Relicensing Study 3.3.10

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

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 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 Northfield Mountain and Turners Falls Projects using 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.

This report documents the results of Study No. 3.3.10: *Assess Operational Impacts on Emergence of State-Listed Odonates in the Connecticut River*. The study goal was to assess potential effects of Project operations on emerging dragonflies (Insecta: Odonata; hereafter called "odonates") in the Connecticut River. To meet this goal, field surveys were conducted to characterize the habitat, assemblage structure and emergence/eclosure behavior of odonates in the Project area. This information was compared with existing data on odonates and water surface elevation (WSEL) collected throughout the Project.

Two phases of fieldwork were completed. Phase 1, completed in 2014, included qualitative surveys of odonate larvae and exuviae at eight sites from the Connecticut River, including Barton Cove, the Turners Falls Project bypass reach and locations downstream of Cabot Station, to determine species assemblage structure and to collect habitat data. For tenerals or exuviae, biologists recorded the vertical and lateral distance from the water's edge, and the surface that each was collected on.

Phase 2, completed in 2015, included quantitative odonate surveys, observations of emergence/eclosure behavior, and concurrent collection of water surface elevation and water temperature data to analyze potential effects of Project operations on odonates and their habitat. In consultation with the MA Natural Heritage and Endangered Species Program, FirstLight conducted quantitative surveys at five sites, and at each site established six transects oriented perpendicular to the river and spanning the continuum from the water's edge into the upland terrestrial vegetation. Surveys for emerging larvae, exuviae, and tenerals were conducted at each transect during eight sampling periods that occurred approximately every two weeks beginning on May 27 and ending on September 2, 2015. Biologists looked for larvae exiting the water or crawling on land, and attempted to track and record the time it took for individuals to complete the eclosure process and fly away. For each exuvia and teneral, the vertical height above the water's surface, the distance from the water's edge, and its eclosure structure/substrate was recorded.

Hourly variability in the WSEL and rates of change were computed at each site and used to compare with odonate emergence and eclosure behavior (i.e., crawl height, crawl distance, and crawl speed).

A total of 17 confirmed species were collected in 2014 and 2015 combined, including the state-listed *Gomphus abbreviatus, Gomphus vastus, Gomphus ventricosus, Neurocordulia yamaskanensis*, and *Stylurus amnicola*. A total of 622 individuals representing 16 species were collected during the 2015 quantitative sampling. Species found most frequently in the riverine environments of Sites 1 to 4 included *Gomphus vastus, Boyeria vinosa, Stylurus spiniceps, Ophiogomphus rupinsulensis, Neurocordulia yamaskanensis, Dromogomphus spinosus, Gomphus abbreviatus*, and *Macromia illinoiensis*. Site 5 (Barton Cove) was inhabited by several species more tolerant of lentic conditions, such as *Epitheca princeps, Perithemis tenera*, and *Libellula sp*.

For all species combined, larvae crawled an average vertical height of 5.0 ft from the water's surface, and an average distance of 12.4 ft from the edge of the water. There was considerable variation within and among species. Among the riverine species, crawl height was greatest for *Macromia illinoiensis, Gomphus abbreviatus, Gomphus vastus*, and *Neurocordulia yamaskanensis*; each of these species crawled an average height of near or above 7 ft. Riverine species that crawled the shortest height from the water's surface

included *Stylurus amnicola* (3.2 ft), *Ophiogomphus rupinsulensis* (3.3 ft), and *Stylurus spiniceps* (4.5 ft). The more lentic species collected in Barton Cove crawled shorter heights from the water's surface than the riverine species.

Average horizontal crawl distance was usually between 10 and 15 ft for most species, with maximum distances often 3-4 times greater than the average. Shortest crawl distance was for *Perithemis tenera* (a lentic species that prefers to emerge on aquatic vegetation) and *Stylurus amni*cola. Considering crawl height and crawl distance together, the riverine species that tended to eclose closest to the water were *Stylurus amnicola* and *Ophiogomphus rupinsulensis*. In general, species eclosed on a wide variety of available surfaces.

Due to low and erratic emergence, especially during what should have been the peak emergence period from late May to early July, data on emergence and eclosure speed are somewhat limited. The average elapsed time from when a larva stopped to when it completed metamorphosis was 36 minutes (N=10, range: 9 to 81 minutes). The time elapsed from completion of metamorphosis to flight ranged from 7 to 235 minutes (N=22, average = 47 minutes). The 235-minute observation appears to be an anomaly; without that value, the average was 38 minutes and the range was from 7 to 96 minutes. Together, these two time periods comprise the critical time period from when a larva stops to eclose to when it flies away. A total of nine specimens were observed to complete the entire critical time period, including *Ophiogomphus rupinsulensis* (1), *Dromogomphus spinosus* (2), *Stylurus amnicola* (2), *Stylurus spiniceps* (3), and one unidentified individual. The average duration was 70 minutes and ranged from 54 to 123 minutes.

The water surface elevation (WSEL) changes and rates of change were characterized at each odonate survey site.

Site 1: Near the Route 116 Bridge, the Connecticut River undergoes relatively low daily and hourly water level fluctuations. Over the entire data collection period, the daily fluctuation in WSEL ranged from 0.1 to 4.8 ft (average daily = 2.2 ft). The maximum hourly rate of change in WSEL each day rarely exceeded 1.0 ft/hr (average = 0.41 ft/hr) and the average hourly rate of change was 0.15 ft/hr.

Site 2: The Connecticut River near Third Island undergoes relatively low daily and hourly water level fluctuations compared to areas closer to Cabot Station. Over the entire data collection period, the daily fluctuation in WSEL ranged from 0.0 to 4.8 ft (average daily = 2.4 ft). The maximum hourly rate of change in WSEL each day rarely exceeded 1.0 ft/hr (average = 0.51 ft/hr) and the average hourly rate of change was 0.18 ft/hr.

Site 3: The Connecticut River near Poplar Street, which is not far downstream from Cabot Station and directly across the river from the Deerfield River confluence, undergoes relatively high daily and hourly water level fluctuations. Over the entire data collection period, the daily fluctuation in WSEL ranged from 0.2 to 6.7 ft (average daily = 3.1 ft). The maximum hourly rate of change in WSEL each day rarely exceeded 2.0 ft/hr (average = 1.09 ft/hr) and the average hourly rate of change was 0.24 ft/hr.

Site 4: The Connecticut River in the bypass reach, which is where Rock Dam is located, experienced relatively high daily and hourly water level fluctuations during the study period in 2015 compared to other sites, more so downstream from Rock Dam than upstream of it. Special bypass flow releases were being provided from May, June and early July 2015 for other relicensing studies, which caused atypical water level fluctuations in the bypass reach during this period. Therefore, a low flow period in late July-August when minimum flows were in the bypass reach was also evaluated.

For the entire monitoring period, the average daily range of WSEL was 1.9 ft downstream from Rock Dam and 0.9 ft upstream. During the period July 25-August 22, 2015, when bypass flows were stable and Cabot Station was operating, the maximum hourly rate of change in WSEL below Rock Dam was 1.91 ft/hr (average daily max = 0.97 ft.hr) which is comparable to Site 3 WSEL data below Cabot Station for this period. In contrast, upstream from Rock Dam the maximum hourly rate of change in WSEL each day rarely

exceeded 1.0 ft/hr (average = 0.55 ft/hr), and the average hourly rate of change was 0.07 ft/hr. Above Rock Dam, water levels are typically stable in the absence of spillage at Turners Falls Dam. During a low flow period in late July-August when minimum flows were in the bypass reach, the average daily rate of change in WSEL above Rock Dam was 0.09 ft/hr.

Site 5: Barton Cove experiences relatively low hourly water level fluctuations compared to other sites. The average daily range of WSEL in Barton Cove was 2.5 ft, and over the entire data collection period ranged from 0.6 to 4.5 ft. The maximum hourly change in WSEL at Barton Cove never exceeded 1.0 ft/hr (average = 0.56 ft/hr) and the average hourly rate of change was 0.20 ft/hr.

In terms of understanding potential effects of water level fluctuations, the concern is for those species and individuals that remain close to the water's edge, especially in areas of the river where daily and hourly water level fluctuations and rates of change are greatest. Water level fluctuations and rates of change, resulting from Project operations, may affect odonate emergence in areas of the Connecticut River closest to Cabot Station. State-listed odonate species documented in these areas include *Gomphus abbreviatus*, *Gomphus vastus, Neurocordulia yamaskanensis*, and *Stylurus amnicola*.

Precisely which areas are affected, and to what extent, depend on timing and magnitude of flows through Cabot Station, Station No. 1, or spill over the Turners Falls Dam. Spill over the Turners Falls Dam during the Odonate emergence period is usually associated with large precipitation events rather than Project operations. Flows through Cabot Station affect WSEL both upstream (up to, but not above, Rock Dam) and downstream from Cabot Station, but these effects diminish with increasing distance downstream from Cabot Station. At Third Island, approximately 5 miles downstream from Cabot Station, neither the hourly/daily changes in WSEL or rates of change appeared to have a strong effect on odonate emergence. Release of water through Station No. 1 could affect odonate emergence in downstream areas of the bypass reach, but specific effects would depend on the timing (time of day or time of year) of such releases. Neither hourly/daily changes in WSEL or rate of change in Barton Cove appear to affect odonate emergence.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

cfs	cubic feet per second
FERC	Federal Energy Regulatory Commission
FirstLight	FirstLight Hydro Generating Company
ft	feet
hr	hour
ILP	Integrated Licensing Process
N	number of observations
NHESP	Natural Heritage and Endangered Species Program
Northfield Mountain Project	Northfield Mountain Pumped Storage Project
PAD	Pre-Application Document
PSP	Proposed Study Plan
RSP	Revised Study Plan
RTK-GPS	Real-Time Kinematic-Global Positioning System
SD1	Scoping Document 1
SD2	Scoping Document 2
SPDL	Study Plan Determination Letter
TFI	Turners Falls Impoundment
Turners Falls Project	Turners Falls Hydroelectric Project
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VY	Vermont Yankee Nuclear Power Plant
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 Northfield Mountain and Turners Falls Projects using the FERC's Integrated Licensing Process (ILP). The current licenses for Northfield Mountain and Turners Falls Projects were issued on May 14, 1968 and May 5, 1980, respectively, with both set to expire on April 30, 2018.

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

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

On August 27, 2013 Entergy Corp. announced that the Vermont Yankee Nuclear Power Plant (VY), located on the downstream end of the Vernon Impoundment on the Connecticut River and upstream of the two Projects, will be closing no later than December 29, 2014. With the closure of VY, certain environmental baseline conditions will change during the relicensing study period. On September 13, 2013, FERC issued its first Study Plan Determination Letter (SPDL) in which many of the studies were approved or approved with FERC modification. However, due to the impending closure of VY, FERC did not act on 19 proposed or requested studies pertaining to aquatic resources. The SPDL for these 19 studies was deferred until after FERC held a technical meeting with stakeholders on November 25, 2013 regarding any necessary adjustments to the proposed and requested study designs and/or schedules due to the impending VY closure. FERC issued its second SPDL on the remaining 19 studies on February 21, 2014, approving the RSP for Study No. 3.3.10: *Assess Operational Impacts on Emergence of State-Listed Odonates in the Connecticut River* with certain modifications. This report contains the results of this study.

FERC's recommended study plan modifications are listed below. These issues were discussed further with the Massachusetts Natural Heritage and Endangered Species Program (NHESP) and the United States Fish and Wildlife Service (USFWS) in preparation for the field data collection and are addressed throughout this report.

- *Emergence Speed*- FERC recommended FirstLight record a minimum of 10 observations per species or species groups, provided that 10 individuals form each group are encountered during the emergence surveys.

- *Quantitative Survey Effort*- FERC recommended FirstLight stratify the survey effort for surveys of emergence/eclosure behavior to a minimum of six 2-meter transects in each available habitat type (natural vegetation, gradual sloping mud/sand banks and rock substrate) in each study reach.

- *Quantitative Survey Constraints*- FERC recommended FirstLight provide precipitation data including any justification for conducting or not conducting odonate surveys due to precipitation events.

- *Water Level Fluctuation Analysis*- FERC recommended FirstLight deploy a water level logger (with the capability to record temperature) set to record data at 15-minute intervals, at each of the quantitative survey locations to accurately evaluate water levels, standardized field measurements and describe temperature in relation to odonate emergence behavior. FERC also recommended that FirstLight use the quantitative data collected under Study No. 3.1.2, such as frequency, amplitude and speed of boat wakes when evaluating effects on odonate emergence.

1.1 Study Goals and Objectives

The study was designed to assess potential effects of Project operations on emerging dragonflies (Insecta: Odonata; hereafter called "odonates") in the Connecticut River. This study had two objectives:

- Synthesis of existing data, supplemented with field surveys, to characterize the assemblage structure and emergence/eclosure behavior of odonates in the Project area.

- Assess the effects of Project operations, especially water surface elevation (WSEL) changes, on the emergence, eclosure, and habitat of state-listed odonate species and the odonate community.

Two phases of fieldwork were completed. Phase 1, completed in 2014, included qualitative surveys of odonate larvae and exuviae at eight sites to determine species assemblage structure and to collect habitat data. Key elements of Phase 1 are included in this comprehensive report. The Phase 1 work was summarized in an interim report filed with FERC on September 14, 2015, and this report is attached herein as Appendix A. Phase 2, completed in 2015, included quantitative surveys, observations of emergence/eclosure behavior, and concurrent collection of WSEL and water temperature data to analyze potential effects of Project operations on odonates and their habitat.

2 STUDY SITES AND METHODS

2.1 Phase 1: Qualitative Surveys

2.1.1 Agency Coordination and Permitting

A study plan and scientific collection permit application were submitted to the Massachusetts Natural Heritage and Endangered Species Program (NHESP), and NHESP issued the permit on May 15, 2014.

2.1.2 Qualitative Study Sites

FirstLight conducted qualitative surveys of odonate larvae and exuviae at four areas (5 sites) between the Turners Falls Dam and the Route 116 Bridge in Sunderland, and one area (3 sites) in the Turners Falls Impoundment (TFI) near Barton Cove (Appendix A includes the Phase 1 Interim Report, which includes maps and site descriptions). Representative aquatic and shoreline habitats were surveyed in Barton Cove and on the other side of Campground Point, totaling approximately 350 meters of shoreline. In the Turners Falls Project's bypass reach, representative aquatic and shoreline habitats were surveyed in a ~500 meter reach upstream and downstream from Rock Dam[1]. Representative aquatic and shoreline habitats were surveyed along 400 meters of shoreline in two areas between the Railroad Bridge and Third Island (Montague/Deerfield), and along 150 meters of shoreline near the Route 116 Bridge in Sunderland.

2.1.3 Qualitative Methods

Surveys were conducted on June 2, 6, 9, and 20 (2014). Barton Cove and the Route 116 Bridge were also checked twice in May 2014 to determine if emergence had begun early. However, the spring of 2014 was cooler than average, river flows were higher than average, and emergence was not detected until early June. Collection methods for larvae included aquatic D-nets and hand picking in the water or on land. Collections were made while wading, snorkeling, and while walking along the riverbank. If present, tenerals or exuviae were collected on the riverbank. For tenerals or exuviae, biologists recorded the vertical and lateral distance from the water's edge, and the surface that each was collected on. At each site, aquatic, riparian, and upland habitat parameters were recorded or photographed (Appendix A):

- Aquatic Parameters: water depth, water velocity, dominant substrate types, presence and coverage of aquatic vegetation and organic material;
- Riparian/Upland Parameters: bank slope, bank height, bank stability, riparian vegetation, tree canopy height and density, land use/land cover.

2.2 Phase 2: Quantitative Surveys

2.2.1 Agency Coordination and Permitting

The Phase 2 study plan was discussed in a meeting with NHESP and United States Fish and Wildlife Service (USFWS) on April 28, 2015. Concurrence was reached on survey site locations and numbers of transects, and a final sampling plan was sent to NHESP and USFWS on May 12, 2015. A copy of the field sampling plan and associated correspondence is contained in Appendix B. A scientific collection permit was issued by NHESP for the Phase 2 work on June 18, 2015.

[1] Rock Dam is located in the bypass reach. It is a comprised of near vertical bedrock falls.

2.2.2 Survey Sites

FirstLight conducted quantitative surveys at five sites along the Connecticut River (Table 2.2.2-1, Figure 2.2.2-1).

- Site 1: Eastern shore near the Route 116 Bridge (Sunderland)
- Site 2: Massachusetts Division of Fisheries and Wildlife conservation lands on the eastern shore upstream from the Sawmill River confluence (Montague)
- Site 3: Area from bike path bridge to Montague City Road, opposite the Deerfield River confluence (Montague)
- Site 4: Upstream and downstream from the Rock Dam in the bypass reach (Montague)
- Site 5: Barton Cove (Gill)

2.2.3 Transect Set-up and Data Collection

At each site, FirstLight established six transects that were oriented perpendicular to the river and spanned the continuum from the water's edge into the upland terrestrial vegetation. Transects were established to provide adequate representation of available habitat types, such as natural vegetation, gradually sloping mud/sand, and rock, and of varying bank slopes (i.e., steep versus shallow). Each transect was three meters wide, and extended upslope from the water's edge a minimum of 12 meters (longer in some cases). Transects were monumented with rebar. Benchmark elevations were surveyed and geo-referenced with GPS, and benchmarked to Project (NGVD29) datum using a Real-Time Kinematic-Global Positioning System (RTK-GPS) unit.

The following habitat data were collected for each transect: GPS locations, estimate of bank slope, types and percent cover of each substrate type, substrate embeddedness, presence and percent cover of aquatic and upland plants, and other noteworthy features (Table 2.2.3-1). All transects were photo-documented (Appendix C). The time of day, weather, water level, and a qualitative assessment of boat traffic were recorded at the time of each survey. Boat traffic was extremely light at all sites on all dates, and no disturbance from boat wakes was ever observed. Thus, this parameter is not discussed further in this report.

2.2.4 Quantitative Odonate Surveys

Surveys for emerging larvae, exuviae, and tenerals were conducted at each transect during 8 sampling periods that occurred approximately every two weeks beginning on May 27 and ending on September 2, 2015, with several additional days in June and July to increase sample sizes for eclosure speed (Table 2.2.2-1). Surveys were usually done in the first half of the day, with one site per day on consecutive days. In some cases, two sites per day were surveyed if work proceeded quickly due to low emergence. For each exuvia and teneral, the vertical height above the water's surface, the distance from the water's edge, and its eclosure structure/substrate were recorded. Each exuvia was collected, stored, labeled with site information and date, and identified at the University of Connecticut by Joseph Medwid and his faculty advisor, Dr. David Wagner, with additional assistance from their colleague, Dr. Michael Thomas.

Surveys were generally timed to coincide with fair weather (warm air temperatures, dry and sunny days) and flow conditions that are conducive to emergence (average to below-average flows, based on United States Geological Survey (USGS) streamflow data at the Montague City gage (01170500). Special bypass flow releases were being provided from May through June 2015 for other relicensing studies. Cool rainy weather, and frequent high-flow events from late May to early July made it challenging to schedule fieldwork and may have also delayed or possibly prevented emergence. Figure 2.2.4-1 shows the daily precipitation at Greenfield, MA.

2.2.5 Emergence and Eclosure Speed

Biologists looked for larvae exiting the water or crawling on land, and attempted to track single individuals as they crawled upslope and came to rest to begin the eclosure process. The most critical period was the time from when larvae began to eclose to when the teneral's wings hardened and the adult flew away. Biologists used a stopwatch to record the duration of this process. Some of these events were recorded using time-lapse photography (using a GoPro). For each exuvia (i.e., post-eclosure), the vertical height above the water's surface, the distance from the water's edge, and its eclosure structure/substrate was recorded.

Biologists attempted to record emergence/eclosure speed for 20 individuals of each species per site, with a focus on uncommon species. However, extremely low rates of emergence and challenging weather conditions during what should have been peak emergence period (late May to early July) greatly reduced our ability to gather these data. Although observations were supposed to coincide with the quantitative exuvia surveys, biologists also spent additional days in June and July trying to gather eclosure speed data within and outside of transects. This was done solely in response to low emergence rates and low sample sizes within transects.

