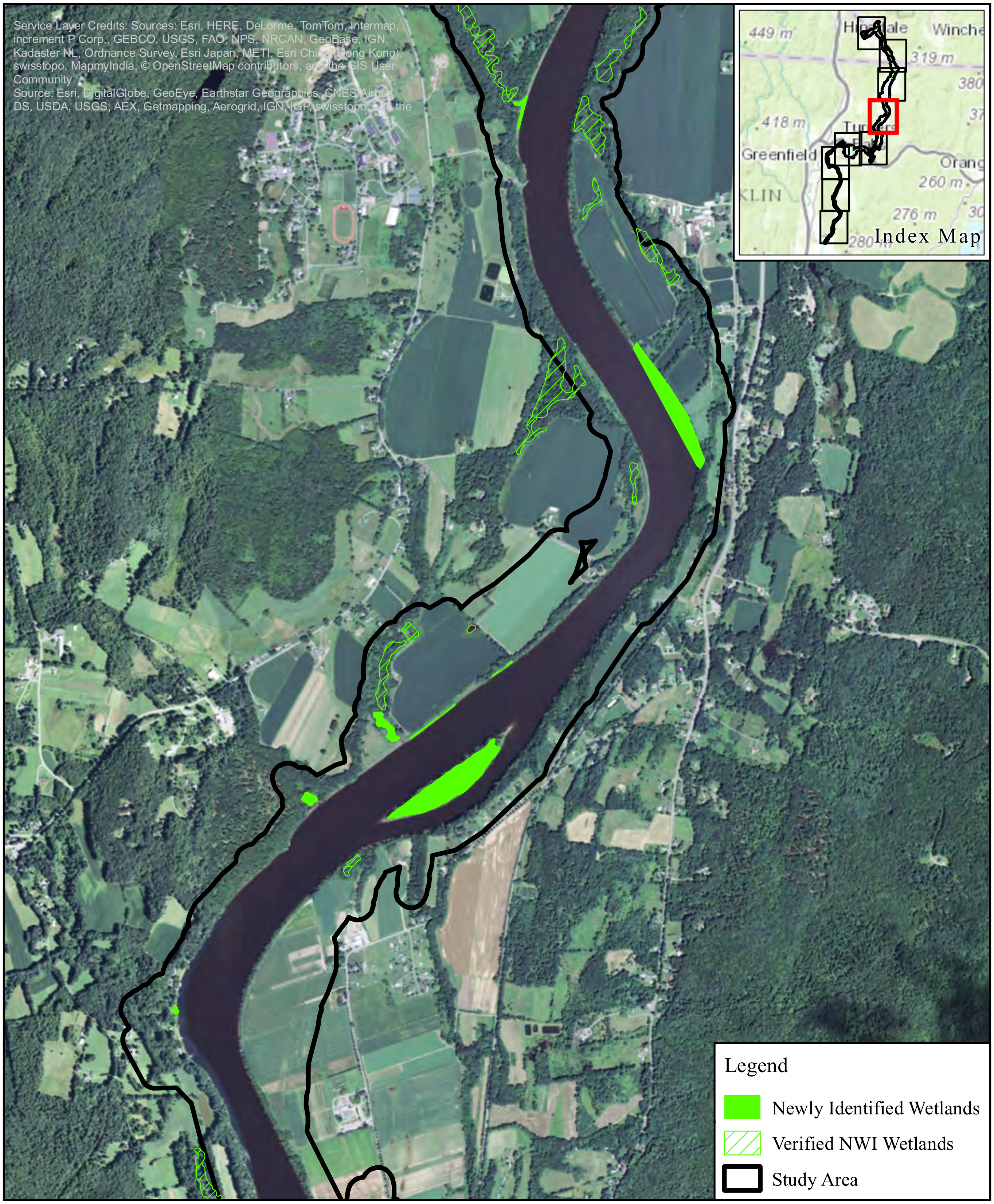

Northfield Mountain Pumped Storage Project (No. 2485) and Turners Falls Hydroelectric Project (No. 1889)

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

N

0 0.125 0.25 0.5 Miles

Figure 4.5- 1: Wetland Mapping within the Study Area
Map 6

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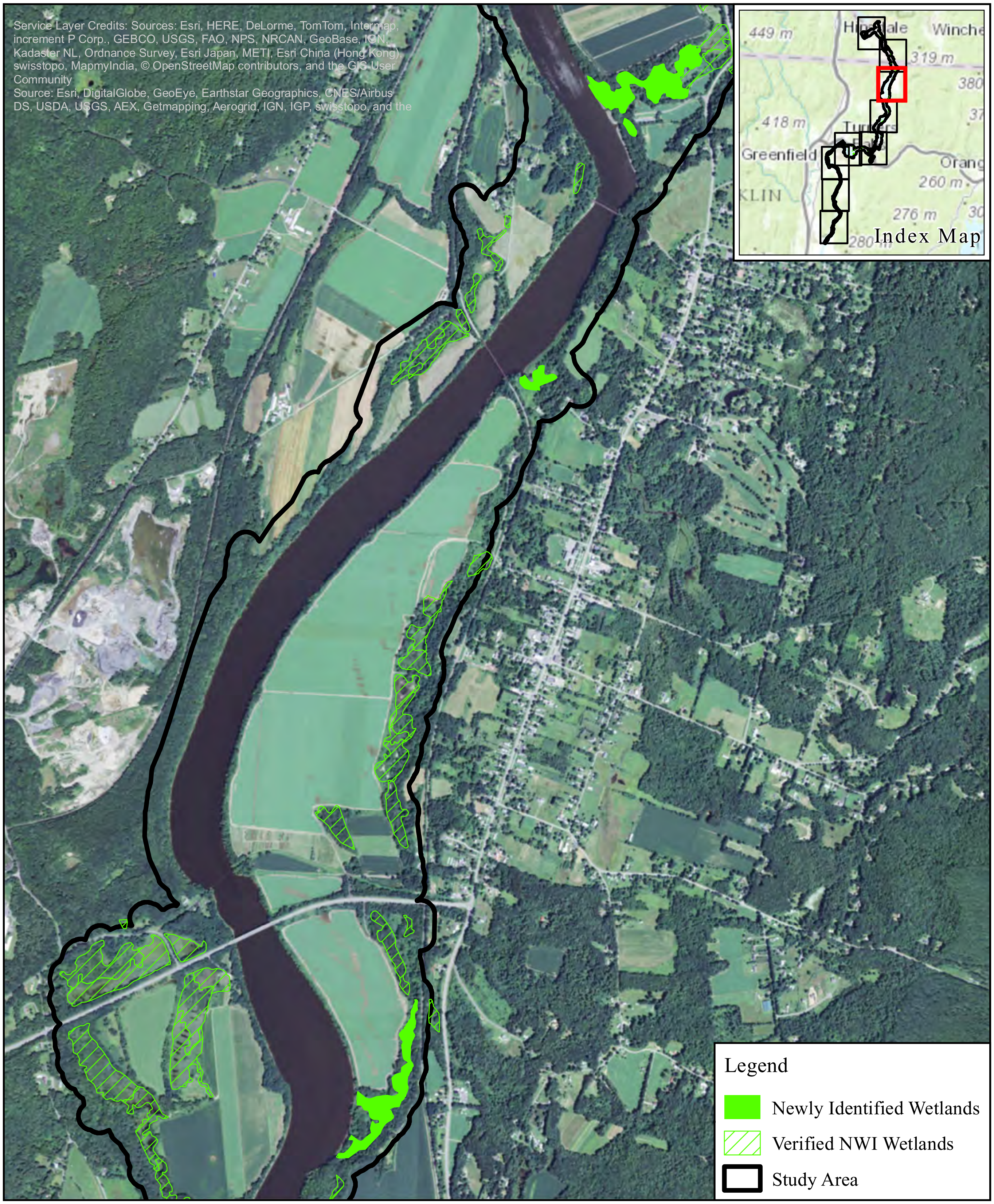

Northfield Mountain Pumped Storage Project (No. 2485)
and Turners Falls Hydroelectric Project (No. 1889)
Study 3.5.1 Baseline Inventory of Wetland, Riparian and Littoral Habitat in the Turners Falls Impoundment and Assessment of Operational Impacts on Special Status Species