2.3 Water Level Fluctuation Impact Assessment

2.3.1 Water Level Data Collection

FERCs February 21, 2014 Study Plan Determination Letter recommended that FirstLight deploy a water level and temperature logger at each quantitative survey reach to accurately evaluate water levels, standardize field measurements, and describe temperature in relation to odonate emergence behavior. As stated in the approved RSP, "the field data will be used to determine if water level fluctuations affect the emergence and eclosure success of state listed odonates." Temporary loggers were installed at each site for the duration of the quantitative surveys to supplement data from the permanent gages at the Turners Falls Dam and the USGS Montague City gage (Table 2.2.2-1, Figure 2.2.2-1). All loggers collected data at 15-minute intervals.

Water level data from the site below Rock Dam from May 28 – June 24, 2015 were rejected. A high flow event on June 2 caused the water level logger to move to deeper waters outside the instrument range of tolerance. A new logger was installed on June 24 once flows receded. Also note that special bypass flow releases were being provided during May and June for other relicensing studies.

2.3.2 Water Level Data Analysis

For analyses relevant to the odonate study, WSEL data were trimmed to the period from May 15 to September 15. For the Rock Dam sites, data collection with temporary loggers ended on September 2, 2015. Hourly and daily variability in the WSEL and rates of change were computed at each site compared with odonate emergence and eclosure behavior (i.e., crawl height, crawl distance, and crawl speed).

Table 2.2.2-1: Survey Sites and Dates for the Phase 2 Quantitative Odonate Surveys in the Connecticut River, Including a Description of Dataloggers Used to Collect WSEL and Water Temperature Data at or Near Each Site

Site	Location	Town	Date Surveyed	WSEL and Temperature Data Source
1	Route 116	Sunderland	May 30. June 10, 20, 25, 30. July 7, 18, 21. August 5, 20. Sept 1.	Temporary datalogger installed near the Route 116 Bridge. WSEL and temperature recorded at 15-minute intervals.
2	MADFW conservation lands upstream from the Sawmill River confluence	Montague	May 30. June 11, 23. July 6, 14, 21. August 4, 20. Sept 1.	Temporary datalogger installed near Third Island. WSEL and temperature recorded at 15-minute intervals.
3	Poplar Street boating access area across from Deerfield River confluence	Montague	May 29. June 12, 22. July 9, 17, 20. August 3, 19, 31	Temporary datalogger installed near the bike path bridge, which provided river temperature data and a backup data source for WSEL. Analyses used WSEL data from the USGS Montague City streamgage.
4	Rock Dam in the bypass reach; 2 transects upstream and 4 downstream from the Rock Dam	Montague	May 29. June 11, 22. July 9, 17, 20, August 3, 19, 31.	Temporary dataloggers (2) installed upstream and downstream from the Rock Dam, providing WSEL and temperature data. Equipment issues caused data loss from site below Rock Dam for part of May and June. Loggers retrieved on September 2.
5	Barton Cove	Gill	May 27. June 8, 19. July 2, 8, 25. August 5, 18. Sept 2.	WSEL data from FirstLight's permanent gage at the Turners Falls Dam. Water temperature from a datalogger installed at the boat barrier (Site 7 of the Water Quality Study).

Note: The site numbers above were ordered from downstream to upstream. These numbers are different (reversed) than those reported in the Updated Study Report Summary.

Table 2.2.3-1: Summary of Habitat Parameters Recorded at Each Transect Sampled During the Phase 2 Quantitative Odonate Surveys

Site	Trans	Latitude	Longitude	Slope*	Embed**	Emergence/Eclosure Habitat Types***											
						Silt	Sand	Grav	LRock	Root	CWood	Detr	Emerg	Moss	Herb	Shrub	TreeTr
1	1	42.46716	-72.58354	2	10	95	0	0	5	0	0	0	0	0	10	60	P
	2	42.46734	-72.58342	3	10	85	0	0	15	0	0	0	0	T (2)	5	5	P
	3	42.46756	-72.58334	2	0	40	0	40	20	0	0	0	0	0	5	10	P
	4	42.46822	-72.58284	1	0	95	0	0	0	0	5	0	0	0	60	5	0
	5	42.46952	-72.58181	1	0	100	0	0	0	0	0	0	0	5	30	15	P
	6	42.46975	-72.58160	1	30	75	0	0	25	0	0	0	0	10	35	5	P
2	1	42.53894	-72.56413	2	0	60	0	15	5	20	0	0	0	10	10	5	P
	2	42.53898	-72.56411	2	0	70	0	15	5	10	0	0	0	10	10	0	0
	3	42.53903	-72.56407	2	0	50	0	30	10	10	0	0	0	10	10	0	0
	4	42.53907	-72.56402	2	0	65	0	15	5	15	0	0	0	10	5	0	P
	5	42.53916	-72.56393	2	0	80	0	10	0	5	5	0	0	10	30	5	0
	6	42.53953	-72.56365	2	0	80	0	5	0	15	0	0	0	10	30	15	P
3	1	42.58020	-72.57455	2	0	90	0	0	5	5	0	0	0	T (2)	50	15	P
	2	42.58018	-72.57471	3	0	20	0	5	75	0	0	0	0	0	5	T (2)	P
	3	42.58021	-72.57484	2	0	85	0	0	5	10	0	0	0	10	20	T (2)	P
	4	42.57983	-72.57603	2	0	85	0	0	0	10	5	0	0	5	40	30	P
	5	42.57974	-72.57624	2	0	60	10	0	0	25	5	0	0	T (2)	10	15	P
	6	42.57958	-72.57699	1	0	95	0	0	0	0	5	0	0	0	30	15	0
4	1	42.59332	-72.58211	1	0	60	40	0	0	0	0	0	0	0	30	5	P
	2	42.59370	-72.58189	1	0	70	25	0	0	0	5	0	0	5	30	5	P
	3	42.59497	-72.57996	1	0	20	0	20	60	0	0	0	0	5	20	5	P
	4	42.59499	-72.57924	1	0	50	30	20	0	0	0	0	0	T (2)	20	5	P
	5	42.59515	-72.57871	1	0	80	0	0	10	10	0	0	0	15	20	10	P
	6	42.59543	-72.57861	3	0	0	0	0	95	5	0	0	0	35	T (2)	T (2)	P
5	1	42.60600	-72.53146	1	0	50	30	0	0	0	10	10	60	0	0	20	0
	2	42.60591	-72.53139	1	0	60	25	0	0	0	5	10	80	0	0	20	0
	3	42.60512	-72.53125	2	0	50	0	10	30	0	0	10	0	5	25	20	0
	4	42.60408	-72.53344	3	60	50	0	5	35	0	10	60	0	10	15	T (2)	P
	5	42.60401	-72.53371	3	0	40	0	10	50	0	0	0	0	25	10	10	P
	6	42.60363	-72.53384	2	0	5	0	5	90	0	0	0	0	0	5	5	0

**Slope = 1: Shallow gradient, 2: Moderate gradient, 3: Steep gradient. Gradient always variable along the length of each transect.*

*** Embed = percent embeddedness of coarse rock, in 10 percent intervals from 0 (completely unembedded) to 100 (complete embedded). Not applicable if coarse rock not present.*

****Substrate Abbreviations: Grav = gravel, LRock = large rock, Root = generally, roots of large woody vegetation, CWood = coarse wood (logs, limbs, etc.), Detr = detritus (leaf litter, etc.), Emerg = emergent aquatic vegetation, such as Typha sp., TreeTr = Tree trunks*

T = trace

SB6
SB5
SB4
Route 116
Bridge
SB3
SB2
SB1

Service Layer Credits: Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
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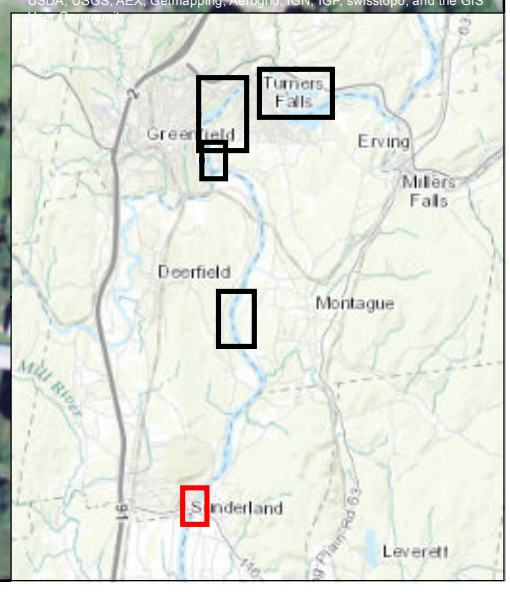

Legend

- Odonate Transect Location
- Permanent Gage
- Temporary Logger

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GDF SUEZ

N

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Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889
Relicensing Study 3.3.10
Assess Operational Impacts on Emergence of State-Listed Odonates in the Connecticut River

0 150 300 600 Feet

Figure 2.2.2-1: Phase 2 Quantitative Odonate Survey Sites

Site 1: Eastern shore near the Route 116 Bridge (Sunderland)

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FS6
FS4
FS5
FS2
FS3
FS1
Third Island
Service Layer Credits: Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
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Turners Falls
Greenfield
Erving
Millers Falls
Deerfield
Montague
Sunderland
Leverett
Mill River
Legend
Odonate Transect Location
Permanent Gage
Temporary Logger
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Turners Falls Hydroelectric Project No. 1889
Relicensing Study 3.3.10
Assess Operational Impacts on Emergence of State-Listed Odonates in the Connecticut River
0 225 450 900
Feet
Figure 2.2.2-1: Phase 2 Quantitative Odonate Survey Sites
Site 2: Massachusetts Division of Fisheries and Wildlife conservation lands on the eastern shore upstream from the Sawmill River confluence (Montague)
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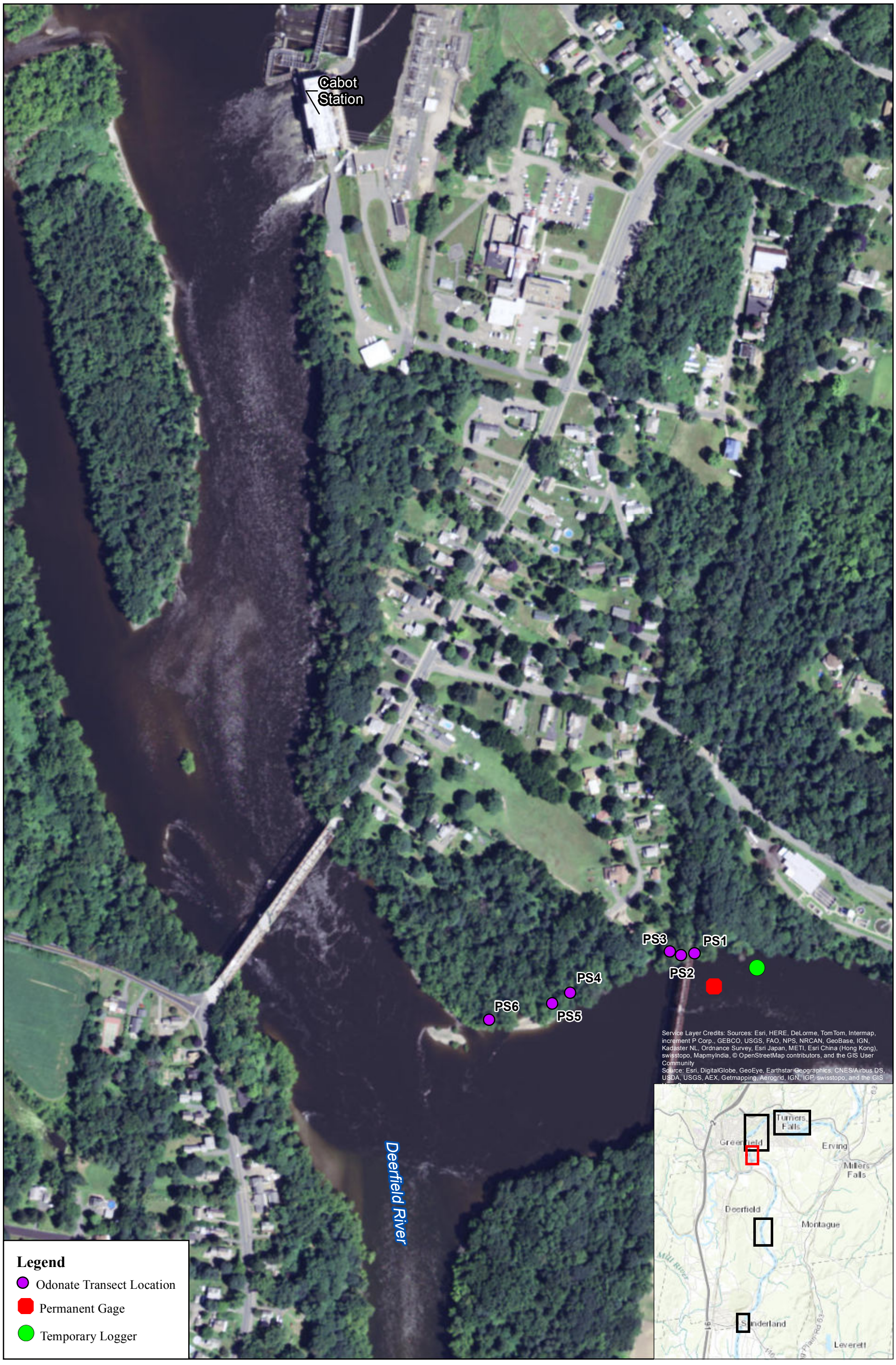

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Assess Operational Impacts on Emergence of State-Listed Odonates in the Connecticut River

0 150 300 600 Feet

Figure 2.2.2-1: Phase 2 Quantitative Odonate Survey Sites

Site 3: Area from bike path bridge to Montague City Road, opposite the Deerfield River confluence (Montague)

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Station No. 1

Rock Dam

RD6

RD5

RD3

RD4

RD2

RD1

Cabot Station

Service Layer Credits: Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
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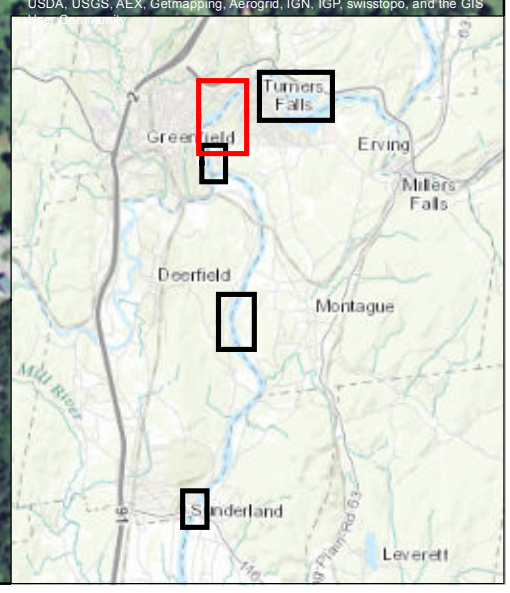

Legend

- Odonate Transect Location
- Permanent Gage
- Temporary Logger

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Turners Falls Hydroelectric Project No. 1889
Relicensing Study 3.3.10
Assess Operational Impacts on Emergence of State-Listed Odonates in the Connecticut River

0 300 600 1,200 Feet

Figure 2.2.2-1: Phase 2 Quantitative Odonate Survey Sites

Site 4: Upstream and downstream from the Rock Dam in the bypass reach (Montague)

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BC1
BC2
BC3
BC4
BC5
BC6
Turners Falls Dam

Service Layer Credits: Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
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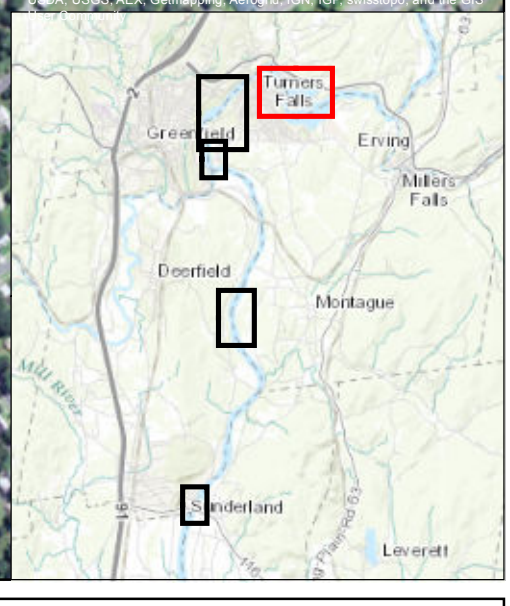

Legend

- Odonate Transect Location
- Permanent Gage
- Temporary Logger

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Relicensing Study 3.3.10
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0 300 600 1,200 Feet

Figure 2.2.2-1: Phase 2 Quantitative Odonate Survey Sites

Site 5: Barton Cove (Gill)

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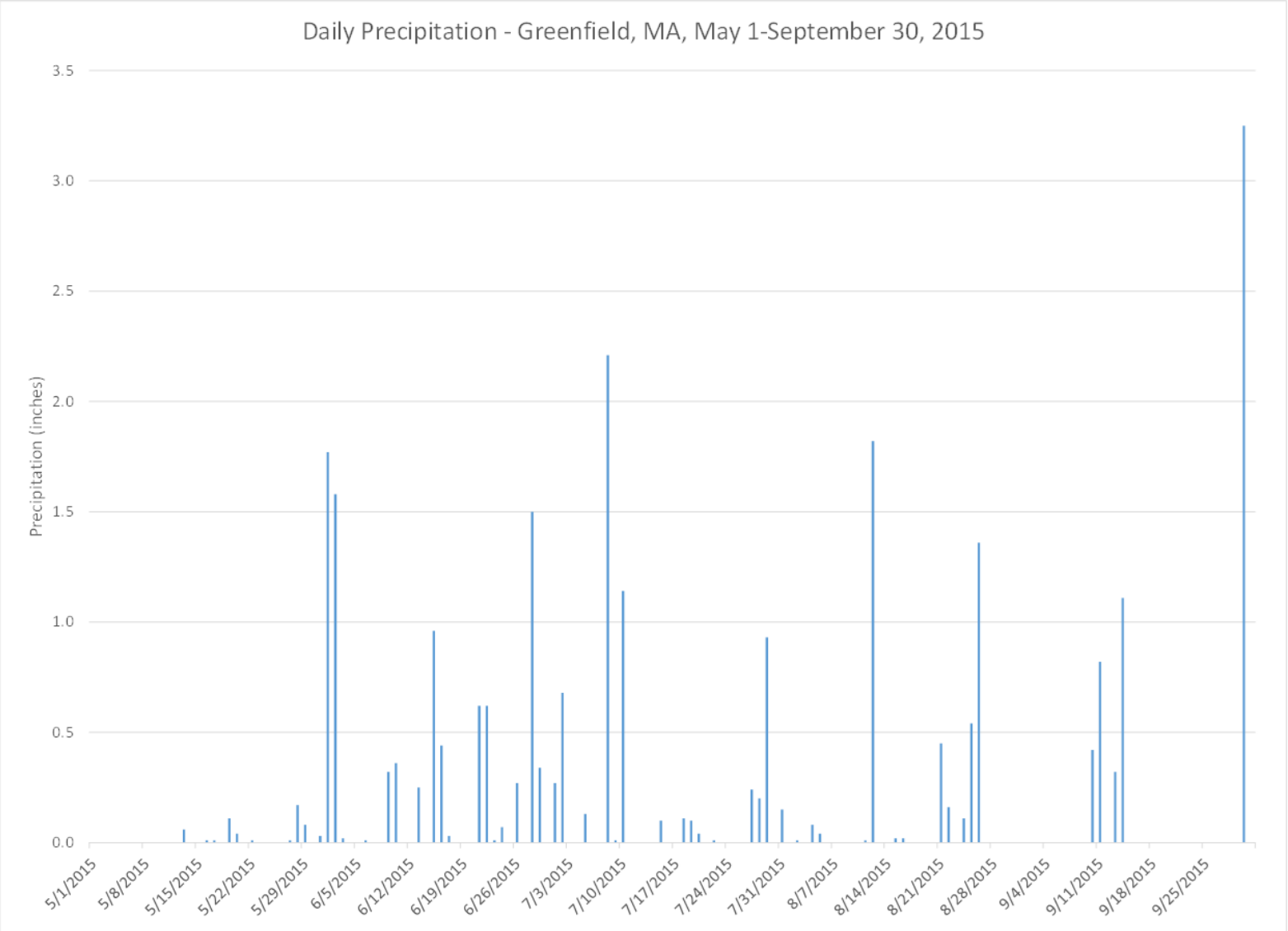

Figure 2.2.4-1: Daily Precipitation at Greenfield, MA from May – September, 2015

3 RESULTS

3.1 Phase 1 Qualitative Survey

3.1.1 Species Assemblage

The genera and species collected in 2014 are listed in Table 3.1.1-1 (see Appendix A for site locations and descriptions). *Epitheca princeps*, a species common in lentic habitats, was the most common species collected at Sites 1-3. These sites, located in the lowermost portion of the TFI (Barton Cove), contain mostly lentic habitat with submerged and emergent vegetation. Sites 4-8 were generally more lotic; dominant taxa in these samples included *Gomphus vastus, Ophiogomphus rupinsulensis, Neurocordulia yamaskanensis, Boyeria vinosa*, and *Macromia illinoiensis*. There was very little variation in the odonate assemblage among sites 4-8.

3.1.2 Emergence and Eclosure

In 2014, approximately 250 exuviae were collected across the eight survey sites. Exuviae were found primarily on terrestrial herbaceous vegetation, soil, trees, coarse fallen wood, and rock (Table 3.1.2-1). At Sites 1 and 3, they were also found on emergent aquatic vegetation, an emergence substrate that was typically absent at other sites. They were found as high as nine feet above the water's surface (mean = 4.4 ft) and as far as 42 feet from the edge of the water (mean = 12.7 ft).

3.2 Phase 2 Quantitative Survey

3.2.1 Species Assemblage

A total of 622 individuals representing 16 species were collected during the 2015 season (Table 3.2.1-1). Dominant species included *Gomphus vastus* (219; 35.2% of total), *Boyeria vinosa* (78; 12.5% of total), *Epitheca princeps* (102; 16.4% of total), and *Stylurus spiniceps* (62; 10.0% of total). Of these, *Epitheca princeps* was found almost exclusively in the weedy lentic habitats at Site 5 in Barton Cove, along with several other species that can tolerate this type of environment (e.g., *Perithemis tenera* and *Libellula* sp.). Species found most frequently in the riverine environments of Sites 1 to 4 included *Gomphus vastus, Boyeria vinosa, Stylurus spiniceps, Ophiogomphus rupinsulensis, Neurocordulia yamaskanensis, Dromogomphus spinosus, Gomphus abbreviatus*, and *Macromia illinoiensis*.

Odonates were far less numerous than anticipated at all sites. For example, only 37 specimens were collected over the duration of the study at Site 3, with an average of only 0.77 specimens per transect per sampling date (6 transects x 8 dates = 48 sampling events per site). Similarly, low numbers of odonates were collected at Site 4 (55 specimens, 1.15 specimens per transect per sampling date). Total counts were higher and more comparable at Sites 1, 2, and 5, although still lower than exuviae densities that were observed in these areas during the 2014 qualitative surveys. Total counts of exuviae and tenerals per transect (all sampling periods combined) are plotted on Figure 3.2.1-1 (also see Appendix D for raw data).

3.2.2 Timing of Emergence

Emergence was first detected early in the fourth week of May, which prompted quantitative sampling to begin on May 26. Summary statistics for exuviae and tenerals (all species combined) and species richness for each survey site and sampling period are provided in Table 3.2.2-1, and individual species counts are provided in Table 3.2.2-2 (also see Appendix D for further breakdown by transect). Counts were low for all species during the first round of sampling, reached a peak during the second round, then dropped and remained consistent for the next four rounds before diminishing to very low numbers during the final two rounds (Figure 3.2.2-1).

3.2.3 Crawl Distances and Heights

Data were collected for 622 individuals and 16 species, with sample sizes per species ranging from 1 to 219 (Table 3.2.3-1, Appendix E). For all species combined, larvae crawled an average distance of 12.4 ft from the edge of the water and a vertical height of 5.0 ft from the water's surface. There was considerable variation within and among species, as shown on the scatterplot (Figure 3.2.3-1) and box plots for crawl heights and distances (Figures 3.2.3-2 and 3.2.3-3). Some of the variation is due to low sample sizes, and two species (*Basiaeschna janata* and *Cordulegaster maculata*) are not included in Figures 3.2.3-2 or 3.2.3-3 because sample sizes were too low.

The more lentic species collected at Site 5 (i.e., *Perithemis tenera*, *Libellula* sp. *Epitheca princeps*), which tend to emerge on aquatic vegetation, crawled shorter vertical distances from the water's surface than the riverine species that were more prevalent at Sites 1 to 4. Among the riverine species, crawl height was greatest for *Macromia illinoiensis*, *Gomphus abbreviatus*, *Gomphus vastus, and Neurocordulia yamaskanensis*; each of these species crawled an average vertical distance of near or above 7 ft. Riverine species that crawled the shortest average vertical distances from the water's surface included *Stylurus amnicola* (3.2 ft), *Ophiogomphus rupinsulensis* (3.3 ft), and *Stylurus spiniceps* (4.5 ft). One *Stylurus spiniceps* exuvia was collected 22.5 ft above the water's surface, which is the greatest ascent recorded during the study.

Boyeria vinosa crawled the longest distances from the edge of the water, at 17.2 ft, and one individual had crawled 58.9 ft before stopping to eclose. Average crawl distance was usually between 10 and 15 ft for most species, with maximum distances often 3-4 times greater than the average. Shortest crawl distance was for *Perithemis tenera* (a lentic species that prefers to emerge on aquatic vegetation) and *Stylurus amnicola*. Considering crawl height and crawl distance together, the riverine species that tended to eclose closest to the water were *Stylurus amnicola* and *Ophiogomphus rupinsulensis*.

3.2.4 Substrate Selection

Eclosure substrate preferences are shown on Table 3.2.3-1 (see also Appendix E). Preferences are expressed as a percentage. In several cases, multiple substrate types were recorded for single exuviae (e.g., on detritus, among rocks). Percent preference was computed by dividing the number of observations for each substrate type per species by the total number of substrate observations for each species. In general, species eclosed on a wide variety of surfaces that were available to them. At Site 5, this included large amounts of emergent aquatic vegetation, detritus, rock, trees, and roots. At Sites 1 to 4, emergent aquatic vegetation was absent and species eclosed on bare sediment (from silt to coarse rock), ground-level cover such as moss, roots, and detritus, and on vertical surfaces such as stems of herbaceous plants, vines, trees, and vertical rock faces.

3.2.5 Emergence and Eclosure Speed

Due to low and erratic emergence, especially during what should have been the peak emergence period from late May to early July, we obtained little data on emergence and eclosure speed. Other challenges to documenting emergence and eclosure timing included larvae that often returned to the water rather than stopping to eclose, larvae that remained under rocks without even starting to eclose, larvae that remained motionless on the edge of the water without coming onto land, attacks by ants during the eclosure process, and heavy predation by birds.

The average elapsed time from when a larva stopped to when it completed metamorphosis was 36 minutes (range: 9 to 81 minutes) (Table 3.2.5-1). The average time elapsed from completion of metamorphosis to flight (i.e., the time it takes for the wings to unfurl and harden to the point where the adult can fly away) was 47 minutes and ranged from 7 to 235 minutes. The 235-minute observation appears to be an anomaly; without that value, the average was 38 minutes and the range was from 7 to 96 minutes. Together, these two time periods comprise the critical time period from when a larva stops to eclose to when it flies away.

We successfully observed nine specimens complete the entire critical time period, representing four riverine species (*Ophiogomphus rupinsulensis* (1), *Dromogomphus spinosus* (2), *Stylurus amnicola* (2), and *Stylurus spiniceps* (3), and one unidentified individual. The average duration was 70 minutes and ranged from 54 to 123 minutes.

3.3 Water Surface Elevation Analysis

Figure 3.3-1 shows relatively low water for the first two weeks of the data collection period, then rapid increases in the beginning of June in response to heavy rainfall, high and erratic flows throughout all of June before the hydrograph finally settled to near-normal after the first week of July and remained low throughout most of July, August, and early September. Cool water temperatures (also plotted on Figure 3.3-1) and persistent cloudy/rainy weather accompanied the high flows of June and early July, together creating exceptionally poor emergence conditions for dragonflies.

For the period from May 15 to September 15 (minus missing data from below Rock Dam), key summary statistics for WSEL, daily rates of change in WSEL, and maximum rates of change in WSEL are provided in Table 3.3-1. Average daily rates of change in WSEL are low across all sites, typically less than 0.3 ft/hr (Figure 3.3-2, Table 3.3-1). The highest computed average hourly rates of change varied among sites, ranging from 0.33 ft/hr at the Route 116 Bridge to 0.59 ft/hr upstream from the Rock Dam. The maximum rates of change each day were more variable (Table 3.3-1, Figure 3.3-2). WSELs and the daily mean and daily maximum rates of change are plotted separately for each site (Figures 3.3-3 to 3.3-8). Monthly WSEL charts for each site are provided in Appendix F. Overall, water level rates of change are lowest for Barton Cove, Third Island, and the Route 116 Bridge, and highest for the site below Rock Dam in the bypass reach and at the Montague gage (excluding the anomalous maximum at the site above Rock Dam, explained below).

During May and June 2015, FirstLight was providing coordinated flow releases in the bypass reach in support of other relicensing studies; therefore, the frequency and magnitude of water level fluctuations in the bypass reach during this period were atypical of bypass flow conditions. Other relicensing studies were also in progress during the summer. Therefore, WSEL data from a period from July 25- August 22, 2015 were evaluated to better understand WSEL changes when only Cabot Station was running, as opposed to WSEL changes during periods of controlled and uncontrolled spillage from the Turners Falls Dam. Data from this period are summarized in Table 3.3-2. Data from this period show the maximum rates of change at the Montague gage and below Rock Dam are still similar, but lower by 0.6-0.7 ft/hr compared to the full period. The biggest difference is apparent at the site above Rock Dam. WSELs were fairly constant at this site during the low flow period (max rate of change = 1.32 ft/hr).

These results are used in the analysis of potential effects of Project operations below.

Table 3.1.1-1: List of Odonate Species Collected in the Project Area during Phase 1 (2014) Qualitative Surveys and Phase 2 (2015) Quantitative Surveys

Species	Abbreviation	Status	2014 Phase 1 Survey Site								2015 Phase 2 Survey Site				
			1	2	3	4	5	6	7	8	1	2	3	4	5
Arigomphus furcifer	ArFu			X											
Basiaeschna janata	BaJa														X
Boyeria vinosa	BoVi		X			X	X	X	X	X	X	X	X	X	
Cordulegaster maculata	CoMa													X	
Dromogomphus spinosus	DrSp										X	X	X	X	X
Epitheca princeps	EpPr		X	X	X	X	X							X	X
Gomphus abbreviates	GoAb	Special Concern				X	X	X	X	X	X	X		X	
Gomphus vastus	GoVa	Special Concern				X	X	X	X	X	X	X	X	X	
Gomphus ventricosus	GoVe	Threatened					X								
Hagenius brevistylus	HaBr										X	X	X		
Libellula sp.	Lisp														X
Libellulinae (unidentified)	Li														X
Macromia illinoiensis	MaIl		X	X	X	X	X	X	X	X	X	X	X	X	X
Neurocordulia yamaskanensis	NeYa	Special Concern	X	X	X	X	X	X	X	X	X	X	X	X	X
Ophiogomophus rupinsulensis	OpRu					X	X	X	X	X	X	X			
Perithemis tenera	PeTe					X	X	X	X	X					X
Stylurus amnicola	StAm	Endangered									X	X	X		
Stylurus spiniceps	StSp					X					X	X	X	X	

Species abbreviations are used in subsequent tables and graphs in this report.

Phase 1 surveys sites are listed below. Also see Appendix A for maps and additional descriptions of Phase 1 survey sites:

Sites 1 – 3: Barton Cove

Site 4: Bypass Reach above and below Rock Dam

Site 5: Downstream from Railroad Bridge

Site 6: Between Railroad Bridge and Third Island

Site 7: Upstream from Third Island

Site 8: Route 116 Bridge, Boat Ramp

Table 3.1.2-1: Summary Statistics for Crawl Height, Crawl Distance, and Eclosure Substrate for Exuviae Collected During Phase 1 (2014) Qualitative Sampling

Parameter	2014 Qualitative Survey Site*							Total
	1	3	4	5**	6	7	8	
Sample Size	28	-	37	53	50	79	-	247
Vertical Height from Waters Surface (ft)								
Mean	1.5	-	4.1	5.1	5.4	4.1	-	4.4
Minimum	0.5	0.0	0.3	0.5	1.5	2.0	4.0	0
Maximum	3.0	3.0	7.0	9.0	8.5	8.0	8.0	9
Lateral Distance from Waters Edge (ft)								
Mean	14.0	-	13.8	17.8	5.8	7.9	-	12.7
Minimum	0.0	0.0	2.0	0.0	0.0	5.5	10.0	0
Maximum	15.0	3.0	23.0	42.0	8.0	20.0	25.0	42
Eclosure Substrate								
Aquatic Emergent Vegetation	25	X	0	0	0	0	0	25
Terrestrial Herbaceous Vegetation	0	0	23	10	18	48	X	99
Tree	0	0	4	33	0	3	X	40
Coarse Fallen Wood	3	X	3	2	1	2	X	11
Soil	0	0	6	7	31	25	X	69
Rock	0	0	1	1	0	1	X	3

**These data were not collected at Site 2. Ranges and cursory descriptions were recorded at Site 3 and Site 8, thus sample size and means were not calculated.*

***At least 200 more exuviae found at Site 5. Mostly 2-8 ft above water's surface and 4-7 ft from water's edge. Found mostly on low herbaceous vegetation and trees.*

Table 3.2.1-1: Species Counts at Each Survey Site in the Phase 2 (2015) Quantitative Sampling and the Relative Abundances of Each Species

Species	Abbreviation	2015 Phase 2 Survey Site					Phase 2 Total	Percent of Total
		1	2	3	4	5		
Arigomphus furcifer	ArFu	0	0	0	0	0	0	0.0
Basiaeschna janata	BaJa	0	0	0	0	2	2	0.3
Boyeria vinosa	BoVi	58	3	11	6	0	78	12.5
Cordulegaster maculata	CoMa	0	0	0	1	0	1	0.2
Dromogomphus spinosus	DrSp	3	10	1	2	2	18	2.9
Epitheca princeps	EpPr	0	0	0	1	101	102	16.4
Gomphus abbreviatus	GoAb	2	4	0	14	0	20	3.2
Gomphus vastus	GoVa	70	129	2	18	0	219	35.2
Gomphus ventricosus	GoVe	0	0	0	0	0	0	0.0
Hagenius brevistylus	HaBr	2	1	1	0	0	4	0.6
Libellula sp.	Lisp	0	0	0	0	6	6	1.0
Libellulinae (unidentified)	Li	0	0	0	0	12	12	1.9
Macromia illinoiensis	MaIl	3	2	6	2	1	14	2.3
Neurocordulia yamaskanensis	NeYa	3	8	4	6	2	23	3.7
Ophiogomphus rupinsulensis	OpRu	5	20	0	0	0	25	4.0
Perithemis tenera	PeTe	0	0	0	0	27	27	4.3
Stylurus amnicola	StAm	3	1	5	0	0	9	1.4
Stylurus spiniceps	StSp	23	25	9	5	0	62	10.0
Totals		**172**	**203**	**39**	**55**	**153**	**622**	**100%**

Table 3.2.2-1: Counts and Summary Statistics for Exuviae (all Species Combined) and Species Richness at each Survey by Sampling Period and by Transect, for the Phase 2 (2015) Quantitative Sampling

Parameter	Number of Individuals						Number of Species					
	Survey Site						Survey Site					
	1	2	3	4	5	Total	1	2	3	4	5	Total
Sampling Period												
1	5	19	0	10	30	64	2	2	0	2	2	5
2	36	122	3	17	15	193	2	4	2	3	4	7
3	35	15	7	4	24	85	4	3	4	4	3	9
4	27	11	7	7	34	86	8	5	4	4	6	12
5	24	26	8	9	11	78	4	5	4	5	4	11
6	35	9	10	6	24	84	2	3	4	3	3	9
7	7	0	4	1	15	27	3	0	2	1	3	6
8	3	1	0	1	0	5	1	1	0	1	0	2
Total	172	203	39	55	153	622	10	10	8	9	8	16
Average	21.5	25.4	4.9	6.9	19.1	77.8	3.3	2.9	2.5	2.9	3.1	7.6
SD	14.32	40.00	3.72	5.28	11.04	55.42	2.19	1.81	1.77	1.46	1.73	3.29
Minimum	3	0	0	1	0	5	1	0	0	1	0	2
Maximum	36	122	10	17	34	193	8	5	4	5	6	12
Transect	**1**	**2**	**3**	**4**	**5**		**1**	**2**	**3**	**4**	**5**	
1	28	40	5	6	12		6	5	3	3	2	
2	20	23	15	6	20		3	7	5	4	4	
3	25	18	7	3	82		4	6	4	2	5	
4	23	34	6	6	12		8	7	5	3	3	
5	48	51	1	13	17		6	5	1	4	4	
6	22	37	3	21	4		6	6	3	6	2	
Total	166	203	37	55	147		10	10	8	9	8	
Average	27.7	33.8	6.2	9.2	24.5		5.5	6.0	3.5	3.7	3.3	
SD	10.33	11.92	4.83	6.68	28.69		1.76	0.89	1.52	1.37	1.21	
Minimum	20	18	1	3	4		3	5	1	2	2	
Maximum	48	51	15	21	82		8	7	5	6	5	

Species counts are shown in Table 3.2.2-2 and Appendix D.

Table 3.2.2-2: Species Counts at Each Site and for Each Sampling Period for the Phase 2 (2015) Quantitative Sampling

		Species																	
Site	**Period**	**BaJa**	**BoVi**	**CoMa**	**DrSp**	**EpPr**	**GoAb**	**GoVa**	**HaBr**	**Lisp**	**Li**	**MaIl**	**NeYa**	**OpRu**	**PeTe**	**StAm**	**StSp**	**Total**	**# Species**
1	1	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	5	2
1	2	0	0	0	0	0	0	34	0	0	0	0	0	2	0	0	0	36	2
1	3	0	2	0	0	0	0	30	1	0	0	0	2	0	0	0	0	35	4
1	4	0	12	0	3	0	0	5	1	0	0	1	1	0	0	3	1	27	8
1	5	0	11	0	0	0	0	1	0	0	0	1	0	0	0	0	11	24	4
1	6	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0	10	35	2
1	7	0	5	0	0	0	0	0	0	0	0	1	0	0	0	0	1	7	3
1	8	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1
1	ALL	0	58	0	3	0	2	70	2	0	0	3	3	5	0	3	23	172	10
2	1	0	0	0	0	0	3	0	0	0	0	0	0	16	0	0	0	19	2
2	2	0	0	0	0	0	1	111	0	0	0	0	6	4	0	0	0	122	4
2	3	0	0	0	2	0	0	11	0	0	0	0	2	0	0	0	0	15	3
2	4	0	0	0	4	0	0	3	1	0	0	0	0	0	0	1	2	11	5
2	5	0	2	0	4	0	0	1	0	0	0	1	0	0	0	0	18	26	5
2	6	0	1	0	0	0	0	3	0	0	0	0	0	0	0	0	5	9	3
2	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	8	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1
2	ALL	0	3	0	10	0	4	129	1	0	0	2	8	20	0	1	25	203	10
3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	2	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0	3	2
3	3	0	0	0	0	0	0	1	1	0	0	4	1	0	0	0	0	7	4
3	4	0	3	0	0	0	0	0	0	0	0	0	1	0	0	2	1	7	4
3	5	0	1	0	1	0	0	0	0	0	0	0	0	0	0	2	4	8	4
3	6	0	4	0	0	0	0	0	0	0	0	2	0	0	0	1	3	10	4
3	7	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	2
3	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	ALL	0	11	0	1	0	0	2	1	0	0	6	4	0	0	5	9	39	8
4	1	0	0	1	0	0	9	0	0	0	0	0	0	0	0	0	0	10	2
4	2	0	0	0	0	0	4	12	0	0	0	0	1	0	0	0	0	17	3
4	3	0	0	0	0	1	1	1	0	0	0	0	1	0	0	0	0	4	4
4	4	0	1	0	1	0	0	4	0	0	0	0	1	0	0	0	0	7	4
4	5	0	2	0	0	0	0	1	0	0	0	2	3	0	0	0	1	9	5
4	6	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	4	6	3
4	7	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
4	8	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
4	ALL	0	6	1	2	1	14	18	0	0	0	2	6	0	0	0	5	55	9
5	1	1	0	0	0	29	0	0	0	0	0	0	0	0	0	0	0	30	2
5	2	1	0	0	0	12	0	0	0	0	0	1	1	0	0	0	0	15	4
5	3	0	0	0	1	22	0	0	0	0	0	0	0	0	1	0	0	24	3
5	4	0	0	0	1	17	0	0	0	2	6	0	1	0	7	0	0	34	6
5	5	0	0	0	0	3	0	0	0	2	1	0	0	0	5	0	0	11	4
5	6	0	0	0	0	9	0	0	0	0	5	0	0	0	10	0	0	24	3
5	7	0	0	0	0	9	0	0	0	2	0	0	0	0	4	0	0	15	3
5	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	ALL	2	0	0	2	101	0	0	0	6	12	1	2	0	27	0	0	153	8
ALL	1	1	0	1	0	29	14	0	0	0	0	0	0	19	0	0	0	64	5
ALL	2	1	0	0	0	12	5	158	0	0	0	1	10	6	0	0	0	193	7
ALL	3	0	2	0	3	23	1	43	2	0	0	4	6	0	1	0	0	85	9
ALL	4	0	16	0	9	17	0	12	2	2	6	1	4	0	7	6	4	86	12
ALL	5	0	16	0	5	3	0	3	0	2	1	4	3	0	5	2	34	78	11
ALL	6	0	31	0	1	9	0	3	0	0	5	2	0	0	10	1	22	84	9
ALL	7	0	9	0	0	9	0	0	0	2	0	1	0	0	4	0	2	27	6
ALL	8	0	4	0	0	0	0	0	0	0	0	1	0	0	0	0	0	5	2
ALL	ALL	2	78	1	18	102	20	219	4	6	12	14	23	25	27	9	62	622	16

Species are abbreviated as in Table 3.1.1-1. Appendix D shows species counts by sampling period and transect.