N

0 0.125 0.25 0.5 Miles

Figure 4.5- 1: Wetland Mapping within the Study Area
Map 7

FirstLight GDF SUEZ

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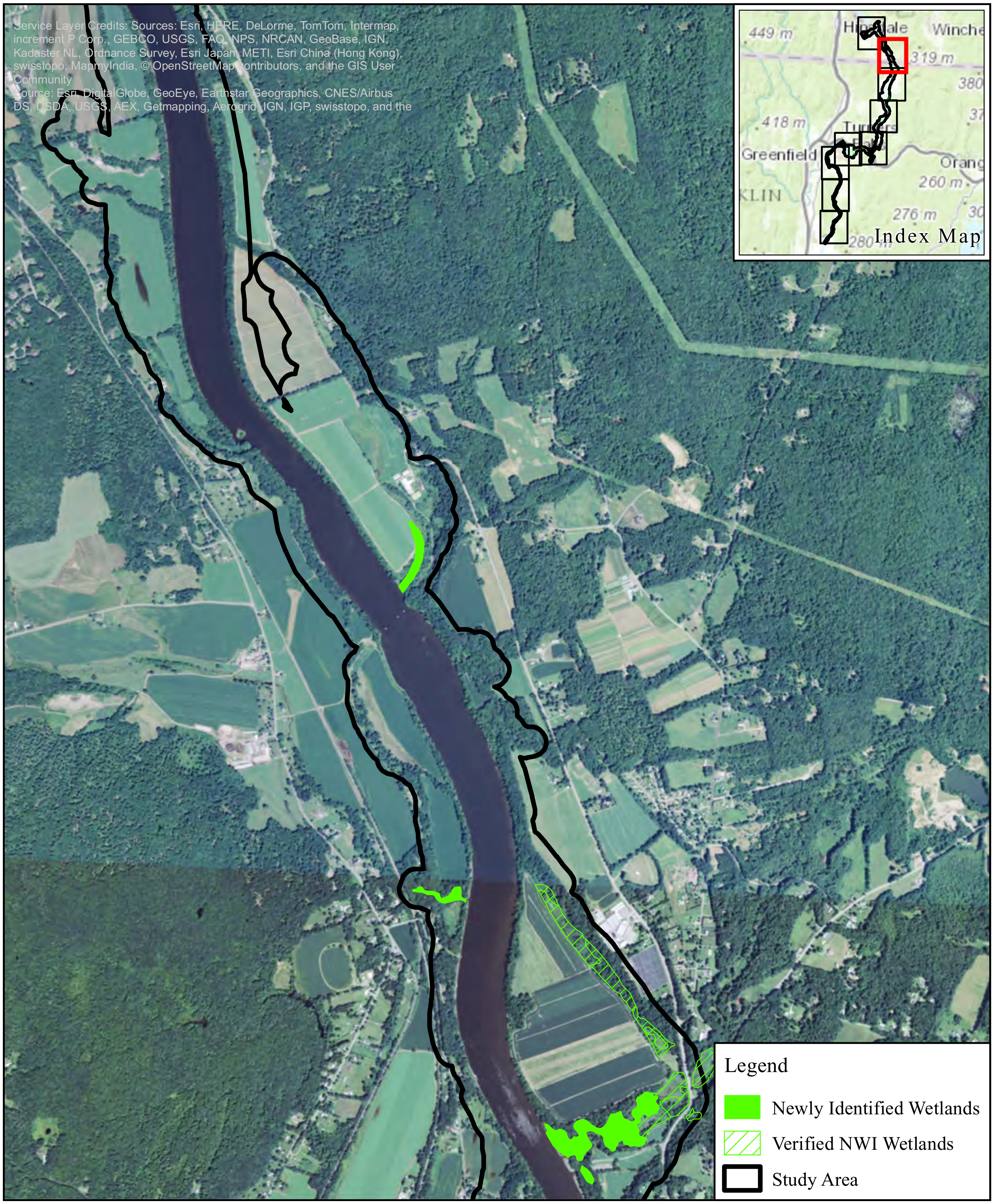

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Northfield Mountain Pumped Storage Project (No. 2485) and Turners Falls Hydroelectric Project (No. 1889)

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

N

0 0.125 0.25 0.5 Miles

Figure 4.5- 1: Wetland Mapping within the Study Area
Map 8

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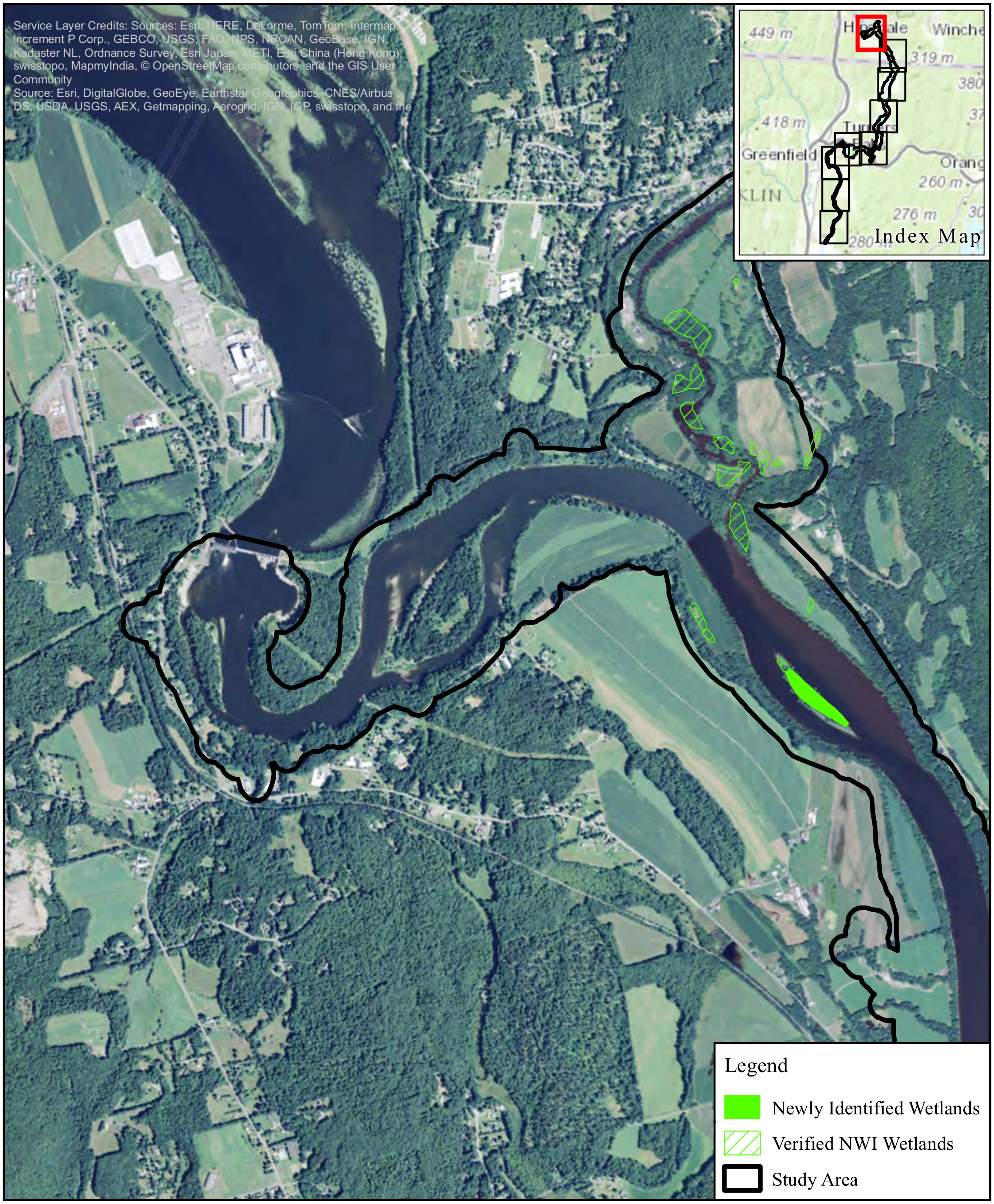

N

0 0.125 0.25 0.5 Miles

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

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

Figure 4.5- 1: Wetland Mapping within the Study Area Map 9

FirstLight GDF SUEZ

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Figure 4.5-2: View of Representative Shoreline Fringe Emergent Wetland (2015)

Figure 4.5-3: View of Representative Hardwood Forested Floodplain in Spring (2014)

Figure 4.5-4: View of Representative Hardwood Forested Floodplain during the Growing Season (2014)

4.6 Assessment of State-Listed Tiger Beetles

In August of 2014, Chris Davis and Kleinschmidt boated from the base of the Vernon Dam to the Turners Falls boat barrier and from Cabot Station to the Oxbow State Boat Launch in Holyoke, MA in search of suitable habitat for the cobblestone and Puritan tiger beetles. Chris Davis holds a collection permit from the USFWS for Puritan tiger beetles.