Table 3.2.3-1: Summary Statistics for Crawl Height, Crawl Distance, and Eclosure Substrate for Exuviae Collected During Phase 2 (2015) Sampling

	Species															
Parameter	**BaJa**	**BoVi**	**CoMa**	**DrSp**	**EpPr**	**GoAb**	**GoVa**	**HaBr**	**Lisp**	**Li**	**MaIl**	**NeYa**	**OpRu**	**PeTe**	**StAm**	**StSp**
Sample Size	2	78	1	18	102	20	219	4	6	12	14	23	25	27	9	62
Crawl Height (ft)																
Average	6.5	5.9	5.0	5.4	4.2	7.1	6.9	5.7	3.5	3.0	7.1	6.6	3.3	2.5	3.2	4.5
StDev	1.27	2.88	-	4.64	2.17	2.69	3.47	4.53	2.02	1.39	4.88	4.66	2.45	1.31	2.52	3.87
Minimum	5.6	0.3	5.0	0.1	0.6	3.0	0.0	0.1	0.5	1.4	0.2	0.2	0.4	0.3	0.0	0.0
25th Percentile	6.1	4.2	5.0	2.0	2.4	5.2	4.3	3.3	2.5	2.3	3.4	3.3	1.2	1.9	1.0	2.1
Median	6.5	5.5	5.0	3.7	4.0	7.1	6.8	5.9	3.6	2.8	7.0	5.6	3.5	2.4	2.5	3.8
75th Percentile	7.0	7.4	5.0	10.1	5.8	8.6	9.4	8.2	5.1	3.2	10.4	9.3	4.3	2.8	5.1	5.9
Maximum	7.4	14.5	5.0	13.3	10.0	13.8	15.1	10.8	5.9	6.6	17.5	17.5	11.5	6.5	7.2	22.2
Crawl Distance (ft)																
Average	13.6	17.2	10.2	11.5	12.4	12.8	12.7	15.5	13.1	9.9	16.5	13.2	10.2	7.7	7.4	14.6
StDev	0.23	9.86	-	7.52	7.62	10.98	8.33	10.05	3.13	7.17	13.23	10.52	6.95	5.17	7.00	11.79
Minimum	13.5	1.5	10.2	0.3	0.3	1.0	0.2	0.5	9.2	3.6	1.3	0.7	0.0	1.3	0.0	0.0
25th Percentile	13.5	11.5	10.2	5.4	7.9	3.4	7.1	15.1	11.6	4.3	5.8	4.5	5.2	3.6	1.1	3.9
Median	13.6	16.2	10.2	10.7	11.6	8.3	11.2	20.2	12.7	7.6	13.0	12.1	8.5	6.7	4.4	12.9
75th Percentile	13.7	22.3	10.2	16.4	13.1	23.0	16.7	20.6	14.1	12.8	25.0	20.3	13.5	11.3	12.8	22.8
Maximum	13.8	58.9	10.2	24.6	39.4	33.1	37.1	21.3	18.4	24.9	43.3	37.1	28.5	20.0	18.7	58.1
Eclosure Substrate (Percent Preference)*																
Silt	0.00	0.30	0.00	0.43	0.05	0.50	0.53	1.00	0.00	0.06	0.44	0.20	0.54	0.00	0.60	0.54
Sand	0.00	0.02	0.00	0.00	0.01	0.09	0.00	0.00	0.17	0.00	0.06	0.00	0.00	0.00	0.00	0.01
Grav	0.00	0.03	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.25	0.03	0.00	0.03
LRock	0.00	0.05	0.00	0.10	0.11	0.14	0.01	0.00	0.00	0.00	0.13	0.20	0.00	0.26	0.00	0.01
Root	0.50	0.16	0.00	0.29	0.05	0.05	0.21	0.00	0.00	0.00	0.00	0.04	0.04	0.03	0.30	0.30
CWood	0.00	0.08	0.00	0.00	0.04	0.05	0.00	0.00	0.00	0.06	0.00	0.04	0.04	0.03	0.00	0.00
Tree	0.00	0.18	1.00	0.00	0.02	0.18	0.17	0.00	0.00	0.00	0.00	0.28	0.04	0.03	0.00	0.01
Herb	0.50	0.16	0.00	0.14	0.42	0.00	0.05	0.00	0.50	0.18	0.25	0.20	0.04	0.14	0.10	0.10
AqHerb	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.17	0.47	0.00	0.00	0.00	0.14	0.00	0.00
Leaf	0.00	0.01	0.00	0.05	0.07	0.00	0.02	0.00	0.17	0.00	0.00	0.04	0.04	0.06	0.00	0.00
Detr	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.24	0.06	0.00	0.00	0.29	0.00	0.00

**Abbreviations: Grav = gravel, LRock = large rock, CWood = coarse woody material, AqHerb = emergent aquatic vegetation, Detr = detritus*

Species are abbreviated as in Table 3.1.1-1

Table 3.2.5-1: Eclosure Speed Collected in 2015, Including Crawl Height, Crawl Distance, and Eclosure Substrate Associated with Each Individual

Site*	Date	Species**	Key Times							Crawl Height (ft)	Crawl Distance (ft)	Emergence and Eclosure Substrate***									Notes
			Larva Observed	1. Start of Eclosure	2. End of Eclosure	3. Adult Flight	Time 1 to 2	Time 2 to 3	Time 1 to 3			Silt	Sand	Grav	LRock	Root	CWood	Tree	Herb	AqHerb	
4-5	5/29/2015	GoAb	-	-	12:12	12:58	-	0:46	-	5.1	1.0							X			
2-6	5/30/2015	OpRu	11:17	11:17	12:09	12:30	0:52	0:21	1:13	3.3	12.1						X				
2-4	5/30/2015	OpRu	-	-	11:55	12:02	-	0:07	-	5.4	20.7	X									
2-4	5/30/2015	OpRu	-	-	12:00	12:11	-	0:11	-	3.3	8.5			X							
2-4	5/30/2015	OpRu	-	-	12:01	12:10	-	0:09	-	3.5	11.5	X									
2-4	5/30/2015	OpRu	-	-	12:02	12:11	-	0:09	-	4.0	13.5	X									
2-3	5/30/2015	OpRu	12:34	-	12:35	1:10	-	0:35	-	3.7	16.7								X		
2-3	5/30/2015	OpRu	12:38	-	12:38	1:03	-	0:35	-	4.7	28.5							X			
5-5	6/19/2015	DrSp	-	-	10:48	11:45	-	0:57	-	2.7	8.7					X					
2-6	6/23/2015	DrSp	10:51	1:08	1:37	2:12	0:29	0:35	1:04	4.1	11.2							X			Recorded with GoPro
1-Q	6/25/2015	BoVi	12:54	4:40	-	-	-	-	-	2.0	4.8	X									Died
1-Q	6/30/2015	BoVi	10:18	-	10:18	11:46	-	1:28	-	2.3	5.2								X		
5-Q	7/2/2015	DrSp	12:52	1:00	2:17	3:03	1:17	0:46	2:03	0.4	0.3						X				
5-Q	7/2/2015	Li	9:36	-	9:36	11:12	-	1:36	-	6.6	4.3								X		
5-Q	7/2/2015	Lisp	10:27	-	10:27	11:19	-	0:52	-	0.7	11.5		X								
5-Q	7/2/2015	PeTe	9:20	-	9:20	9:35	-	0:15	-	4.6	5.2							X			Caught in a spider web
5-Q	7/2/2015	PeTe	9:55	9:55	NA	-	-	-	-	2.5	3.3									X	Did not emerge fully
5-Q	7/2/2015	PeTe	9:57	-	9:57	NA	-	-	-	2.8	3.6									X	Deformed wings, never flew
1-4	7/7/2015	StAm	10:58	11:54	12:18	12:48	0:24	0:30	0:54	1.0	18.7	X									
3-Q	7/9/2015	-	2:21	2:21	2:30	3:24	0:09	0:54	1:03	1.8	1.0					X					
3-Q	7/9/2015	StAm	1:08	-	1:08	5:03	-	3:55	-	2.5	1.1					X					
3-Q	7/9/2015	StAm	2:10	2:10	2:19	3:14	0:09	0:55	1:04	2.4	0.7					X					
1-Q	7/18/2015	GoVa	11:53	12:07	1:28	NA	1:21	-	-	8.2	30.8							X			Killed by ants at 1:44
1-Q	7/18/2015	StSp	12:01	3:25	3:55	4:34	0:30	0:39	1:09	4.6	21.7	X							X		
1-Q	7/18/2015	StSp	1:04	3:36	4:02	4:37	0:26	0:35	1:01	5.9	26.9	X									
1-Q	7/18/2015	StSp	1:50	3:42	4:07	4:44	0:25	0:37	1:02	5.3	25.3	X									
1-1	8/5/2015	-	2:04	2:14	-	-	-	-	-	3.2	18.4				X						Never eclosed
						Min	0:09	0:07	0:54												
						Max	1:21	3:55	2:03												
						Mean	0:36	0:47	1:10												

**"Q" indicates that the individual was observed during qualitative surveys outside of transects.*

***Species are abbreviated as in Table 3.1.1-1.*

****Substrate abbreviations as in Table 3.2.3-1.*

Table 3.3-1: Summary Statistics for Water Surface Elevations (WSEL), Average Hourly Rates of Change in WSEL, and Maximum Hourly Rates of Change in WSEL, May 15-Spetember 15, 2015

Statistic	Location					
	Barton Cove	Above Rock Dam	Below Rock Dam	Montague Gage	Third Island	Route 116 Bridge
Daily Water Level						
Mean	181.8	118.0	112.5	109.6	106.9	105.2
StDev	1.00	2.43	2.12	3.00	2.58	2.53
Minimum	178.2	115.4	110.7	105.4	103.4	101.8
25th Percentile	181.1	115.6	110.9	107.0	104.7	103.1
Median	181.8	118.0	111.9	109.3	106.4	104.7
75th Percentile	182.5	120.3	113.3	111.5	108.4	106.7
Maximum	184.1	123.9	120.8	118.4	114.9	112.8
Range	5.9	8.5	10.1	13.0	11.4	11.0
Average Daily Rate of Change (ft/hr)						
Mean	0.20	0.07	0.15	0.24	0.18	0.15
StDev	0.06	0.09	0.10	0.11	0.09	0.07
Minimum	0.05	0.00	0.00	0.02	0.01	0.01
25th Percentile	0.16	0.01	0.09	0.17	0.13	0.11
Median	0.19	0.02	0.15	0.24	0.17	0.15
75th Percentile	0.24	0.11	0.20	0.30	0.24	0.19
Maximum	0.33	0.59	0.47	0.51	0.47	0.33
Maximum Hourly Rate of Change Each Day (ft/hr)						
Mean	0.56	0.55	0.99	1.09	0.51	0.41
StDev	0.13	0.82	0.51	0.45	0.20	0.18
Lowest Max	0.20	0.02	0.01	0.08	0.04	0.03
25th Percentile	0.47	0.03	0.72	0.81	0.40	0.32
Median	0.56	0.09	1.00	1.11	0.51	0.38
75th Percentile	0.65	0.85	1.32	1.37	0.64	0.48
Highest Max	0.83	4.27	2.54	2.58	1.12	1.15

Table 3.3-2: Average Hourly Rates of Change in WSEL, and Maximum Hourly Rates of Change in WSEL, July 25-August 22, 2015

Statistic	Location					
	Barton Cove	Above Rock Dam	Below Rock Dam	Montague Gage	Third Island	Route 116 Bridge
Average Daily Rate of Change (ft/hr)						
Mean	0.23	0.01	0.12	0.26	0.20	0.16
StDev	0.04	0.02	0.07	0.09	0.09	0.06
Minimum	0.16	0.01	0.01	0.03	0.02	0.02
25th Percentile	0.19	0.01	0.07	0.21	0.16	0.14
Median	0.23	0.01	0.12	0.26	0.20	0.16
75th Percentile	0.27	0.01	0.17	0.34	0.27	0.20
Maximum	0.31	0.08	0.24	0.40	0.46	0.25
Maximum Hourly Rate of Change Each Day (ft/hr)						
Mean	0.62	0.09	0.97	1.21	0.50	0.41
StDev	0.09	0.24	0.52	0.42	0.18	0.14
Lowest Max	0.37	0.02	0.02	0.08	0.05	0.06
25th Percentile	0.56	0.02	0.68	0.94	0.43	0.35
Median	0.62	0.03	0.99	1.26	0.54	0.39
75th Percentile	0.69	0.06	1.35	1.52	0.59	0.50
Highest Max	0.83	1.32	1.91	1.89	0.90	0.74

See Appendix F for WSEL data for this period. No spill at Turners Falls Dam was occurring and Station No. 1 was off-line. Cabot Station was generating on a daily cycle.

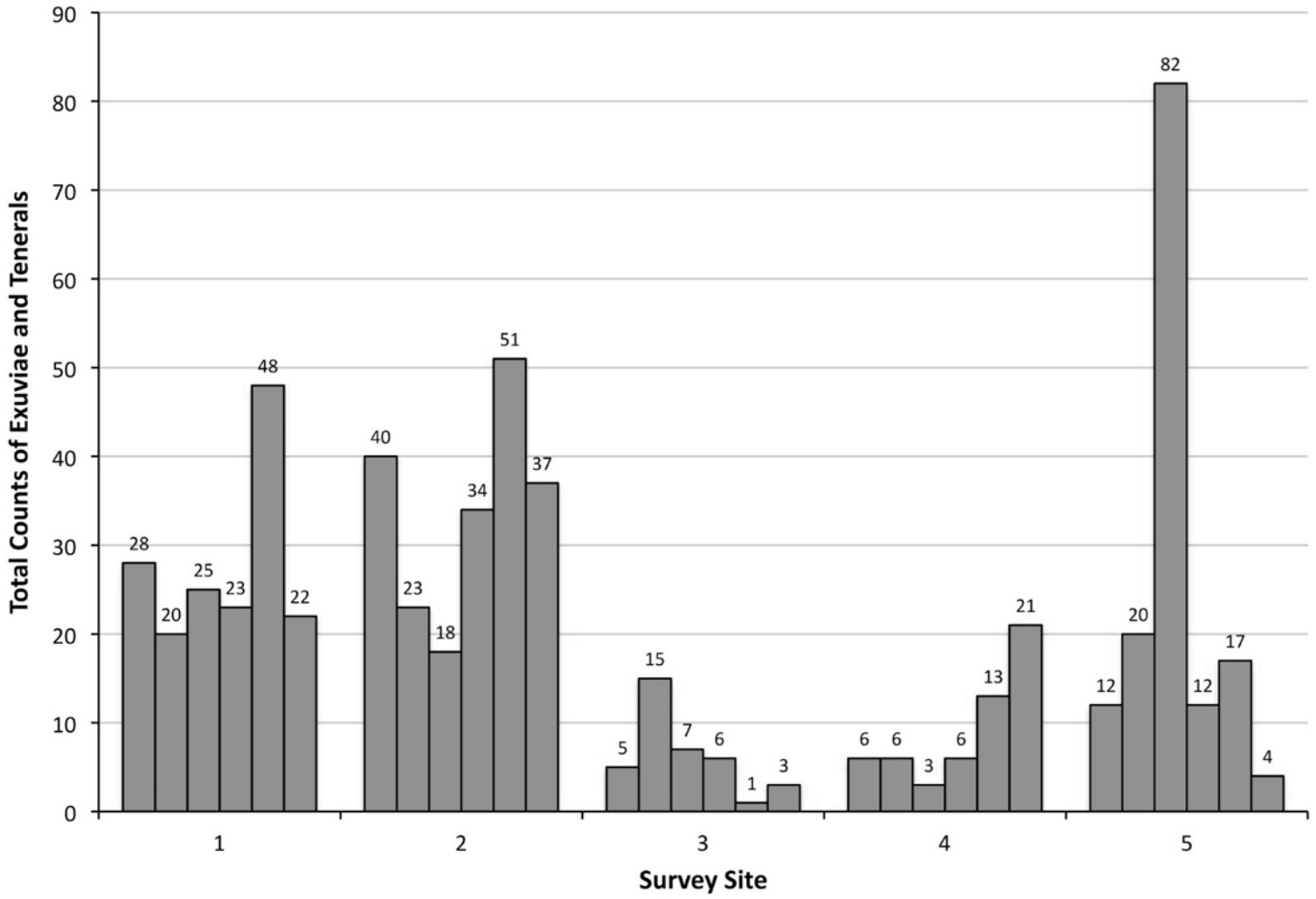

Figure 3.2.1-1: Counts of Odonate Exuviae and Tenerals in each Transect (all Sampling Periods Combined) at each of the Survey Sites