Cobblestone Tiger Beetles

Historic records of the cobblestone tiger beetle are known from a single site in Montague, Massachusetts (first observed in 2000), located in the general vicinity of the confluence of the Deerfield and Connecticut Rivers. Habitat for the species includes riparian cobble bars and adjacent sand beaches (NHESP, 2015). Suitable habitat is found along the cobble shoreline downstream of Cabot Station between the Route 2 Bridge and the Montague wastewater treatment plant. The last known sighting was in 2006-2008. In 2014, this site was searched twice, by Chris Davis, and the site was also visited with Jesse Leddick and Tim Simmons of NHESP. No cobblestone tiger beetles were located during work completed during the 2014 field season. It is presumed that this population is now extirpated (Chris Davis, Personal Communication, 2015).

Puritan Tiger Beetles

Puritan tiger beetle larvae require sandy habitat, which allows for digging of deep vertical channels. In contrast to the common tiger beetle (*Cicindela rapanda*), larval holes are short and angled. Puritan tiger beetle larval habitat is generally 10-20% vegetative cover with an interspersion of open sandy areas.

According to information provided by NHESP, an existing Puritan tiger beetle population has been monitored at a single site at Rainbow Beach in Northampton, Massachusetts since the 1990’s. In addition, Puritan tiger beetles have historic records or potential suitable microhabitat characteristics at an additional four (4) sites near Rainbow Beach. In 2014, a survey of potential Puritan tiger beetle habitat was completed by Kleinschmidt, assisted by Chris Davis. In addition to Rainbow Beach, six additional areas were investigated (Table 4.6-1). None of these other locations provides suitable habitat for Puritan tiger beetles.

Rainbow Beach is the only confirmed Puritan tiger beetle habitat within the study area that maintains a population. Larval habitat occurs throughout Rainbow Beach with no particular location preferred over another. Directly across from Rainbow Beach, on the opposite bank, is a small beach with a steeply banking shoreline. Puritan tiger beetle larvae have been recorded and recovered there by Chris Davis; however, larvae likely do not make it back to Rainbow Beach. The transitional area between the exposed sand and the riparian forest is dominated by rough cocklebur, sandbar willow, dog bane, black willow, cottonwood, and silver maple. Rough cocklebur and sandbar willow are major contributors to fast growing vegetation succession at Rainbow Beach (Figure 4.6-1), which may eventually reduce suitable Puritan tiger beetle habitat. In addition, exotic, invasive species purple loosestrife and Japanese knotweed are present on the site.

In 2013, Chris Davis recorded eight (8) adult Puritan tiger beetles in a mark recapture study. There was a total population estimate of twenty-one (21) Puritan tiger beetle adults in 2013. In that same year, 2013, Chris Davis estimated that the population of the common tiger beetle was in the thousands for Rainbow Beach. At Rainbow Beach, both the Puritan tiger beetle and the common tiger beetle populations appear to be declining, based on several years of annual mark and recapture studies completed by Chris Davis. During field work completed on August 8, 2014, two adult male Puritan tiger beetles were captured and positively identified on Rainbow Beach, confirming their presence (Figure 4.6-2).

The effects of Holyoke Gas and Electric’s (HG&E) run-of-river operation (plus or minus 0.2 feet as measured by at the Holyoke Dam) as specified under the new license issued in 1999 were evaluated by

HG&E, the resource agencies, and stakeholders. These evaluations determined that while the new operating regime resulted in generally stable WSELs in the lower portion of the impoundment, it produced some greater fluctuations in the upper portion of the impoundment, including near Rainbow Beach, and greater flow fluctuations downstream of Holyoke Dam. As a result, HG&E, has been operating the project since 2006 under a modified run-of river operations with WSELs at the Holyoke Dam between 99.47 and 100.67 feet. At flows above about 11,000 cfs, the Montague USGS Gage to Holyoke Dam hydraulic model as well as analyses conducted by HG&E, indicate that the constriction at "The Narrows" (about 3-miles upstream of the Holyoke Dam) decreases the sensitivity of the downstream boundary condition on the resulting WSELs in the rest of the Holyoke impoundment. For example, a stage versus discharge graph based on modeled output for 2012 in the Rainbow Beach area showed less than a 0.5 feet of difference between the low and high boundary conditions at the Holyoke Dam when flows are over 11,000 cfs (Figure 4.6-3).

Based on the Montague USGS Gage to Holyoke Dam hydraulic model completed as part of the Study No. 3.2.2, WSEL fluctuations over the course of the growing season at Rainbow Beach and North Bank are approximately 7.0 feet. Measured 15 minute interval WSELs from 2012 at Rainbow Beach were used to estimate effects of FirstLight's variation of discharges from Cabot Station and Station No.1 (a maximum generation capacity of 15,938 cfs) on the water level at Rainbow Beach. However, in this analysis data was not used from days when the average daily flow at the Montague was above 18,000[9] cfs during the period when Purtain tiger beetle are most active (May 1 to September 30[10]). During this period, the maximum daily change in the inflow to the Holyoke Impoundment, as measured at the Montague Gage, ranged from below 1,000 cfs on 9 days, 67 days (55%) between 6,000 and 13,000 cfs, and there were no days in excess of a daily change of 14,000 cfs (Figure 4.6-4). The resulting daily WSEL fluctuations at Rainbow Beach indicate that 79% of the days (97 days) had daily fluctuation of less than 0.9 feet (Figure 4.6-5).

The elevation survey completed at Rainbow Beach and North Bank, completed in 2014, included the survey of four transects at North Bank and 24 transects at Rainbow Beach (Figure 4.6-6). This elevation information was used to analyze changes resulting from project operations and potential effects on Puritan tiger beetles. Based on the same period of record as discussed above, in 2012, the recorded 15 minute WSELs were always below 103.5 feet and for the vast majority (over 90 % of the time) the WSELs were between 102.0 and 100.5 feet Figure 4.6-7).

Based on the results of the elevation survey, Puritan tiger beetle habitat occurs on Rainbow Beach from the low elevation of 101.3 feet to the high elevation of 115.9 feet, although habitat located at higher elevations is more vegetated. Rainbow Beach is not uniform and elevations vary depending on location. The northern portion of the beach is generally dominated by a consistent slope (Figure 4.6-8). The central portion of the beach includes an area of more level topography which transitions to a steep bank near the start of the riparian vegetation (Figure 4.6-9). Similar in aspect, the southern portion of the beach maintains a more consistent slope (Figure 4.6-10). The North Bank habitat, which does not support breeding populations of Puritan tiger beetles, is very steeply sloping and has little level beach habitat (Figure 4.6-11).

The WSEL described previously, and based on the 15 minute recorded data from 2012, are shown on each of the elevation transect figures. It is apparent that the WSEL of 103.5 feet represents the WSEL that is closely related to the existing edge of terrestrial vegetation. As shown on Figure 4.6-8 and Figure 4.6-9, elevation 103.5 feet coincides with the edge of vegetation at Transect 5 and 9. Importantly, at all locations, the majority of the beach habitat is exposed at the median WSEL of 101.0 feet. In addition, the most commonly occurring (79% of the time) WSEL fluctuation (between 102.0 and 100.5 feet) is below the

[9] 18,000 cfs was determined as a reasonable boundary for flow at Montague gage under peak generation at Cabot Station and Station No.1, flows from the Deerfield River, and flows from tributaries between the Montague Gage and Holyoke Dam.
[10] This resulted in a period of record of May 21 to May 29 and June 9 to September 30 for a total of 123 days.

majority of existing habitat (Figure 4.6-8, Figure 4.6-9, Figure 4.6-10, and Figure 4.6-11). During periods of WSEL at the maximum, of 103.5 feet, much of the beach habitat is inundated.

Table 4.6-1: Additional Surveyed Puritan Tiger Beetle Potential Habitats

Site Name	Location	Description
Mitch's Island	Mitch's Island	Topography is too flat and does not provide a suitable combination of larval and adult habitat. Puritan Tiger beetles have never been recorded here. Substrate is too coarse to support larval habitat.
West bank	North of Mitch's Island	The beach is 20' wide and 150' feet long, but generally is too narrow and has too much cover vegetation. No larval habitat is present and beach is subject to too much inundation to sustain a population.
Hadley Cove Site	600-1000 feet north of Rainbow Beach	Historic mark recapture site, not suitable habitat.
North Banks	Downstream of Rainbow Beach	Likely a population sink for Rainbow Beach, when beetles disperse from Rainbow Beach. There are both larval and adult habitats found at this location, but generally a very narrow beach face and nearly vertical larval habitat. Lots of boat wake disturbances from local recreational uses.
Elwell Island	Southern point on the island	Historic tiger beetle site, but no larval habitat exists. Beetles were last recorded here over 20 years ago. Since that time, private land owners have stabilized the bank upstream on the opposite bank, which likely reduced source for sediment resulting in a loss of larval habitat, leaving the population non-existent today. The northern end of the island is a low profile beach that has no suitable habitat; also, the beach material is too coarse, consisting of sands and gravel.
4^{th} of July beach	4th of July beach	This beach is a popular recreation spot. Habitat is very flat and the wash line shows the entire beach goes under water daily. In addition, there is a lot of vegetation succession along back beach, and the site offers no larval habitat.

Figure 4.6-1: Growth of Rough Cocklebur Along the Upper Interface of Rainbow Beach

Figure 4.6-2: Adult Puritan Tiger Beetle Observed at Rainbow Beach

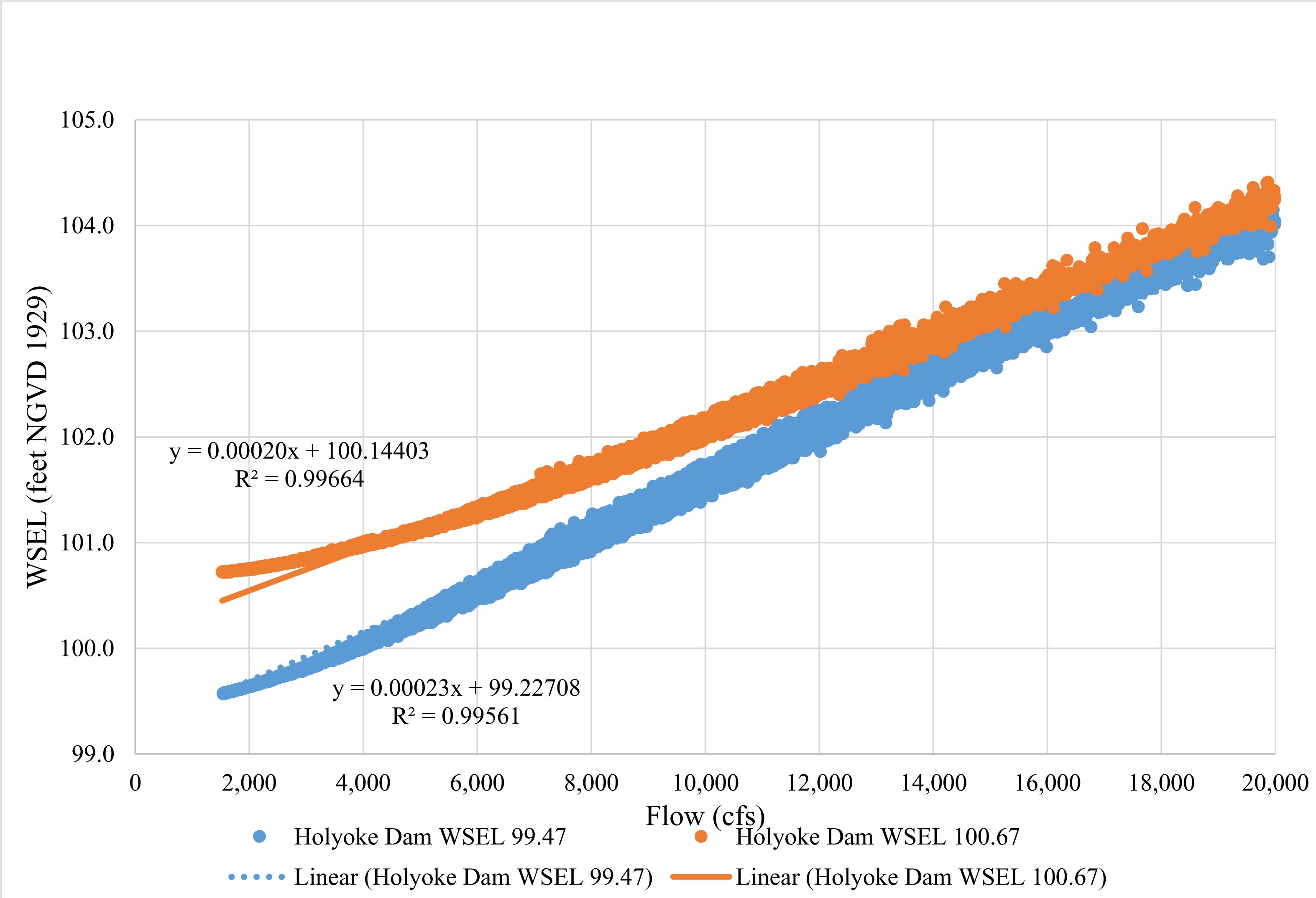


Figure 4.6-3: Stage vs Discharge Graph for Rainbow Beach Based on Output from the Hourly HEC-RAS Model for 2012

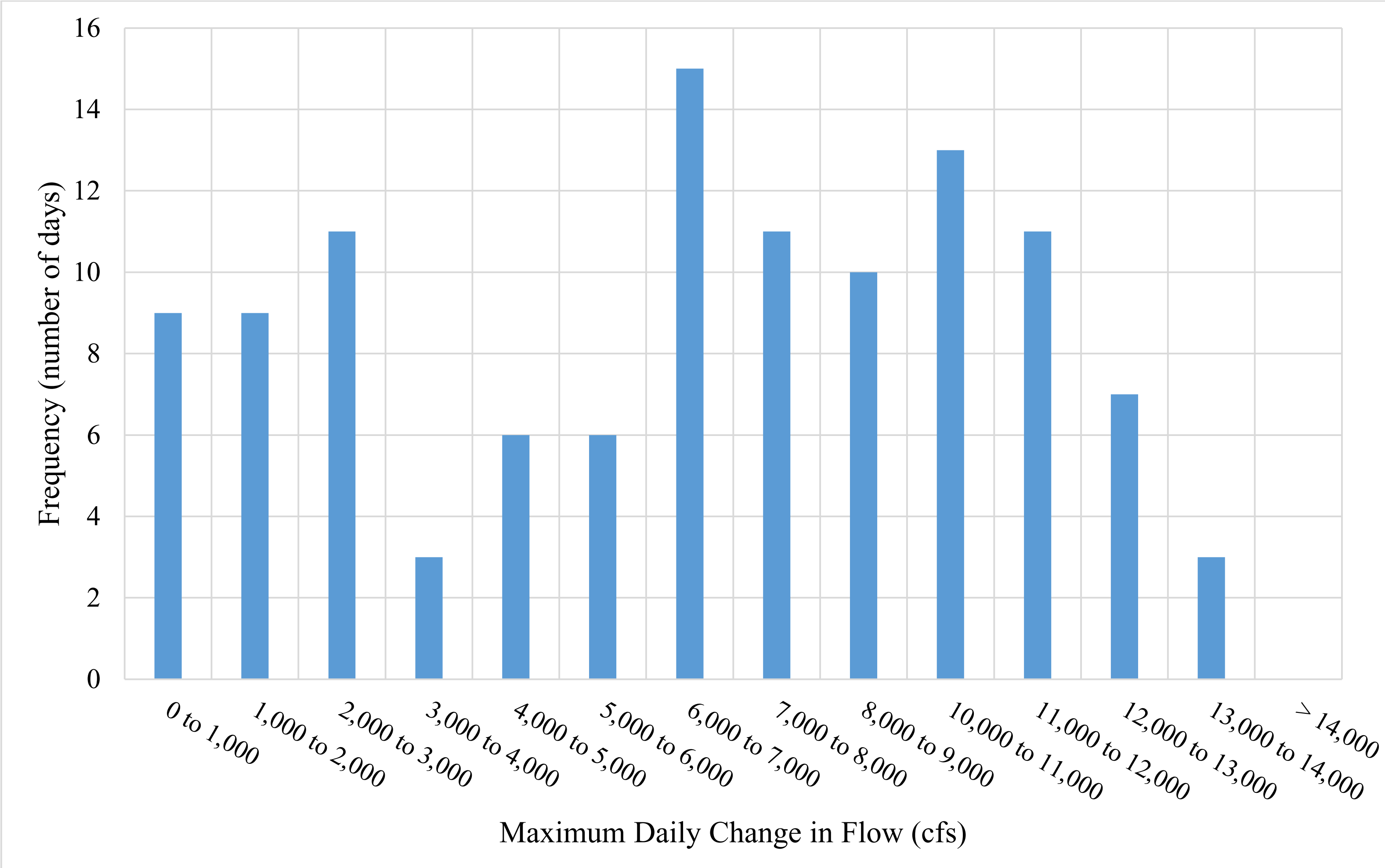


Figure 4.6-4: Montague Gage Fluctuations May 1 to October 1, 2012 (123 Days) When the Montague Gage was Below an Average Daily Flow of 18,000 cfs