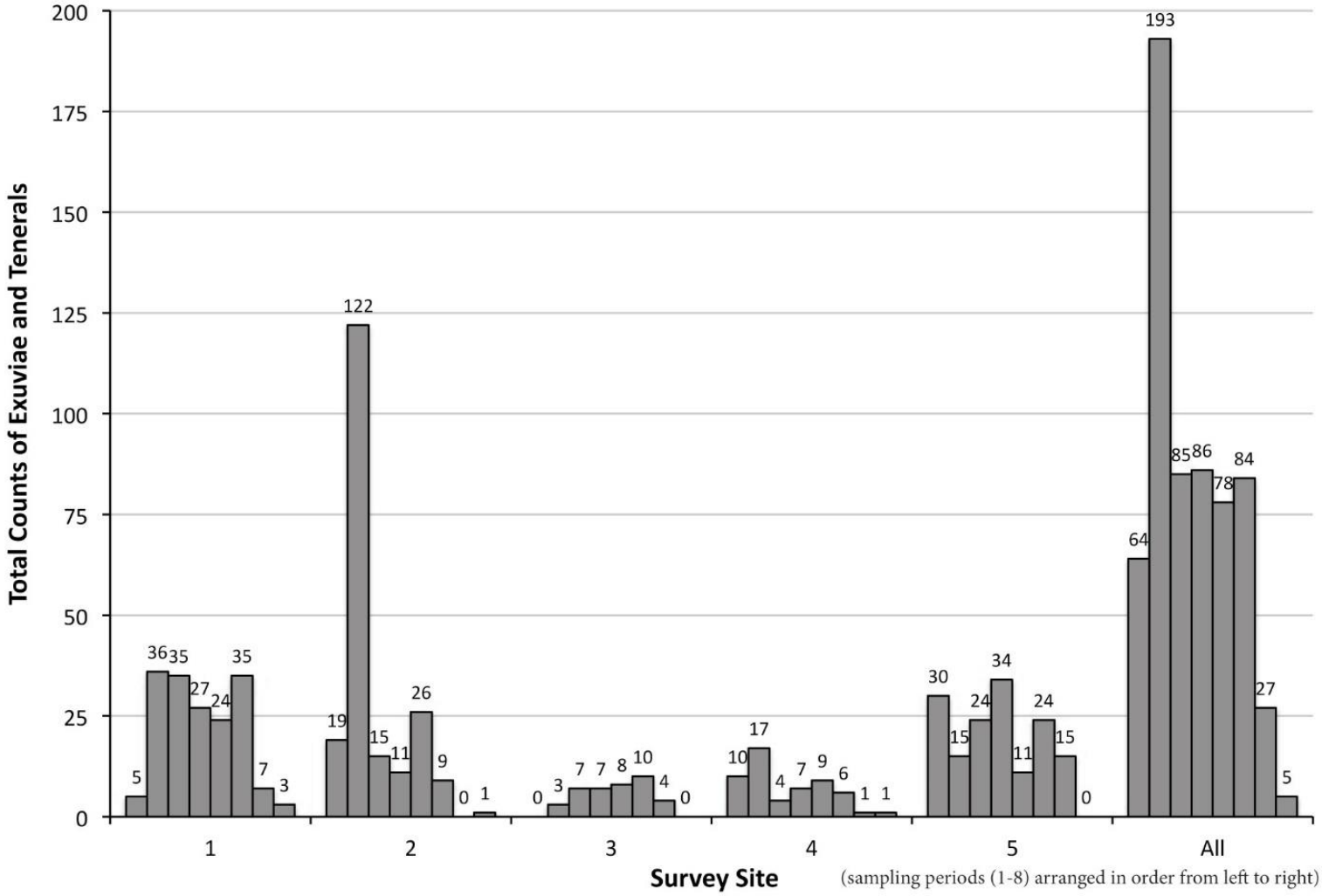

Figure 3.2.2-1: Total Counts of Odonate Exuviae and Tenerals for each Sampling Period, for all Transects Combined at each of the Survey Sites

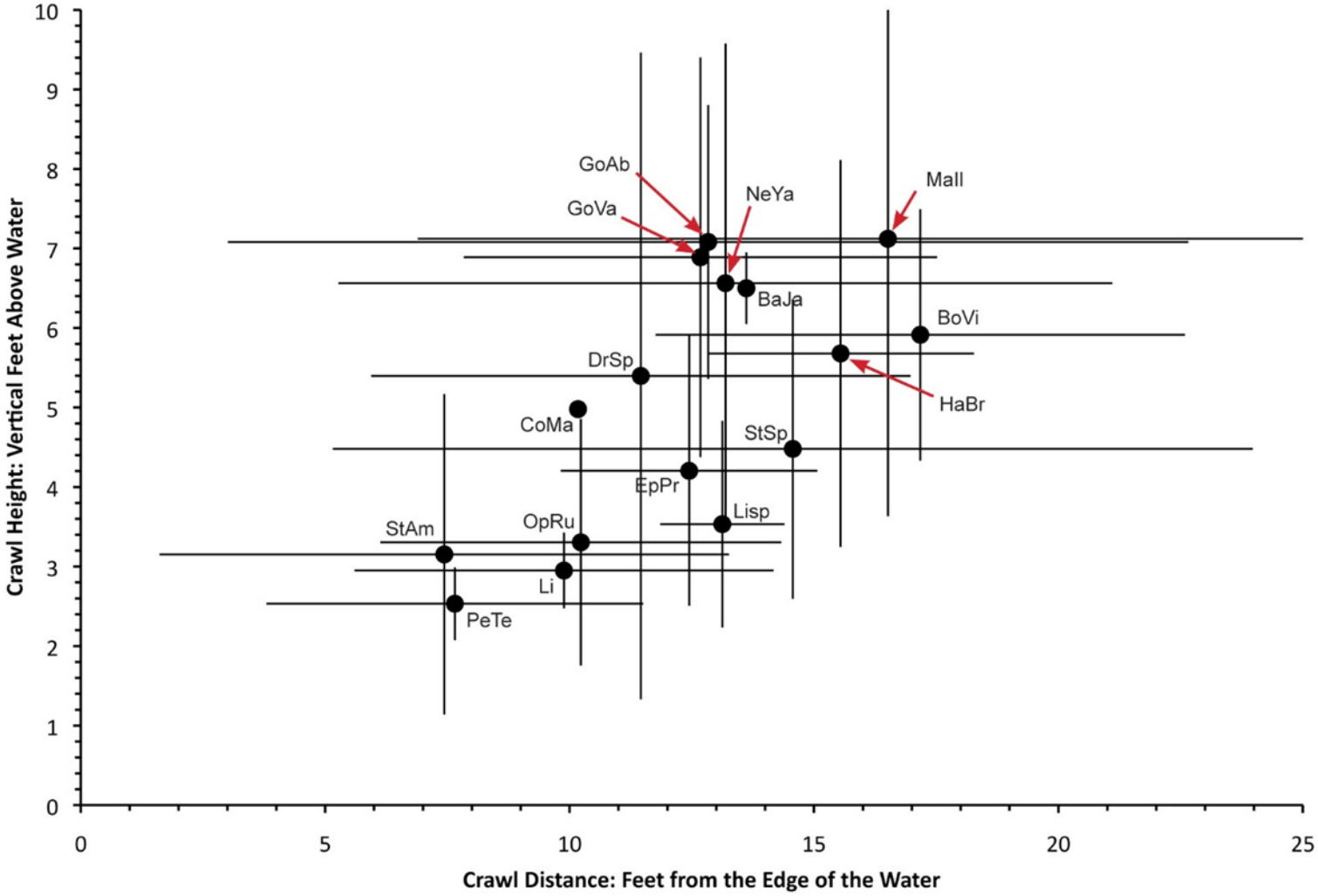

Figure 3.2.3-1: Scatterplot of Crawl Distance and Crawl Height for each Odonate Species Observed During Quantitative Sampling
See Table 3.2.3-1 for Summary Statistics and Figures 3.2.3-2 and 3.2.3-3 for Box Plots, and Table 3.1.1-1 for Species Abbreviations.

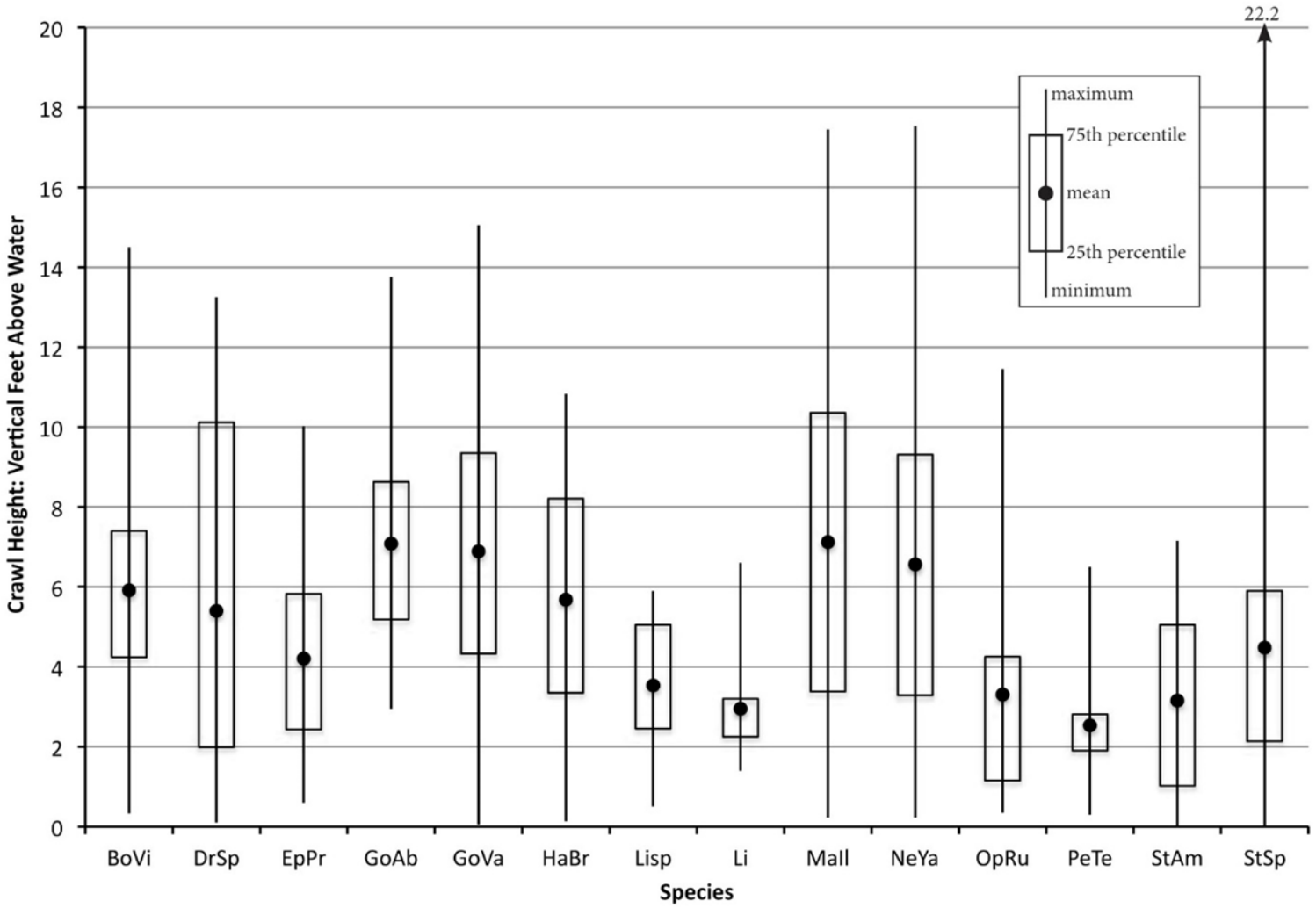

Figure 3.2.3-2: Box Plots (Displaying Minimum - 25th Percentile - Mean - 75th Percentile - Maximum) for Crawl Height for each Odonate Species Observed during Quantitative Sampling

See Table 3.2.3-1 for Summary Statistics and Table 3.1.1-1 for Species Abbreviations.

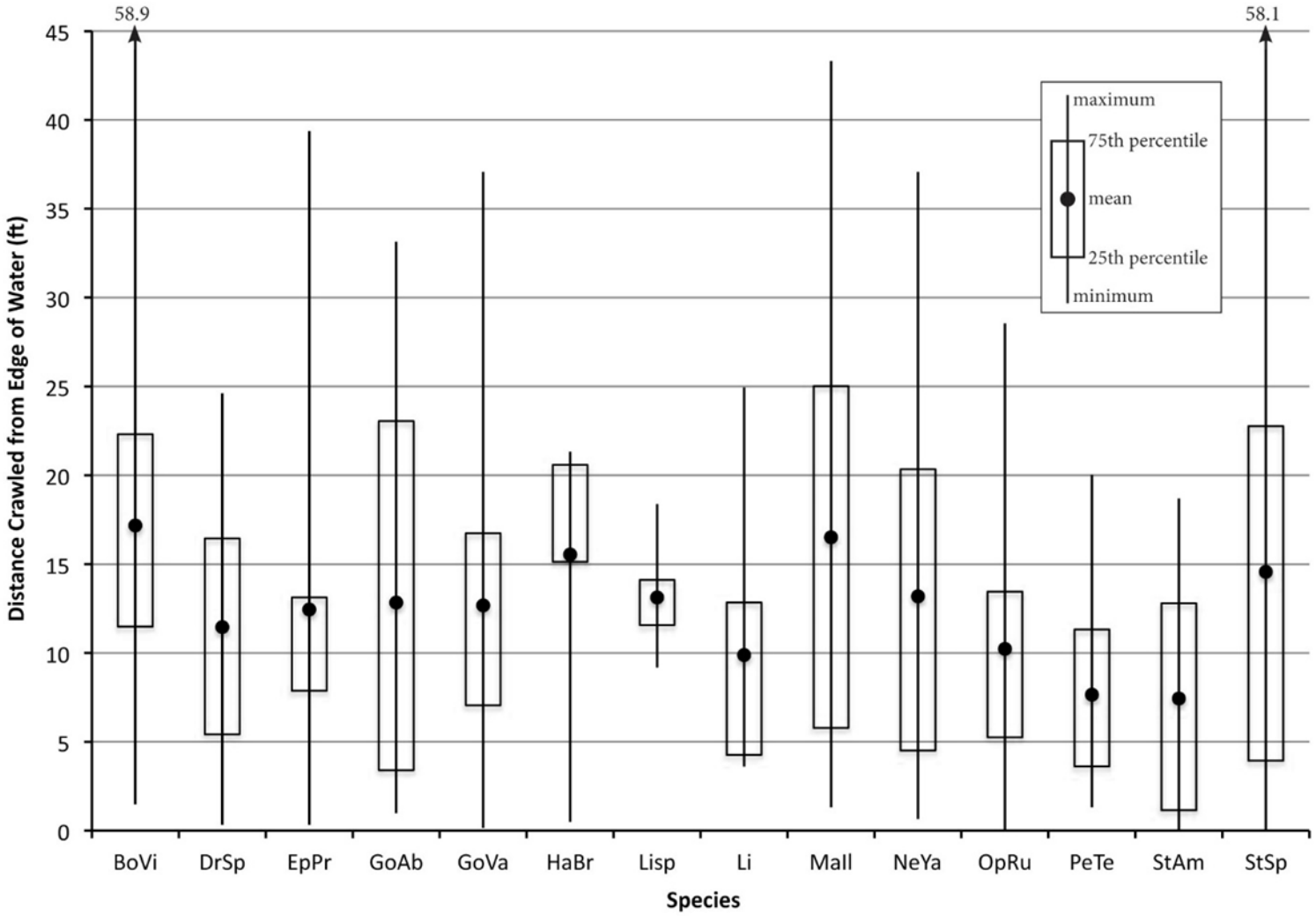

Figure 3.2.3-3. Box Plots (Displaying Minimum - 25th Percentile - Mean - 75th Percentile - Maximum) for Crawl Distance for each Odonate Species Observed during Quantitative Sampling

See Table 3.2.3-1 for Summary Statistics and Table 3.1.1-1 for Species Abbreviations.

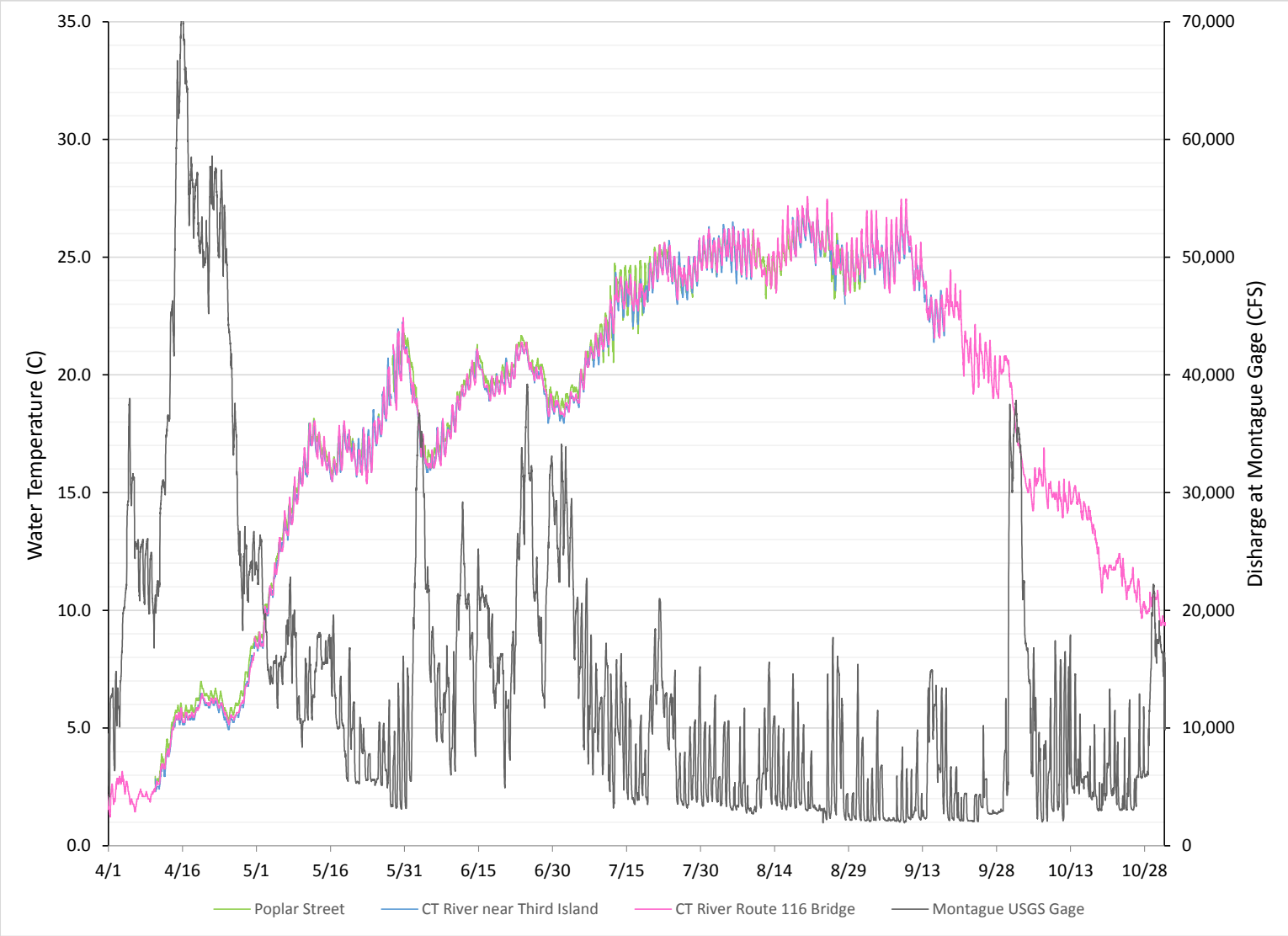

Figure 3.3-1: Montague USGS Gage Discharge and River Temperatures at Three Locations Downstream from Cabot Station, April – October 2015

Data are on a 15-minute time step. USGS gage data are provisional. Note the abrupt transition from the low flows and warm temperatures of May, and the high and erratic flows and cooler temperatures that persisted throughout June and early July.