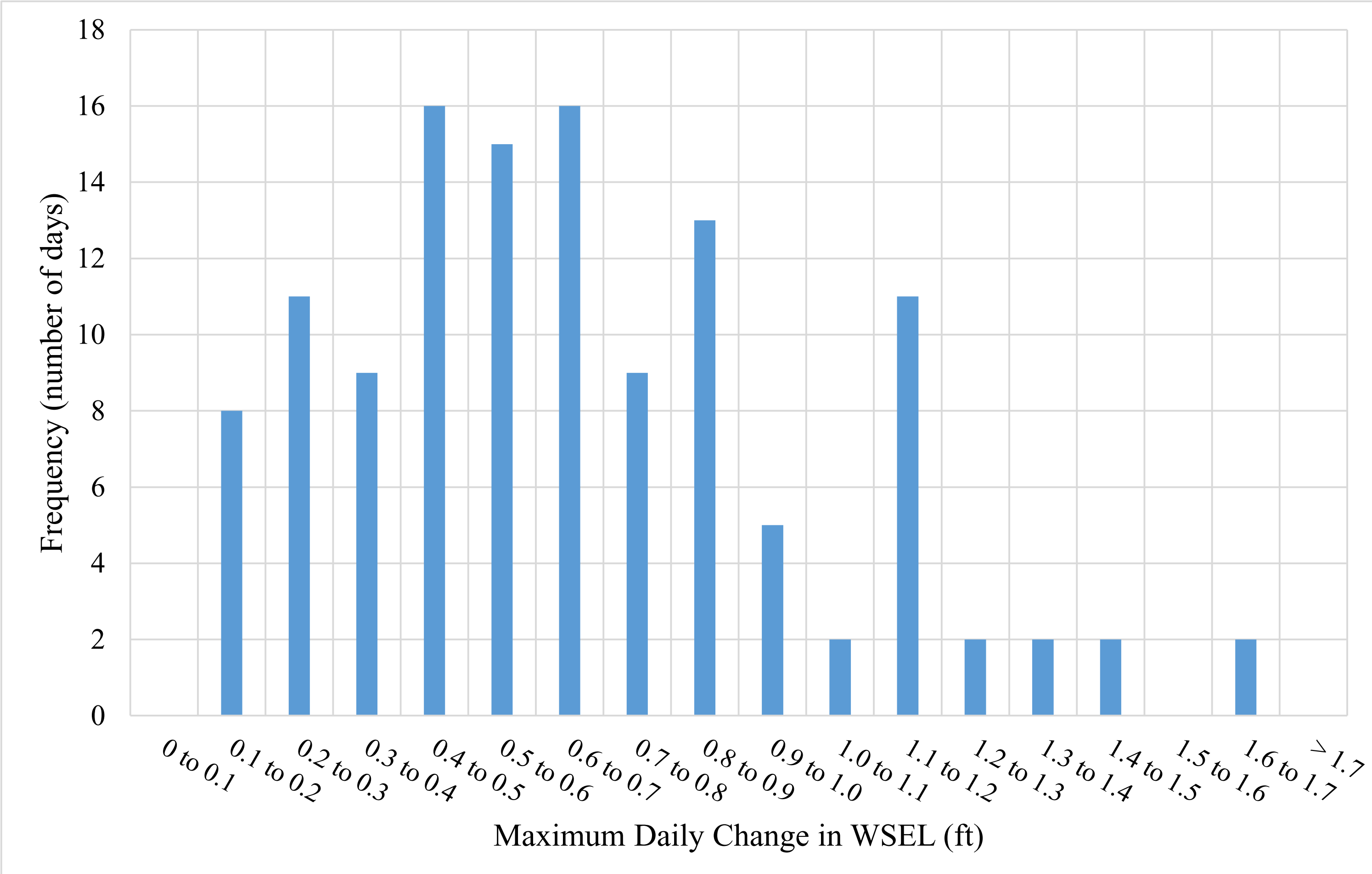
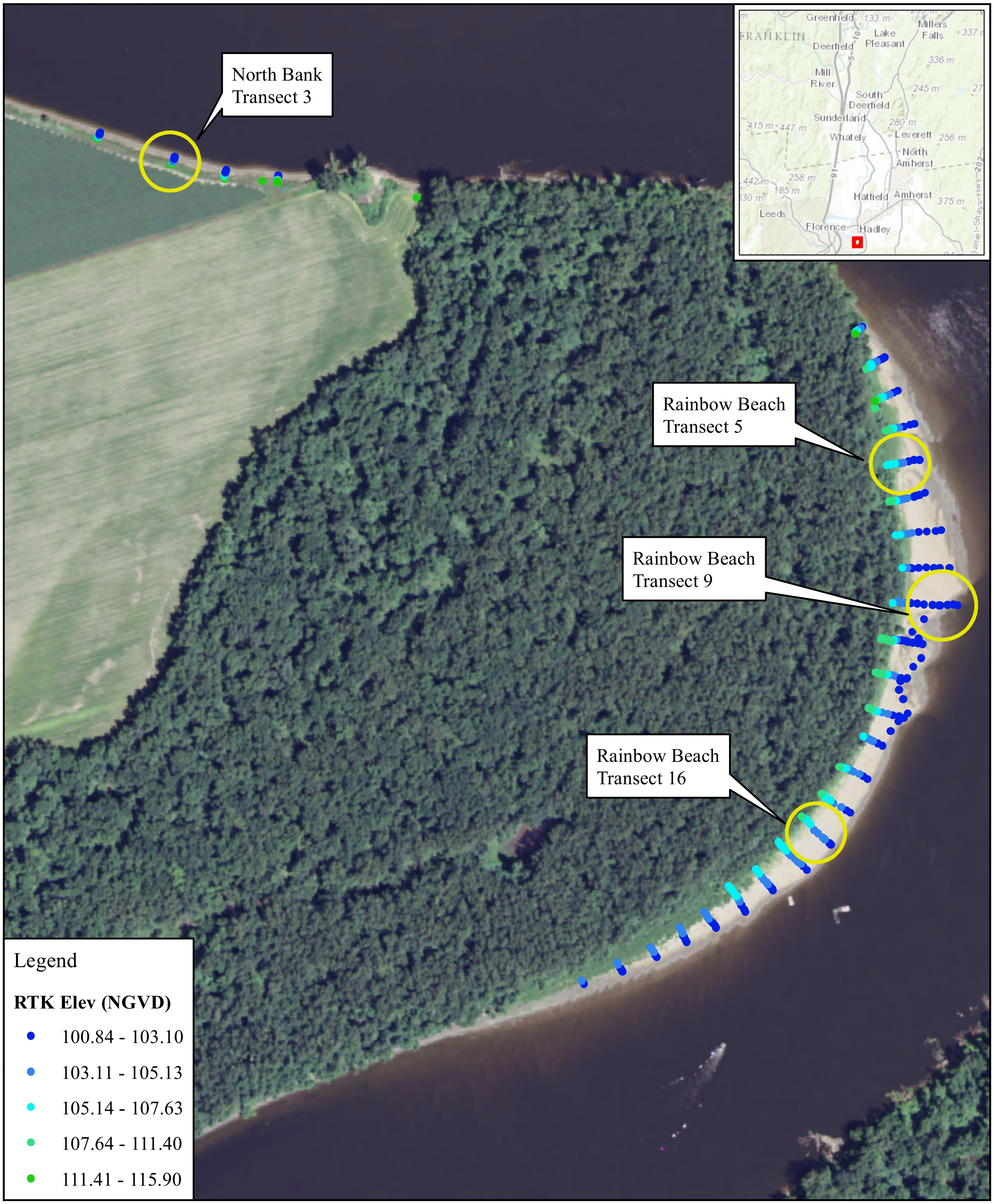


Figure 4.6-5: Rainbow Beach Daily WSEL Fluctuations May 1 to October 1, 2012 (123 Days) When the Montague Gage was Below an Average Daily Flow of 18,000 cfs



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

FIGURE 4.6-6.
Puritan Tiger Beetle Habitat Elevation Survey Results

0 200 400 800 Feet

Path: W:\gis\studies\3_5_1\maps\Study_3_5_1_Beetle_Elevation_Results.mxd

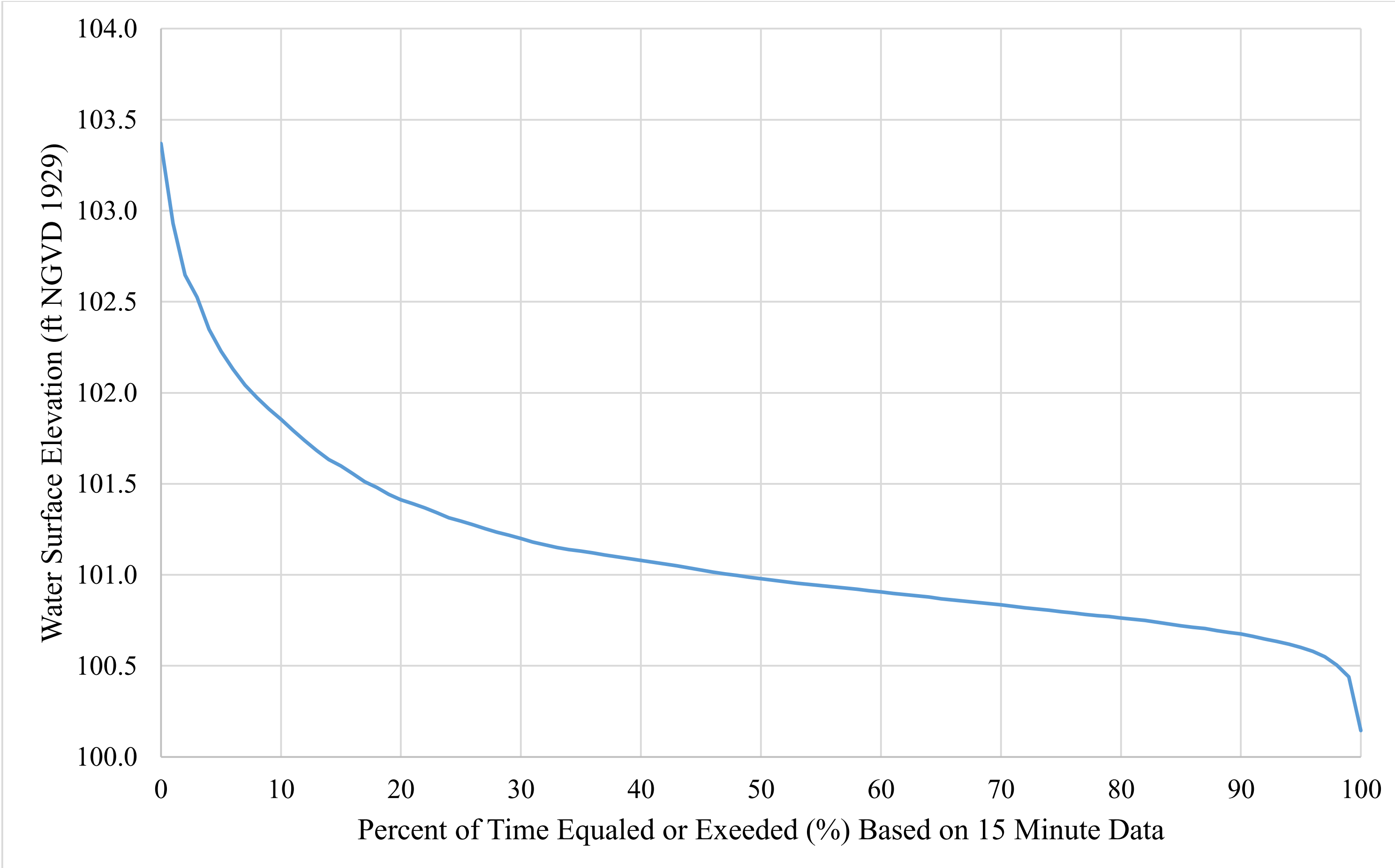

Figure 4.6-7: Rainbow Beach WSEL Exceedance May 1 to October 1, 2012 (123 Days) When the Montage Gage was Below an Average Daily Flow of 18,000 cfs