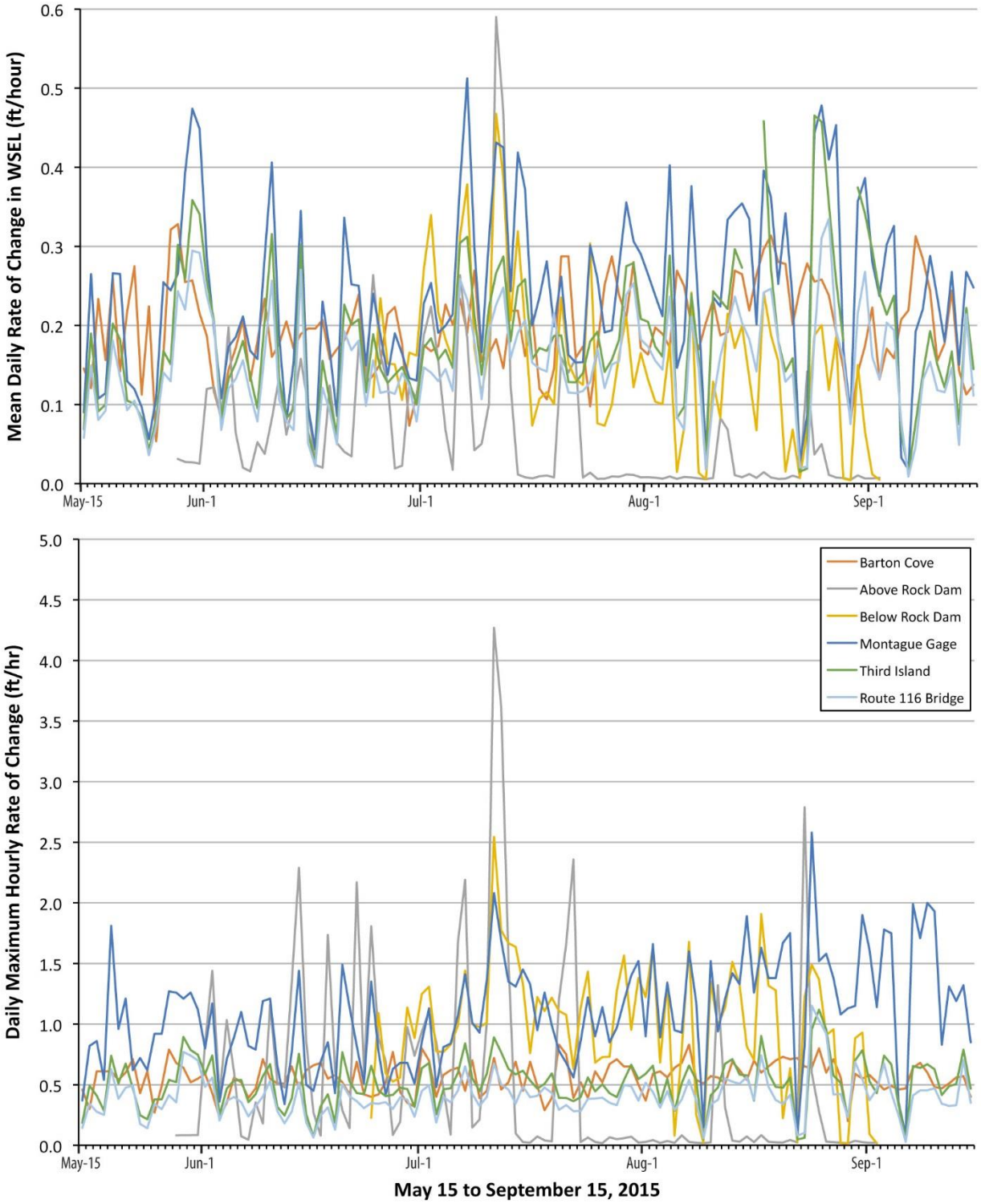

Figure 3.3-2: Variability in Water Surface Elevation Changes at Six Locations near the Odonate Sampling Sites, for the Period from May 15 to September 15, 2015

The top chart shows the average hourly rate of change each day, and the bottom chart shows the maximum hourly rate of change each day (units for both are ft/hr). These data are also shown for individual sites in Figures 3.3-3 to 3.3-8. See Table 2.2.2-1 for description and locations of data loggers.

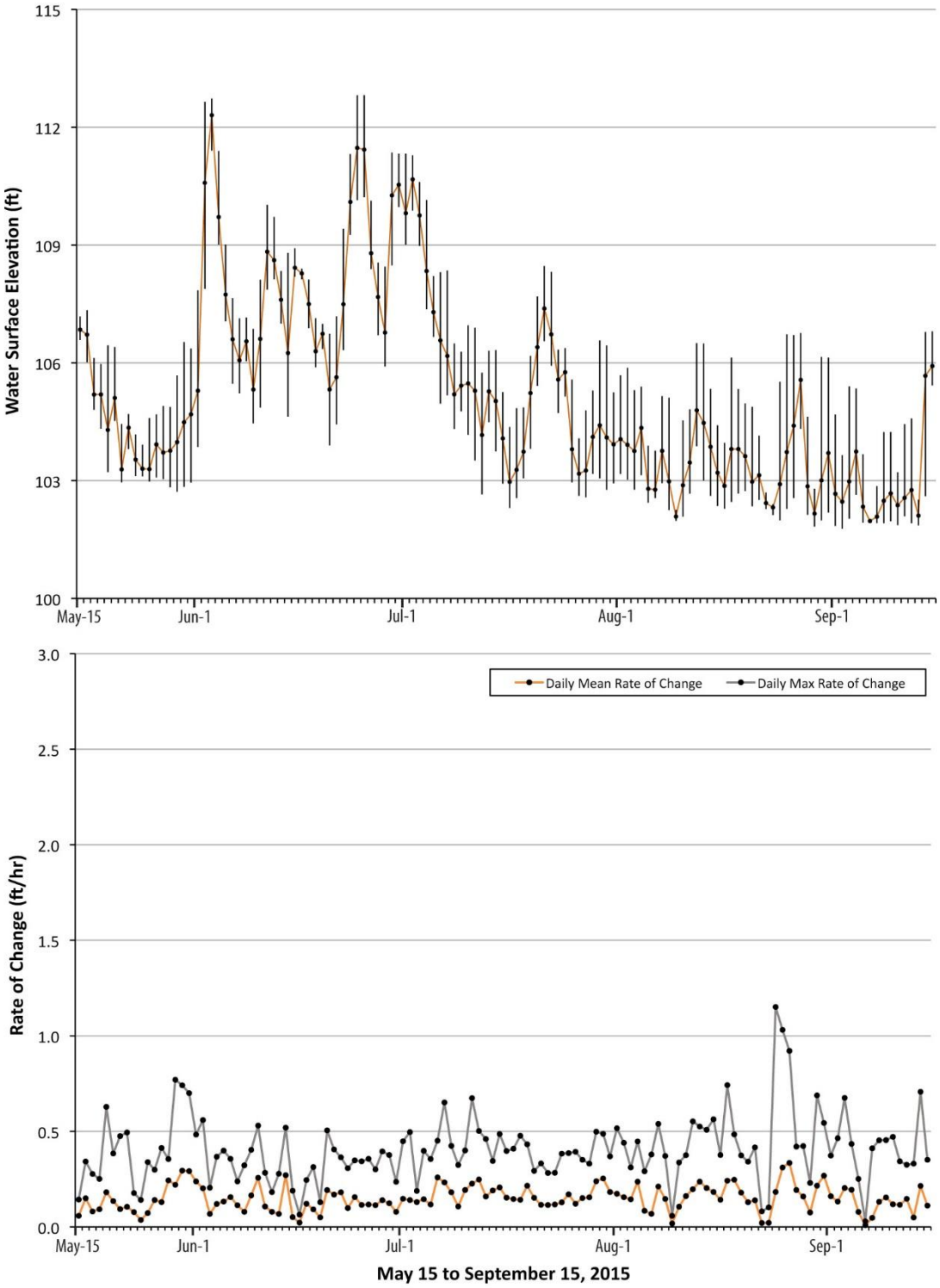

Figure 3.3-3: Variability in Daily WSEL (top) and the Rates of Change in Daily WSEL (bottom) near the Route 116 Bridge, Corresponding with Odonate Survey Site 1 (May 15 to September 15, 2015)

The top chart shows the daily mean WSEL with tails representing the daily minima and maxima. The bottom chart shows the mean and maximum rate of change each day.

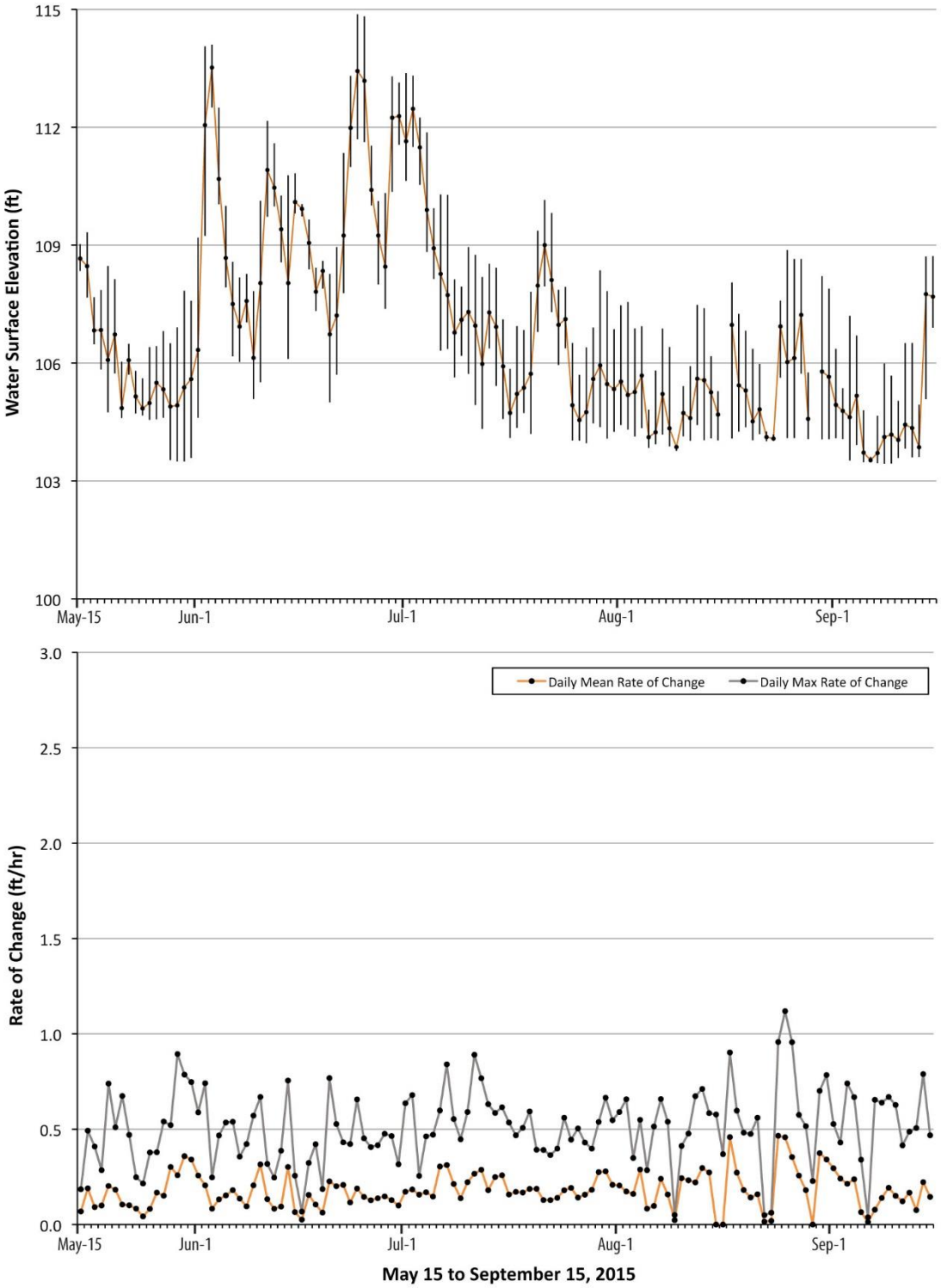

Figure 3.3-4. Variability in Daily WSEL (top) and the Rates of Change in Daily WSEL (bottom) near Third Island, Corresponding with Odonate Survey Site 2 (May 15 to September 15, 2015)

The top chart shows the daily mean WSEL with tails representing the daily minima and maxima. The bottom chart shows the mean and maximum rate of change each day.

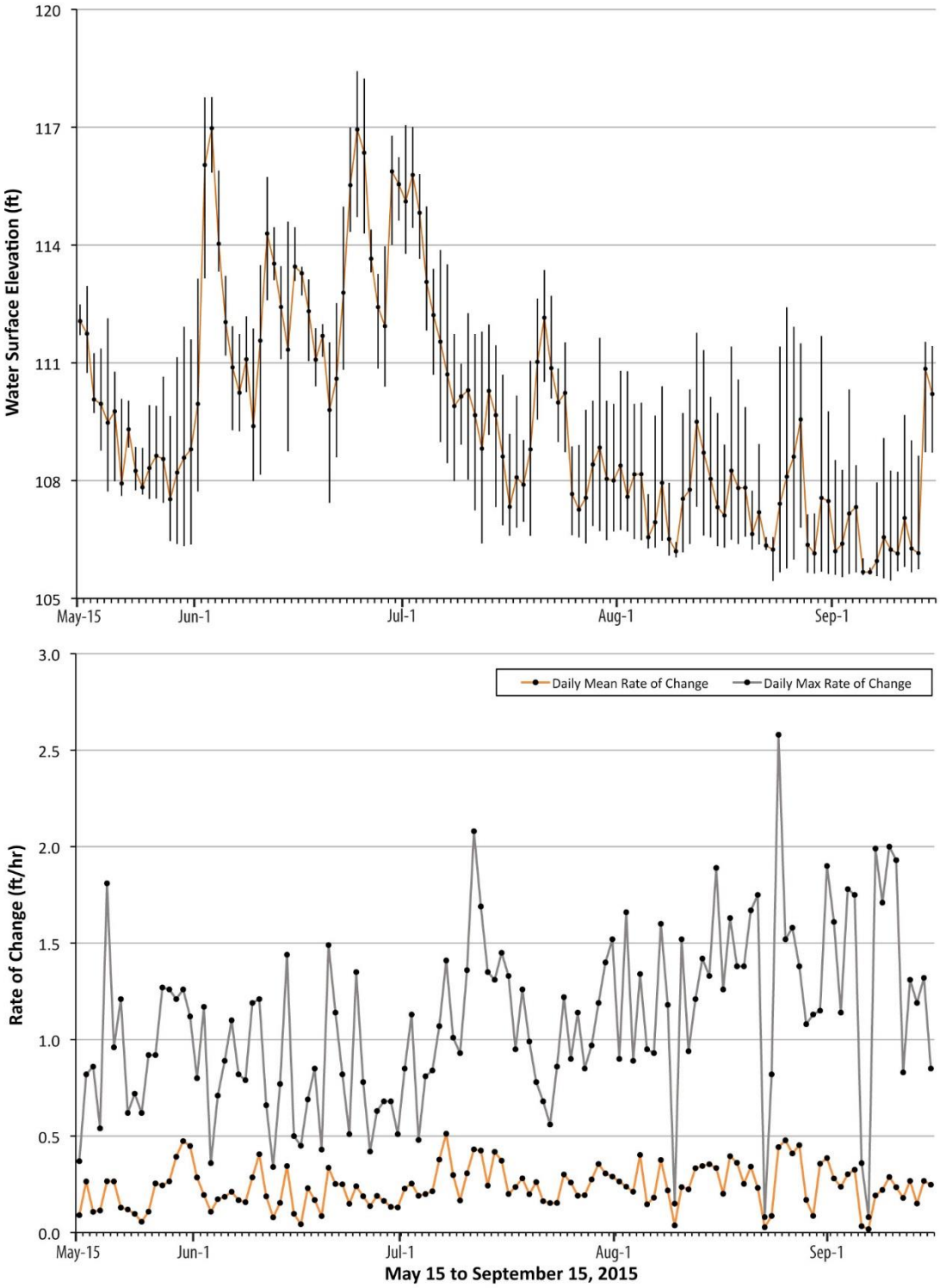

Figure 3.3-5: Variability in Daily WSEL (top) and the Rates of Change in Daily WSEL (bottom) at the USGS Streamgage in Montague, Corresponding with Odonate Survey Site 3 (May 15 to September 15, 2015)

The top chart shows the daily mean WSEL with tails representing the daily minima and maxima. The bottom chart shows the mean and maximum rate of change each day.

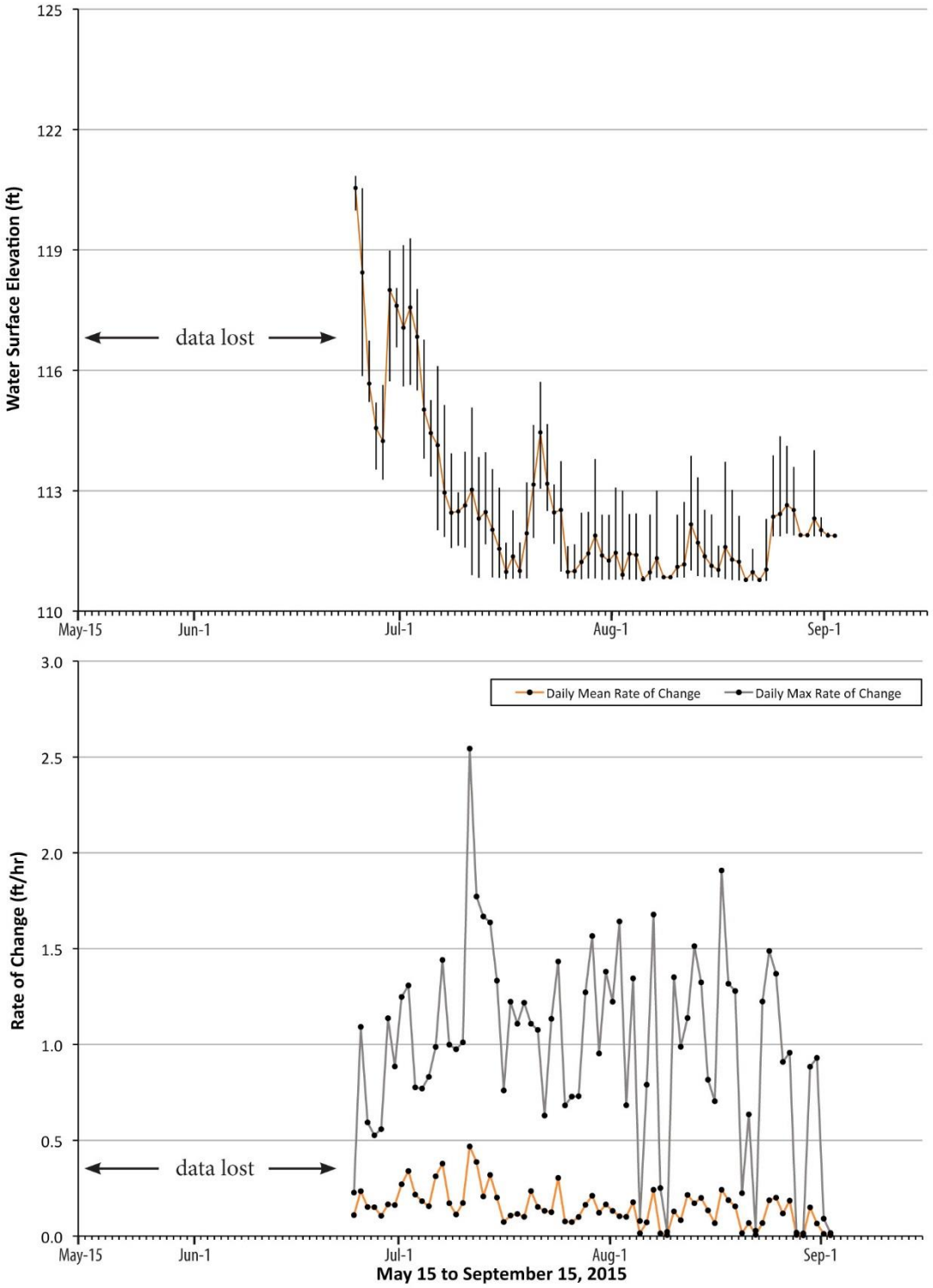

Figure 3.3-6: Variability in Daily WSEL (top) and the Rates of Change in Daily WSEL (bottom) Downstream from the Rock Dam in Montague, Corresponding with Odonate Survey Site 4

The top chart shows the daily mean WSEL with tails representing the daily minima and maxima. The bottom chart shows the mean and maximum rate of change each day. Data until June 24 were lost, and the collection period ended in early September, but these charts were made to be consistent with those from other sites.