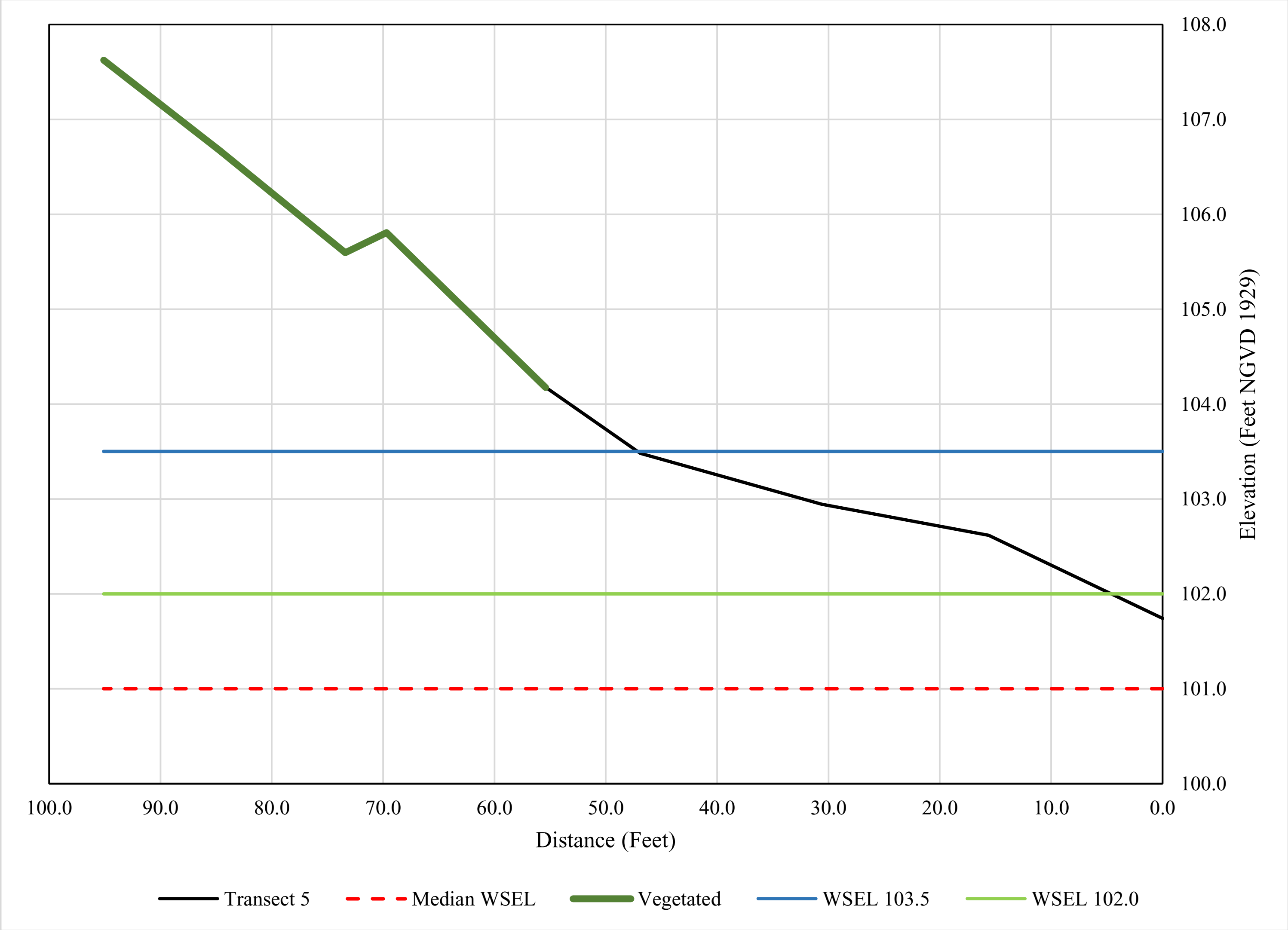

Figure 4.6-8: Rainbow Beach Transect 5 Elevation Survey Results

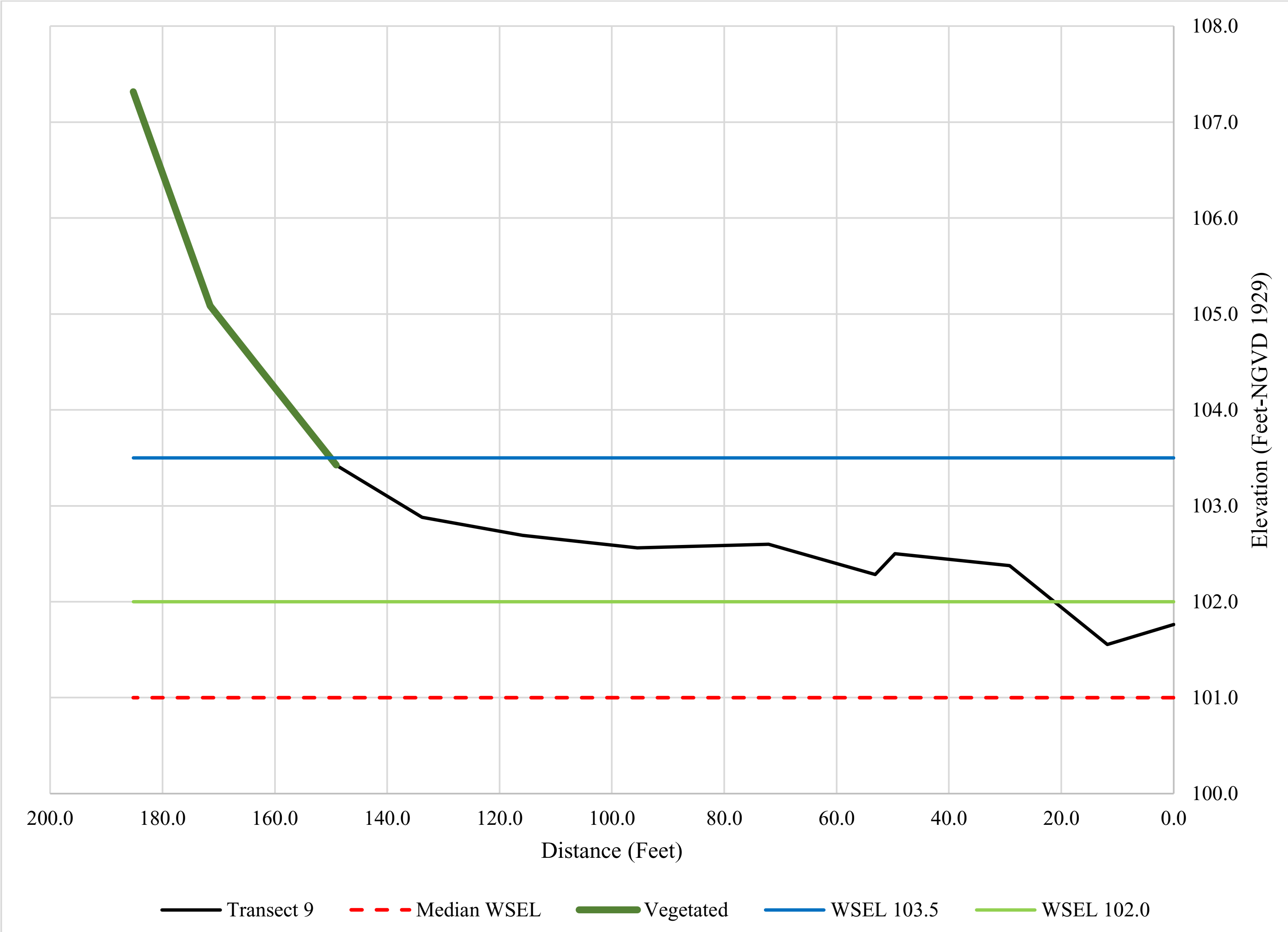

Figure 4.6-9: Rainbow Beach Transect 9 Elevation Survey Results

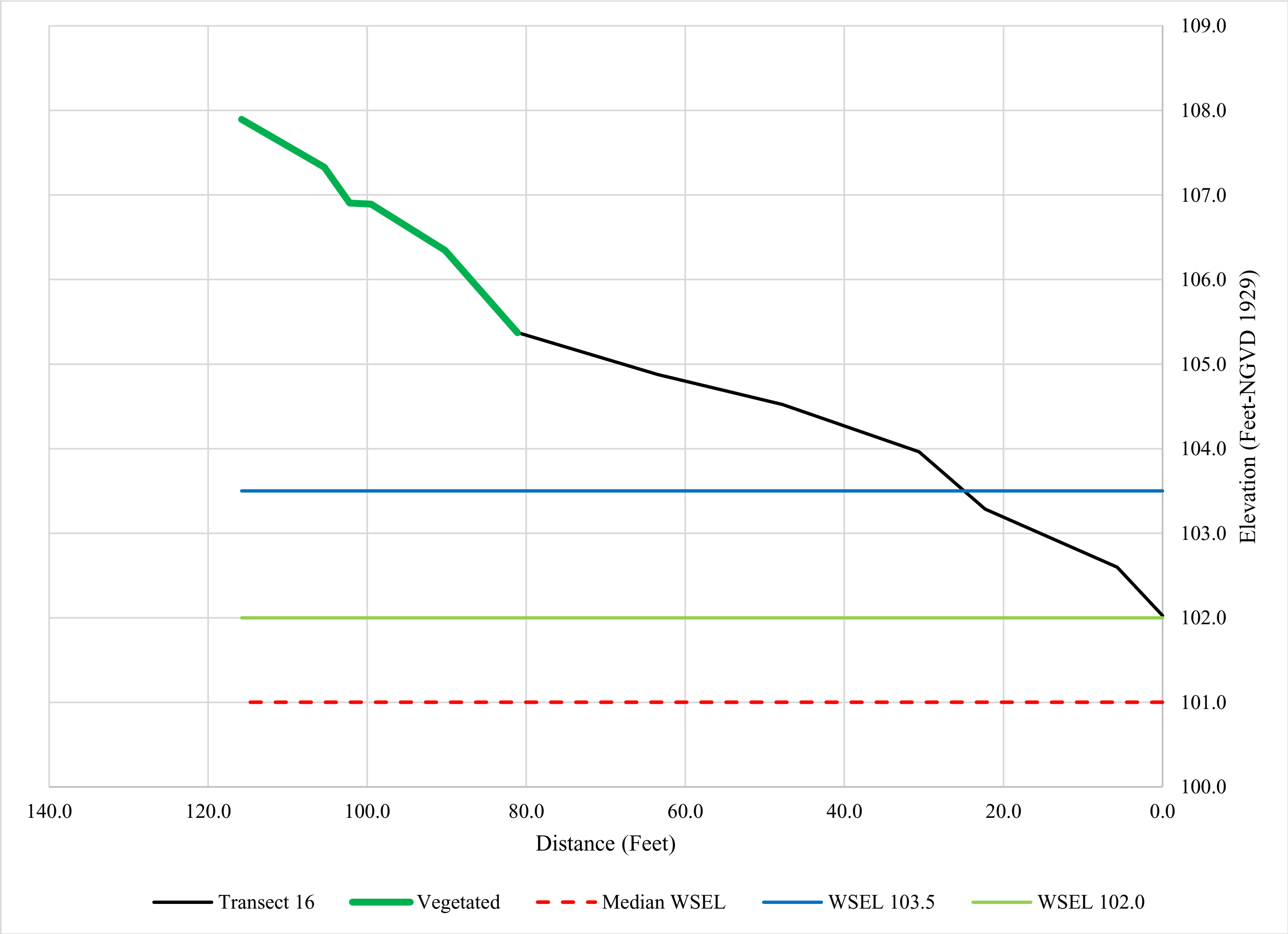

Figure 4.6-10: Rainbow Beach Transect 16 Elevation Survey Results

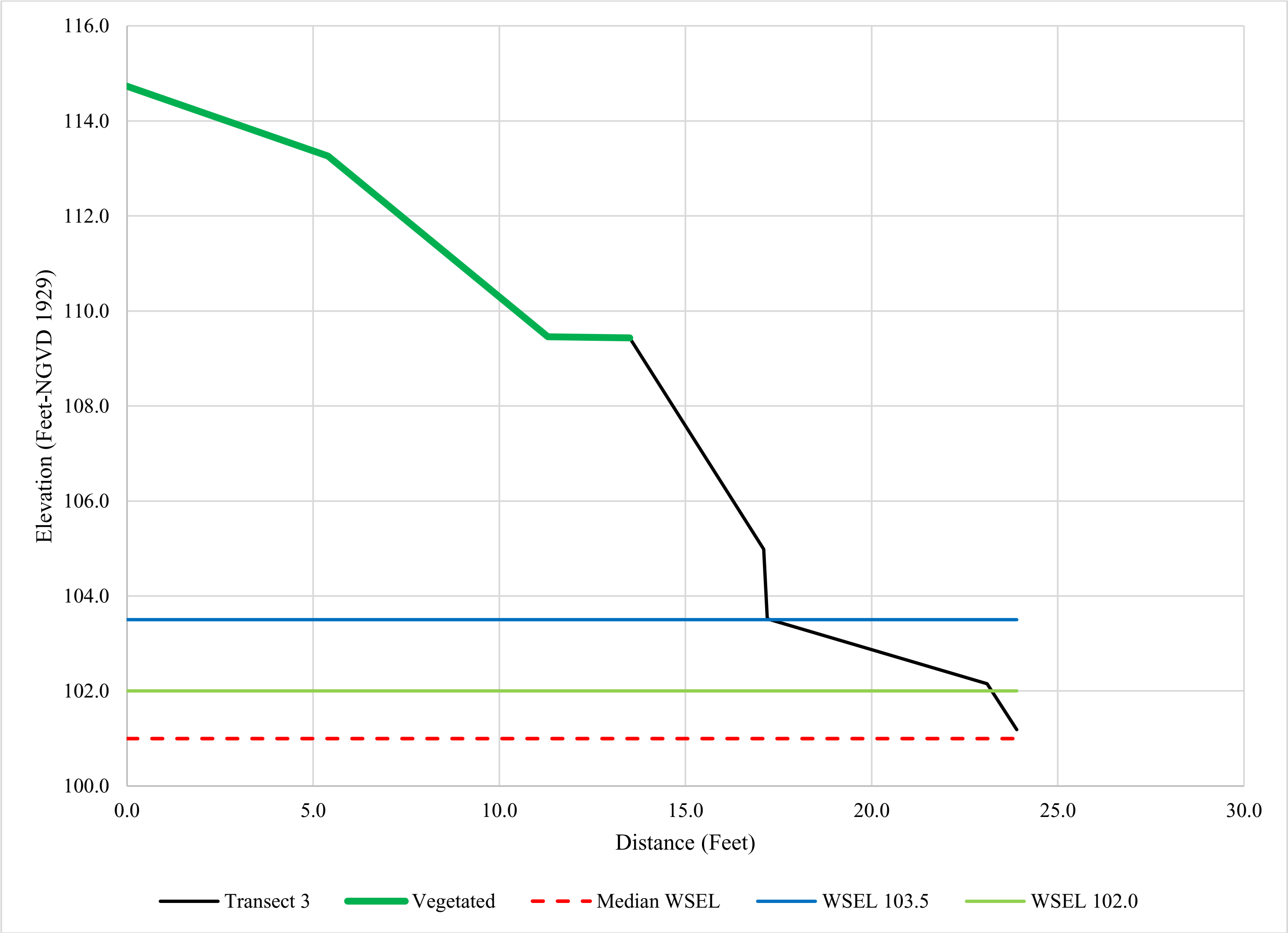

Figure 4.6-11: North Bank Transect 3 Elevation Survey Results

5 DISCUSSION

The review of existing information provided helpful background information for field studies completed in 2014 and 2015. Information provided by the NHESP on the location and occurrence of RTE species was helpful in determining study areas and placement of survey transects.

Riparian habitat in the study area is dominated by northern hardwood forests with some mixed softwood species. Additional detail regarding riparian habitats is discussed in Study Report No. 3.4.1 (GSE, 2015b).

SAV is an important habitat feature within aquatic systems, particularly for fish and other aquatic wildlife. SAV within the study area is extensive, particularly immediately upstream of the Turners Falls Dam. Outside of this lower area and within the upper TFI, SAV beds generally occur as narrow bands along the shoreline. Downstream of the Turners Falls Dam (from below Cabot to Sunderland), SAV is generally found as narrow bands along the shoreline and occasionally larger beds associated with protected channels associated with islands. No SAV was observed within the bypass reach. Within the study area, shoals or other shallow areas within the main channel do support SAV beds, but these areas are not common. Based on the extent and overall distribution of SAV beds within the study area, project operations appear to have a limited impact on the growth of submerged vegetation within the Connecticut River. 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. The bypass reach has no mapped beds of SAV, but this is likely related to the lack of suitable substrate. Within the overall study area, SAV beds are limited in areas of coarse substrate and bedrock, which is the dominant substrate in the bypass reach.

Field surveys found that invasive, exotic SAV is present throughout the TFI portion of study area, and is most common within the lower portion of the TFI. The presence of this exotic or invasive SAV may ultimately degrade available habitat for fish and wildlife species. No invasive SAV was identified below the Turners Falls Dam. Project operations are not responsible for the presence of invasive, exotic species nor do they enhance the spread of these species. Recreational use, as well as introduction from upstream, may continue to spread exotic species within the study area.

The identified RTE plants within the study area are commonly associated with riparian areas, and several are adapted to frequently flooded locations. Eighteen (18) survey transects were established to investigate the location of occupied and unoccupied habitat and examine relationships with modeled WSELs developed as part of Study No 3.2.2. The elevation surveys identified locations and occurrence data for six botanical RTE species.

Based on the survey results, mountain alder generally occurs within the TFI above the April median WSEL and outside the most commonly occurring daily change in WSEL (Section 4.3). Within the bypass reach, the mountain alder was also not inundated during the flow demonstration. While it is possible that varying flows may result in wetting of mountain alders within the TFI and below, this species appears to prefer habitats that are generally drier and more removed from project operations. In addition upland white aster and sandbar cherry, based on the transects surveyed, generally occur above the median April WSEL and in all cases (Transect 3, 6A, 6B, 6C, 8, 9A, and 9B), the species occur above the May median and annual median WSEL. This includes both transects above and below the Turners Falls Dam. Based on the WSEL data developed from the hydraulic models for the TFI and the Montague Gage to Sunderland Reach, these species occur within available and suitable habitat at elevations closer to the higher, and less commonly observed fluctuation zones.

The two species most commonly observed below the April WSEL, as well as below or near the annual median WSEL, are the Tradescant's aster and the sandbar willow. Both species are adapted to frequently flooded areas, and this is exemplified by the result of the survey data. The sandbar willow appears to prefer habitats closer to the annual median and often slightly higher or lower than the modeled WSEL. Tradescant's aster appears to be the "wettest" of all the species and is often found at the lowest elevations. In the bypass reach, the population of Tradescant's aster is estimated at several thousand, the largest population within the study area. Based on modeling within the bypass reach (Figure 4.3-30), the Tradescant's aster is inundated often. During the demonstration flow releases, the Tradescant's aster was inundated during all demonstration flows (NEE, 2016). Based on observations following the demonstration flows, it was noted that if the existing minimum bypass flow is maintained for the spawning period of key fish species (i.e., 400 cfs through July 15), impacts to the population of Tradescant's aster would be minimized (NEE, 2016). It is likely that maintaining the current flow regime within the bypass reach would not negatively impact species currently present. Higher minimum flows would likely not have negative impacts, as long as flows are reduced to allow exposure during July when these species are flowering.