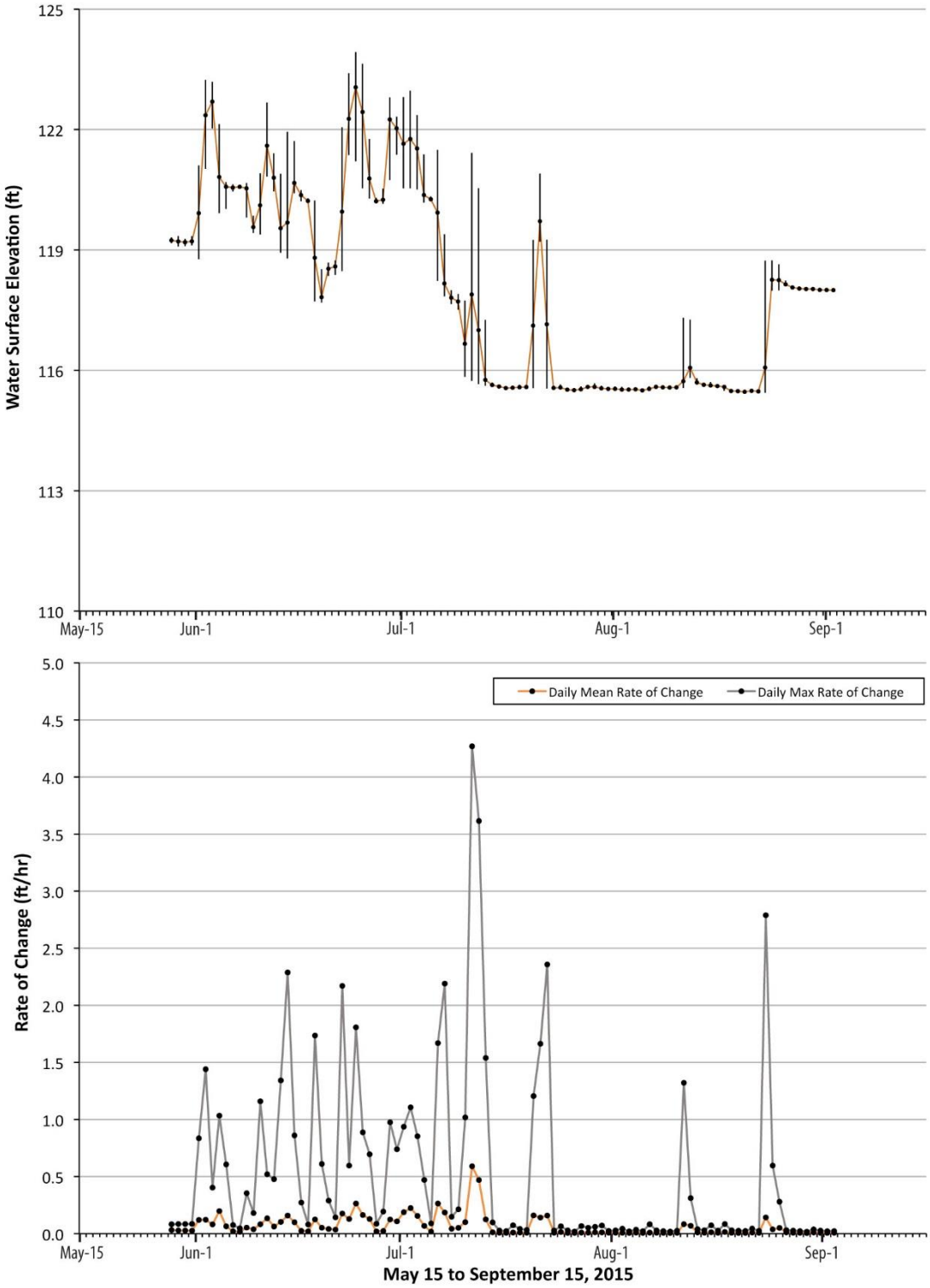

Figure 3.3-7. Variability in Daily WSEL (top) and the Rates of Change in Daily WSEL (bottom) Upstream from the Rock Dam in Montague, Corresponding with Odonate Survey Site 4

The top chart shows the daily mean WSEL with tails representing the daily minima and maxima. The bottom chart shows the mean and maximum rate of change each day. The collection period started on May 28 and ended in early September, but these charts were made to be consistent with those from other sites.

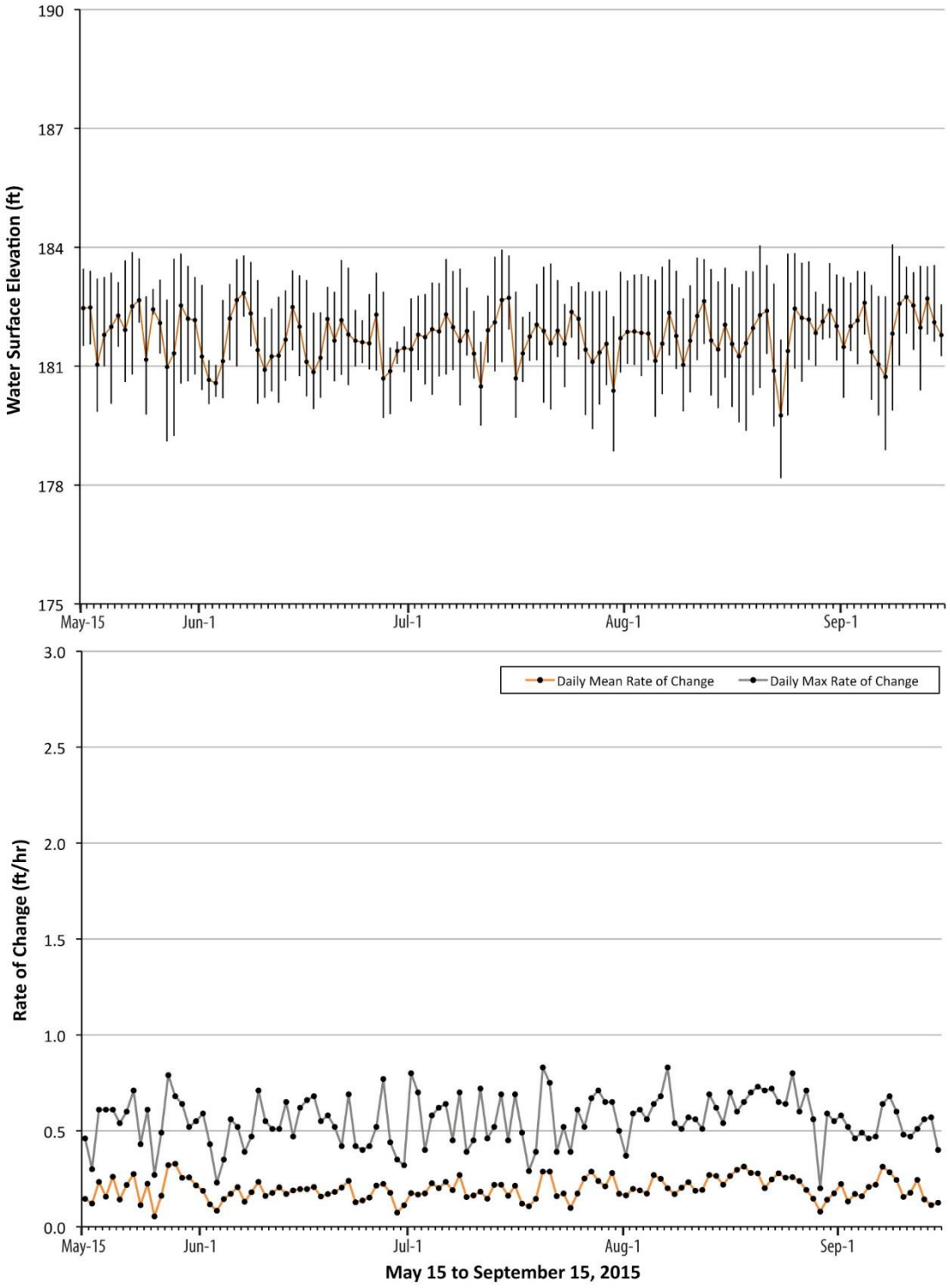

Figure 3.3-8. Variability in Daily WSEL (top) and the Rates of Change in Daily WSEL (bottom) near Barton Cove in Montague, Corresponding with Odonate Survey Site 5

The top chart shows the daily mean WSEL with tails representing the daily minima and maxima. The bottom chart shows the mean and maximum rate of change each day.

4 DISCUSSION

4.1 Emergence and Eclosure Behavior

Table 4.2-1 summarizes published emergence and eclosure data for species that we documented in the project area in 2014 and 2015. For all species combined, larvae crawled an average horizontal distance of 12.4 ft from the edge of the water before stopping to eclose. This is consistent with data from the 2014 qualitative sampling, which documented an average travel distance of 12.7 ft for all species combined. Travel distances were generally higher than those reported in 2006 (Morrison *et al*., 2006) and 2007 (Martin, 2007). However, Martin (2010) reported comparable travel distances for *Gomphus vastus*, especially on non-riprap riverbanks (13.5 ft, standard deviation = 1.14). Martin (2010) reported much lower travel distances for *Stylurus spiniceps* (1.0 ft on non-riprap banks, 0.5 ft on riprap) than we documented in 2015 (14.6 ft). We do not understand the large difference between the two studies for *Stylurus spiniceps*. The very limited travel distance data in Martin (2007) for *Dromogomphus spinosus*, *Hagenius brevistylus*, *Macromia illinoiensis*, and *Neurocordulia yamaskanensis* are all comparable to our 2015 results, indicating travel distances of at least 10-15 ft are common for these riverine species.

Vertical height from the water's surface was not reported in the earlier studies in the Connecticut River. The 2014 qualitative study documented an average vertical distance of 4.4 ft for all species combined, which is similar to the 2015 result of 5.0 ft. There was wide variation within and among species (see Figures 3.2.3-1 - 3.2.3-3). Farthest documented travel distance was nearly 60 ft, and greatest vertical height from the water was 22 ft. Although our total number of observations for each species was lower than anticipated due to low emergence rates in 2015, sample sizes adequately describe the range of variation in crawl distance and crawl height for most species that were detected.

The speed with which larvae ascend the riverbanks, find a spot to eclose, complete the eclosure process, and take flight is important for understanding potential effects of water level fluctuations. The first step of exiting the water and finding a spot to eclose is less critical because larvae can be inundated, blown back into the water, or can hide or return to the water to avoid predation. We observed numerous instances of larvae returning to the water after brief stints on land; Martin (2010) also reported this behavior. This behavior challenged our ability to gather data on the duration of the entire emergence process.

Once the eclosure process begins, the insect is highly susceptible to rising water levels, wind, waves, and predators. Species that select eclosure sites far enough or high enough from the water to avoid inundation will be most successful at escaping one source of mortality. If larvae select eclosure sites within the zone that may be inundated as water levels rise, then they would need to complete the process and fly away quickly enough to avoid inundation. We collected some data on this, but had a difficult time gathering data on many species due to low emergence rates in 2015.

It took an average of 36 minutes for tenerals to completely shed the larval exoskeleton, and a similar amount of time for tenerals to complete transformation to adults and take flight. We tracked nine individuals from the beginning of eclosure to flight; average time was 70 minutes, and ranged from 54 to 73 minutes with one outlier of 123 minutes. Figure 4.1-1 shows an example emergence sequence of *Ophiogomphus rupinsulensis* from larva to adult. This specimen was observed at Site 2 on May 30, 2015. Total elapsed time from the start of eclosure to adult flight for this individual was 73 minutes. Of the species for which some emergence speed data were collected, three were state-listed, including *Gomphus vastus* (1), *Gomphus abbreviatus* (1), and *Stylurus amnicola* (3). Neither our data, nor existing data (which is sparse) suggest that the emergence/eclosure speed varies widely among species.

There are surprisingly little published data to support our observations; the following are a few examples:

- *Stylogomphus albistylus*: 26 minutes for teneral to completely shed its larval exoskeleton, and 48 more minutes for it to fly away. Total critical time = 74 minutes (online: www.giffbeaton.com/Emergence)

- Unnamed species: total critical time = ~90 minutes (https://www.youtube.com/watch?v=zxO-kusdV_4)

- Unnamed species: total critical time = ~90 minutes (https://www.youtube.com/watch?v=F3kutr-3_gM)

In general, it seems 1-2 hours is a reasonable range for the period from when a larvae stops to begin to eclosure process to when the adult flies away.

4.2 Potential Effects of Project Operations

In terms of understanding potential effects of water level fluctuations, the concern is for those species and individuals that remain close to the water's edge, especially in areas of the river where daily and hourly water level fluctuations and rates of change are greatest. Individuals at greatest risk of inundation would be those that (1) live in areas where water level fluctuations and rates of change are high, (2) begin to crawl out of the water when water levels are near the daily low, just as the water begins to rise toward its daily peak, (3) crawl only short distances to eclosure sites, and (4) have relatively long eclosure times and time before flight.

Among the riverine odonate species (generally, those found at Sites 1-4), those that eclosed closest to the water were *Stylurus amnicola* (sample size = 9) and *Ophiogomphus rupinsulensis* (sample size = 25), suggesting these two species may be more vulnerable than others. Of these, *Stylurus amnicola* is state-listed (Endangered) and *Ophiogomphus rupinsulensis* is not. Although most other riverine odonate species did, on average, crawl far enough and high enough from the water to escape risks of fluctuating water levels, a small proportion of all species eclosed close enough that inundation during eclosure was a risk to some individuals.

Our observations and other studies are generally in agreement that most emergence (across all odonate taxa) occurs from pre-dawn through early afternoon. Project operations can affect the timing and magnitude of water level fluctuations and the rate of water level change at each site. In 2015, total change and rates of change were generally highest for the bypass reach and below Cabot Station, and lowest for downstream reaches and Barton Cove.

4.2.1 Site 1

Near the Route 116 Bridge, the Connecticut River undergoes relatively low daily and hourly water level fluctuations compared to areas closer to Cabot Station. The average daily range of WSEL was 2.2 ft, and over the entire data collection period ranged from 0.1 to 4.8 ft. The maximum hourly rate of change in WSEL each day rarely exceeded 1.0 ft/hr (average = 0.41 ft/hr) and the average hourly rate of change was 0.15 ft/hr. Using a conservative eclosure time (from start to adult flight) of 2.0 hours and the average daily maximum rate of water level change (0.41 ft/hr), individuals most at risk would be those that eclose less than 0.82 ft above the water's surface at a time of day when water levels are low and increasing at the maximum daily rate. Of the 176[*] specimens collected at Site 1 within and outside of transects in 2015, only 7 (4%) eclosed less than 1.0 ft from the water's surface. Only 22 (12.5%) eclosed less than 4 ft from the

[*] The total sample size for some sites includes transect counts and individuals found during qualitative searches outside of transects, and also includes a small number of individuals that were not identified to species. Thus, the total is higher than what is shown in Table 3.2.2-2 and Appendix D.

water's surface; using an eclosure time of 2.0 hours, water levels would need to increase 2.0 ft/hr to inundate these animals before they flew. This rate of increase was never recorded at Site 1 in 2015 (highest recorded maximum = 1.15 ft/hr). Among all species, average crawl height at Site 1 was 7.6 ft, which is the highest among all sites. Thus, a small proportion of odonates appear to be at risk from water level fluctuations at Site 1.

4.2.2 Site 2

Similar to Site 1 at the Route 116 Bridge, the Connecticut River near Third Island undergoes relatively low daily and hourly water level fluctuations compared to areas closer to Cabot Station. The average daily range of WSEL was 2.4 ft, and over the entire data collection period ranged from 0.0 to 4.8 ft. The maximum hourly rate of change in WSEL each day rarely exceeded 1.0 ft/hr (average = 0.51 ft/hr) and the average hourly rate of change was 0.18 ft/hr. Using an eclosure time of 2.0 hours and the average daily maximum rate of water level change (0.51 ft/hr), individuals most at risk would be those that eclose less than 1.02 ft above the water's surface at a time of day when water levels are low and increasing at the maximum daily rate. Of the 205* specimens collected at Site 2, 23 (11.2 percent) eclosed less than 1.0 ft from the water's surface. Using the highest recorded water level change of 1.12 ft/hr at Site 2, odonates less than 2.2 ft from the water's surface on that day were at risk. Over the entire sampling season, only 22.4% of the specimens were collected less than 2.2 ft from the water's surface. Thus, a small proportion of odonates appear to be at risk from water level fluctuations at Site 2.

4.2.3 Site 3

The Connecticut River near Poplar Street, which is not far downstream from Cabot Station and directly across the river from the Deerfield River confluence, experiences comparatively high daily and hourly water level fluctuations. The average daily range of WSEL was 3.1 ft, and over the entire data collection period ranged from 0.2 to 6.7 ft. The maximum hourly rate of change in WSEL each day rarely exceeded 2.0 ft/hr (average = 1.09 ft/hr) and the average hourly rate of change was 0.24 ft/hr. Using an eclosure time of 2.0 hours and the average daily maximum rate of water level change (1.09 ft/hr), individuals most at risk would be those that eclose less than 2.2 ft above the water's surface at a time of day when water levels are low and increasing at the maximum daily rate.

Poplar Street had the lowest odonate densities of all sampling sites. Of the 41 specimens collected at Site 3, 7 (17%) eclosed less than 2.2 ft from the water's surface. Using the highest recorded water level change of 2.58 ft/hr at Site 3, odonates less than 5.16 ft from the water's surface on that day were at risk. Over the entire sampling season, 65.9% of the specimens were collected less than 5.16 ft from the water's surface. These data suggest that a relatively high proportion of the odonates near Site 3 appear to be at risk from water level fluctuations. However, water level fluctuations due to Cabot Station generation alone potentially affect odonate emergence to a lesser degree. During the period July 25-August 22, 2015 (Table 3.3-2), when bypass flows were stable and Cabot Station was operating, the maximum hourly rate of change in WSEL was 1.89 ft/hr (average daily max = 1.21 ft.hr) at this site. Using an eclosure time of 2.0 hours, and the maximum water level change of 1.89 ft/hr during this late July-August period at Site 3, of the 41 specimens collected at Site 3, 19 (46.3%) eclosed less than 3.8 ft from the water's surface.

4.2.4 Site 4

The Connecticut River in the bypass reach, which is where the Rock Dam is located, experienced relatively high daily and hourly water level fluctuations during the study period in 2015 compared to other sites, more so downstream from the Rock Dam than upstream of it. During May and June 2015, FirstLight was providing coordinated flow releases in the bypass reach in support of other relicensing studies for American Shad; therefore, the frequency and magnitude of water level fluctuations in the bypass reach during this period were atypical of bypass flow conditions.

Site 4 had the second lowest odonate density of all sampling sites, and transects 1-4, which were all downstream from the Rock Dam, contained only 21 individuals combined over the entire season. Exuviae density was higher at transects 5 and 6 compared to transects 1-4 (34 individuals combined), but still very low compared to Sites 1, 2, and 5.

During the monitoring period, the average daily range of WSEL was 1.9 ft downstream from the Rock Dam and 0.9 ft upstream. Downstream from Rock Dam, the maximum hourly rate of change in WSEL each day frequently exceeded 1.0 ft/hr (average = 0.99 ft/hr), and the average hourly rate of change was 0.15 ft/hr. In contrast, upstream from the Rock Dam the maximum hourly rate of change in WSEL each day rarely exceeded 1.0 ft/hr (average = 0.55 ft/hr), and the average hourly rate of change was 0.07 ft/hr.

Below Rock Dam

Using an eclosure time of 2.0 hours and the average daily maximum rate of water level change (0.99 ft/hr), individuals most at risk would be those that eclose less than 2.0 ft above the water's surface at a time of day when water levels are low and increasing at the maximum daily rate. The highest recorded water level change of 2.54 ft/hr downstream from the Rock Dam. However, that day (July 11, 2015) was an anomaly; that weekend, Cabot Station was shut down due to equipment installation for other relicensing studies and inflows were passed over the Turners Falls Dam.

During the period July 25-August 22, 2015 (Table 3.3-2), when bypass flows were stable and Cabot Station was operating, the maximum hourly rate of change in WSEL below Rock Dam was 1.91 ft/hr (average daily max = 0.97 ft.hr) which is comparable to Site 3 WSEL data below Cabot Station for this period. Using an eclosure time of 2.0 hours, and the maximum water level change of 1.91 ft/hr during this period, 4 of the 21 specimens 19% were collected less than 3.8 ft from the water's surface.

Above Rock Dam

Using an eclosure time of 2.0 hours and the average daily maximum rate of water level change (0.55 ft/hr), individuals most at risk would be those that eclose less than 1.1 ft above the water's surface at a time of day when water levels are low and increasing at the maximum daily rate. None were ever found that close to the water at Site 4. The highest recorded water level change of 4.27 ft/hr upstream from the Rock Dam. Again, that day (July 11, 2015) was an anomaly as Cabot Station was shut down over the weekend due to equipment installation for other relicensing studies and inflows were passed over the Turners Falls Dam. Aside from this anomalous weekend, the highest recorded water level change at this site was of 2.8 ft/hr on August 23, 2015 due to Station No. 1 coming on-line. On this day, odonates less than 5.6 ft from the water's surface on that day were at risk Over the entire sampling season, 50% of the specimens were collected less than 5.6 ft from the water's surface.

Above Rock Dam, water levels are typically stable in the absence of spillage at Turners Falls Dam. During the same July –August period as above, the average daily rate of change in WSEL above Rock Dam was 0.09 ft/hr. The maximum value for this period at this site was 1.32 ft/hr and was related to natural inflow from Fall River.