Invasive species often outcompete native vegetation, degrade habitat and spread rapidly. Invasive terrestrial species are present in varying densities along the entire study area shoreline and on islands within the study area. 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. Mapping of, and further discussion of, terrestrial invasive species is included in Study Report No. 3.4.1 (GSE, 2015b).

Wetlands, particularly when associated with riverine systems provide important functions for wildlife and flood storage as well as important recreational services. 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. Functions of these wetlands are important and are most commonly wildlife habitat and flood flow attenuation. Forested wetlands within the study area are not impacted by project operations; the majority of the forested wetlands within the study area are floodplain wetlands which receive hydrologic input during high flow events (i.e., spring freshet) and then may remain dry for several weeks to months at a time. Emergent wetlands within the study area occur within the fluctuation zone. However, emergent wetland species are often adapted to changes in WSEL. In some cases, increased diversity of emergent species can be attributed to regular changes in inundation, provided inundation is not prolonged.

Cobblestone tiger beetles and Puritan tiger beetles are both protected invertebrate species that are declining in population. Cobblestone tiger beetles and Puritan tiger beetles are known to have occurred within the study area in the past. Searches resulted in no cobblestone tiger beetles being identified within the study area. Searches did confirm the presence of Puritan tiger beetles at Rainbow Beach. With regard to Puritan 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 to examine the potential impact of water level changes on the Puritan tiger beetle. One potential impact to the Puritan tiger beetles are changes in water levels which may cause adult dispersal or flood larval burrows. Based on the results of the water level model, it is possible that changing WSEL may disperse Puritan tiger beetles individuals or impact habitat primarily within the lower portion of the habitat. Based on a review of the 15 minute monitoring data from 2012, the range of fluctuation most commonly observed (79% of the time) at Rainbow Beach is at the lower range of the available habitat (Section 4.6). Project operations may impact available habitat, primarily at the lower range of elevations, at higher elevations the operations may still impact available habitat, but less frequently. In addition, 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. At Rainbow Beach, near Transect 9 (Figure 4.6-9), rapid changes in WSEL may result in mortality or dispersal, particularly where available beetle habitat is more level in topography and therefore more susceptible to changes in WSEL. At higher elevations, dense vegetation growth is limiting the available larval habitat.

In summary, project operations do not appear to be substantially limiting the growth of SAV, but may result in lack of establishment close to the shoreline. Based on the results of data collected in 2014, substantial beds of submerged vegetation are present within the study area. Project operations are not spreading exotic, invasive species; however, there is be potential for additional spread of these species as a result of recreation within the study area. 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. Water level fluctuations may preclude other species which would compete with identified rare species for habitat under more stable conditions. Investigated plants are thriving within habitats that support their growth. All species investigated prefer habitats within or near the high waterline and are adapted to frequent flooding. Terrestrial invasive species within the study area do occur, but additional spread and establishment are not tied to project operations. The species observed within the study area are invasive species that are commonly observed within large river systems. While these species may pose a threat to native plant communities, project operations are not improving the ability of these species to invade native habitats. Wetland communities within the study area are widespread, and supported by tributaries or flood waters. Project operations do not have a negative effect on the existing hardwood floodplains within the study area. Emergent wetlands appear to be healthy and are expansive within the lower portion of the TFI. Cobblestone tiger beetles, based on surveys conducted, appear to be extirpated from the study area. Puritan tiger beetles are present at one location, Rainbow Beach, and it appears that recreation activities and natural succession within larval habitat is likely having a negative impact on tiger beetle populations.

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