4.2.5 Site 5

Barton Cove experiences relatively low daily and hourly water level fluctuations compared to other sites. The average daily range of WSEL in Barton Cove was 2.5 ft, and over the entire data collection period ranged from 0.6 to 4.5 ft. The maximum hourly change in WSEL at Barton Cove never exceeded 1.0 ft/hr (average = 0.56 ft/hr) and the average hourly rate of change was 0.20 ft/hr. Using an eclosure time of 2.0 hours and the average daily maximum rate of water level change in Barton Cove (0.56 ft/hr), individuals most at risk would be those that eclose less than 1.12 ft above the water's surface at a time of day when water levels are low and increasing at the maximum daily rate. Of the 153 specimens collected in Barton

Cove, 13 (8.5%) eclosed less than 1.12 ft from the water's surface. Thus, even under what we have defined as the worst case scenario, and using a conservative eclosure time, a relatively small proportion of odonates appear to be at risk from water level fluctuations in Barton Cove. In Barton Cove, crawl heights were generally shortest for the lentic/backwater species including *Epitheca princeps, Perithemis tenera, Libellula* sp., and an unidentified Libellulinae. None are state-listed. The only state-listed odonate found in Barton Cove was *Neurocordulia yamaskanensis* (2 individuals), and it has a much greater crawl height than the other species in Barton Cove based on our observations.

4.2.6 Overall Assessment

Near Cabot Station and the Bypass Reach: Water level fluctuations and rates of change resulting from Project operations, may affect odonate emergence in areas of the Connecticut River closest to Cabot Station. Precisely which areas are affected, and to what extent, depend on the timing and magnitude of flows through Cabot Station, Station No. 1, and spill over the Turners Falls Dam. Flows through Cabot Station affect WSEL both upstream (up to, but not above, Rock Dam) and immediately downstream from Cabot Station. Other than spill provided for minimum bypass flows conditions (400 cfs), spill events over the Turners Falls Dam during the odonate emergence period are usually associated with large precipitation events rather than Project operations. If water is quickly released through Station No. 1, odonate emergence could be affected in downstream areas of the bypass reach, but specific effects would depend on the timing (time of day or time of year) of such releases.

Downstream from Cabot Station: Effects of Project operations on hourly/daily changes in WSEL and rates of change diminish with increasing distance downstream from Cabot Station. At Third Island, approximately 5 miles downstream from Cabot Station, and at the Route 116 Bridge, approximately 10 miles downstream from Cabot Station, neither the hourly/daily changes in WSEL nor rates of change appeared to have a strong effect on odonate emergence.

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

Table 4.2-1: Summary of Emergence and Eclosure Behavior of State-Listed Odonate Species Documented in 2014 and 2015, or that may occur within the Study Reach.

Species*	Emergence & Flight Period**										Eclosure	
	May		June		July		Aug		Sept		Distance	Speed
Gomphus abbreviatus (SC)											Very little information on rare *Gomphus*. Limited data suggest consistent behavior of crawling past the river's edge and variable vertical distances (up to 10+ ft) up the streambank before eclosing on a range of available substrates. *S. amnicola* may crawl shorter distances and eclose on low-gradient shorelines, cobble bars, beaches.	Species-specific data lacking and is likely influenced by air temperature, humidity, and other factors. Most reports are cursory and somewhat consistent, with ~1-2 hours needed to complete the entire process from emergence to adult flight.
Gomphus descriptus (E)												
Gomphus fraternus (E)												
Gomphus quadricolor (E)												
Gomphus vastus (SC)												
Gomphus ventricosus (T)												
Stylurus amnicola (E)												
Neurocordulia yamaskanensis (SC)											May crawl farther up banks and climb trees	

**Includes Massachusetts Endangered Species Act status: E = Endangered, T = Threatened, SC = Special Concern*

***Shading used to distinguish onset of emergence (light gray), peak emergence and flight period (gray), and end of flight period (dark gray)*

Information Sources:

Species-specific data generally lacking; most known for G. vastus, which is comparatively more common in the Connecticut River.

Morrison et al., *2001*; *McLain* et al., *2004*; *McLain* et al., *2006*; *Morrison* et al., *2006*; *Martin, 2007*; *Martin, 2010*.

Also more general sources: Byers, 1937; *Walker, 1958*; *Needham* et al., *2000*; *Glotzhober & McShaffrey, 2002*; *Nikula & Burne, 2003*; *and NHESP Fact sheets (2015) (online).*

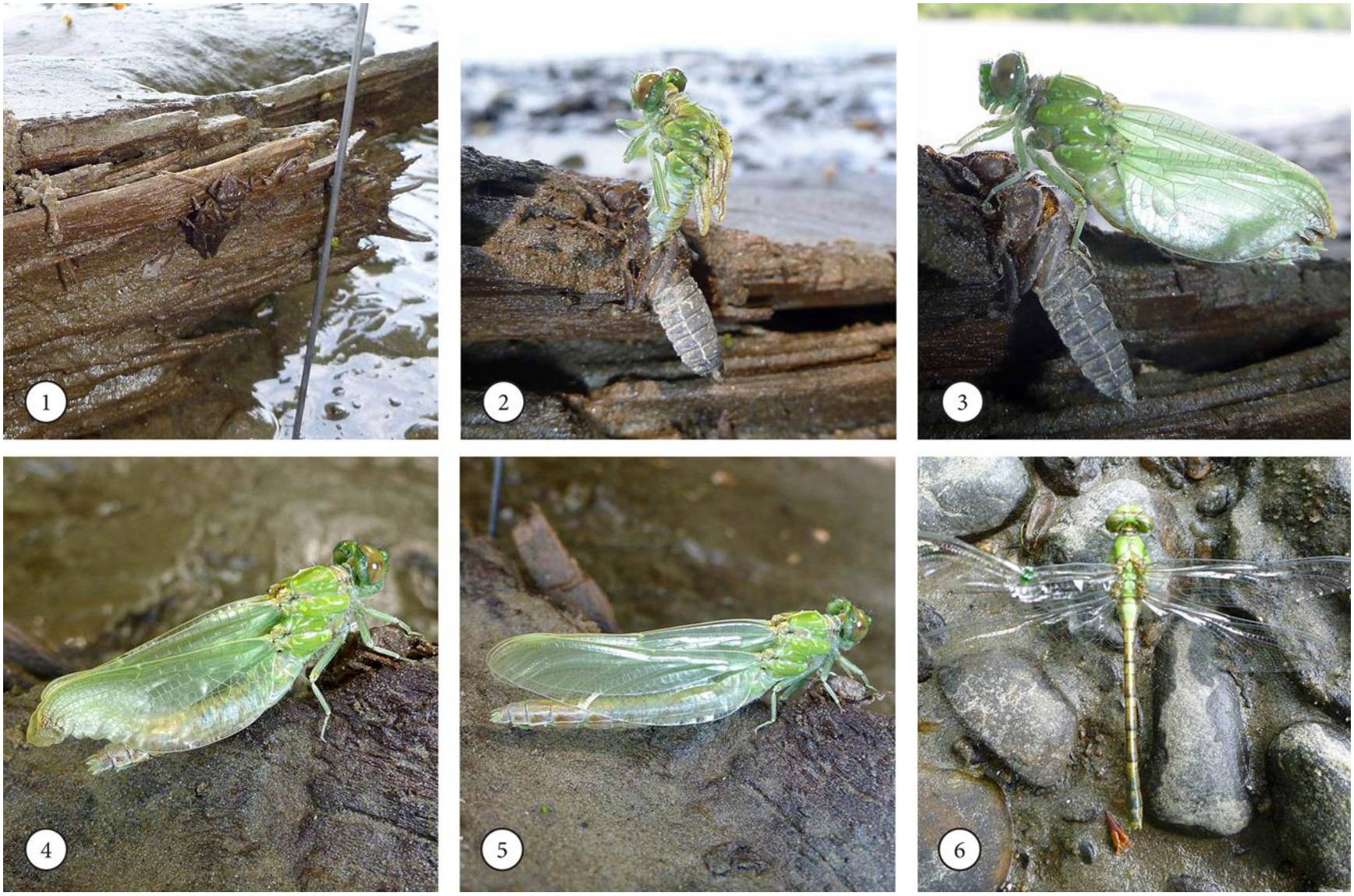

Figure 4.1-1: Example Emergence Sequence of *Ophiogomphus rupinsulensis* from Larva to Adult

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APPENDIX A
INTERIM STUDY REPORT

Relicensing Study 3.3.10

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

Interim Study Report

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

Prepared for:

FirstLight
GDF SUEZ

Prepared by:

biodrawversity
ecological consulting and communications

APRIL 2015

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

FERC	Federal Energy Regulatory Commission
FirstLight	FirstLight Hydro Generating Company
ft	feet
hrs	hours
ILP	Integrated Licensing Process
m	meter
NHESP	Natural Heritage and Endangered Species Program
PAD	Pre-Application Document
PSP	Proposed Study Plan
RSP	Revised Study Plan
SD1	Scoping Document 1
SD2	Scoping Document 2
SPDL	Study Plan Determination Letter
VY	Vermont Yankee Nuclear Power Plant

1 INTRODUCTION

FirstLight Hydro Generating Company (FirstLight), a subsidiary of GDF SUEZ North America, Inc., 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 Northfield Mountain and Turners Falls Projects using the FERC's Integrated Licensing Process (ILP). The current licenses for Northfield Mountain and Turners Falls Projects were issued on May 14, 1968 and May 5, 1980, respectively, with both set to expire on April 30, 2018.

As part of the ILP, FERC conducted a public scoping process during which various resource issues were identified. On October 31, 2012, FirstLight filed its Pre-Application Document (PAD) and Notice of Intent with the FERC. The PAD included FirstLight's preliminary list of proposed studies. On December 21, 2012, FERC issued Scoping Document 1 (SD1) and preliminarily identified resource issues and concerns. On January 30 and 31, 2013, FERC held scoping meetings for the Northfield Mountain and Turners Falls 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[1]. On June 28, 2013, FirstLight filed with the Commission an Updated PSP to reflect further changes to the PSP based on comments received at the meetings. On or before July 15, 2013, stakeholders filed written comments on the Updated PSP. FirstLight filed a Revised Study Plan (RSP) on August 14, 2013 with FERC addressing stakeholder comments.

On August 27, 2013 Entergy Corp. announced that the Vermont Yankee Nuclear Power Plant (VY), located on the downstream end of the Vernon Impoundment on the Connecticut River and upstream of the two Projects, will close at the end of 2014. With the closure of VY, certain environmental baseline conditions will change during the relicensing study period. On September 13, 2013, FERC issued its first Study Plan Determination Letter (SPDL) in which many of the studies were approved or approved with FERC modification. However, due to the impending closure of VY, FERC did not act on 19 proposed or requested studies pertaining to aquatic resources. RSP Study No. 3.3.10 *Assess Operational Impacts on Emergence of State-Listed Odonates in the Connecticut River*, was one of the studies that FERC did not act upon. The SPDL for these 19 studies was deferred until after FERC held a technical meeting with stakeholders on November 25, 2013 regarding any necessary adjustments to the proposed and requested study designs and/or schedules due to the impending VY closure. FERC issued its second SPDL on the remaining 19 studies, including this study, on February 21, 2014, approving the RSP with certain modifications. Those modifications included:

- Relative to emergence speed, FERC recommended that FirstLight record a minimum of 10 observations per species or species group, provided that 10 individuals from each group are encountered during the emergence study.
- Relative to quantitative survey effort, FERC recommended that FirstLight stratify the survey effort (Surveys of Emergence/Eclosure Behavior), to a minimum of six 2-meter transects in each *available* habitat in each study reach.

This interim report presents the results of the qualitative surveys conducted under Task 3 of Study No. 3.3.10.

[1] The ten meetings were held on May 14, 15, 21, and 22, and June 4, 5, 11, 12, and 14 and August 8.

1.1 Study Goals and Objectives

This study was designed to provide information on the effects of project operations, especially the timing, rate, and magnitude of water level changes, on emerging dragonflies (Insecta: Odonata) in the Connecticut River. This study had two objectives:

1. Synthesis of existing data, supplemented with field surveys, to characterize the assemblage structure and emergence/eclosure behavior of odonates in the project area.

2. Determine if project operations affect the emergence and eclosure success of state-listed odonates, and the potential implications for the odonate assemblage in affected areas.

Two phases of fieldwork were proposed. Phase 1, completed in 2014 and summarized in this interim report, included qualitative surveys of odonate larvae and exuviae at selected sites to determine assemblage structure and to collect basic habitat data. Phase 2, planned for 2015, will include quantitative surveys and observations of emergence/eclosure behavior of odonates to provide data for analyses of the effects of project operations on odonates and their habitat. Phase 2 methods were not finalized in the Revised Study Plan, rather, these details were to be discussed in this interim report and finalized before the 2015 field season commences, in consultation with the Massachusetts Natural Heritage and Endangered Species Program (NHESP).

2 STUDY SITES AND METHODS

Preceding the qualitative field surveys, a scientific collection permit was issued by the NHESP on May 15, 2014.

2.1 Study Sites

Biodrawversity biologists conducted qualitative surveys of odonate larvae and exuviae at four areas (5 sites) between the Turners Falls Dam and the Route 116 Bridge in Sunderland, and one area (3 sites) in the Turners Falls Impoundment near Barton Cove (Figure 2.1-1, Table 2.1-1). Surveys were conducted on June 2, 6, 9, and 20 (2014). Barton Cove and the Route 116 Bridge were also checked twice in May to determine if emergence had begun early. However, the spring of 2014 was cooler than average and river flows were higher than average, and emergence was not detected until early June.

- Representative aquatic and shoreline habitats were surveyed in Barton Cove and on the other side of Campground Point, totaling approximately 350 meters of shoreline (Figure 2.1-1a).
- Representative aquatic and shoreline habitats were surveyed in Turners Falls Project's bypass reach. These surveys were mostly conducted in a ~500 meter reach upstream and downstream from Rock Dam, a natural rock formation with a vertical drop (Figure 2.1-1b).
- Representative aquatic and shoreline habitats were surveyed within two reaches in the area between the Railroad Bridge and Third Island (Montague/Deerfield), totaling approximately 400 meters of shoreline (Figure 2.1-1c). In addition, approximately 150 meters of aquatic and shoreline habitat near the Route 116 Bridge in Sunderland were surveyed in a similar manner (Figure 2.1-1d).

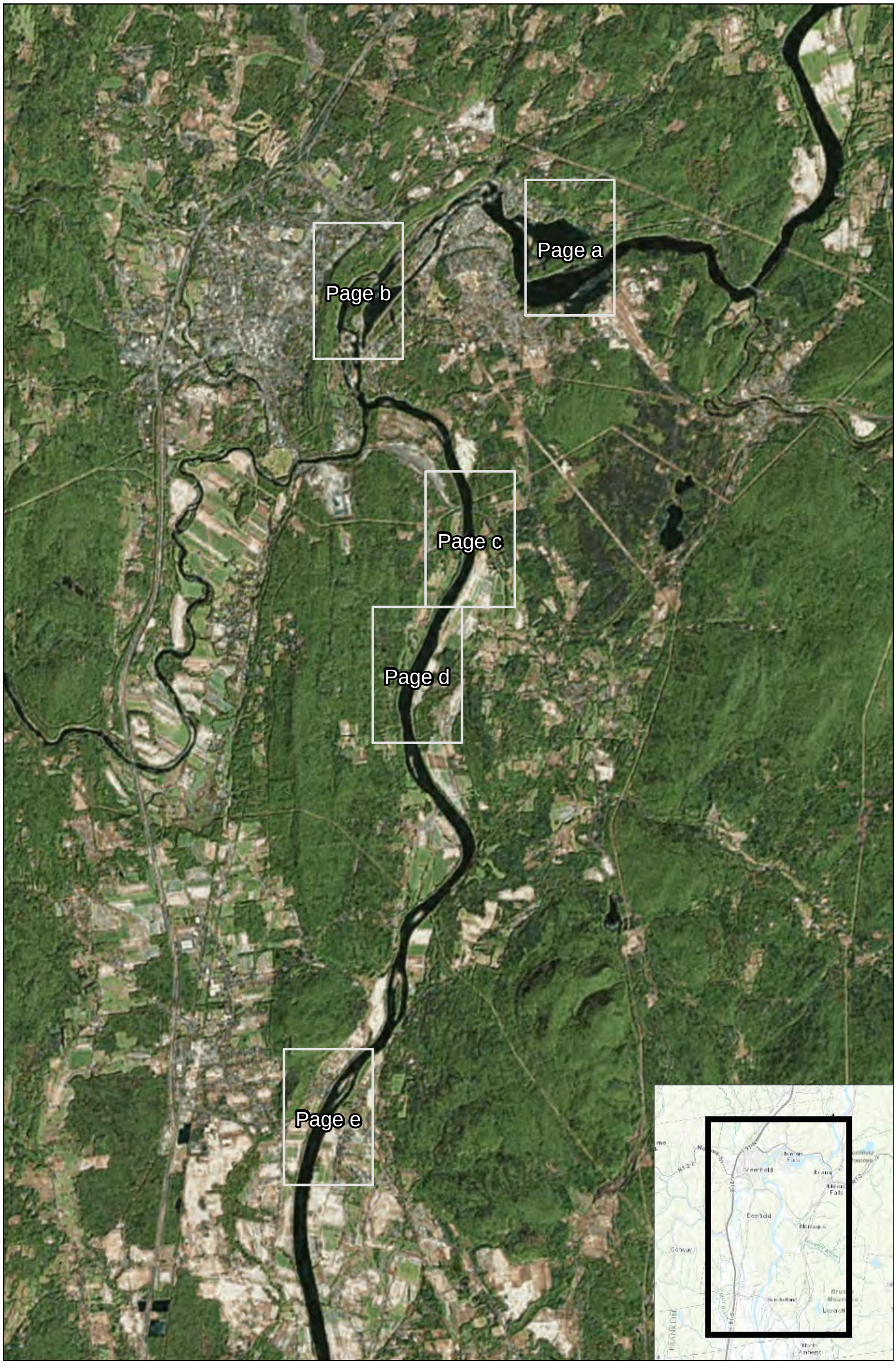
2.2 Methods

Collection methods for larvae included aquatic D-nets and hand picking odonates in the water or on land. Collections were made while wading, snorkeling, and while walking along the riverbank. If present, tenerals or exuviae were collected on the riverbank. For tenerals or exuvia, biologists recorded the vertical and lateral distance from the water's edge, and surface that each was collected on. At each site, aquatic, riparian, and upland habitat parameters were recorded or photographed (Appendix A):

- **Aquatic Parameters**: water depth, water velocity, dominant substrate types, presence and coverage of aquatic vegetation and organic material;
- **Riparian/Upland Parameters**: bank slope, bank height, bank stability, riparian vegetation, tree canopy height and density, land use/land cover.

Table 2.1-1: Locations, dates, and level of effort for each of the eight odonate survey sites in the Connecticut River.

Site	Area	Town	Survey 1	Survey 2	Total Survey Duration (hrs)	Total Linear Survey Distance (m)
1	Barton Cove	Gill	6/2/2014	6/20/2014	3	200
2	Barton Cove	Gill	6/2/2014	-	1	50
3	Barton Cove	Gill	6/2/2014	6/20/2014	2	100
4	Bypass Reach - Rock Dam	Montague	6/6/2014	6/20/2014	6	500
5	Downstream from Railroad Bridge	Montague	6/9/2014	-	3	150
6	Between Railroad Bridge and Third Island	Deerfield	6/9/2014	-	1.5	50
7	Upstream from Third Island	Deerfield	6/9/2014	-	3	200
8	Route 116 Bridge, Boat Ramp	Sunderland	6/20/2014	-	2	150



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

RELICENSING STUDY 3.3.10
Assess Operational Impacts on Emergence of
State-listed Odonates in the Connecticut River

0 0.5 1 2
Miles

Figure 2.1-1 Index. Study Sites

Service Layer Credits: Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
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FirstLight GDF SUEZ

N

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

RELICENSING STUDY 3.3.10

Assess Operational Impacts on Emergence of State-listed Odonates in the Connecticut River

0 0.05 0.1 0.2 Miles

Figure 2.1-1a. Study Sites

Service Layer Credits: Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
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Northfield Mountain Pumped Storage Project (no. 2485) and Turners Falls Hydroelectric Project (No. 1889)

RELICENSING STUDY 3.3.10

Assess Operational Impacts on Emergence of State-listed Odonates in the Connecticut River

0 0.05 0.1 0.2 Miles

Figure 2.1-1b. Study Sites

Service Layer Credits: Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
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Site 5

Legend

Survey Sites

FirstLight™ GDF SUEZ

N

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

RELICENSING STUDY 3.3.10

Assess Operational Impacts on Emergence of State-listed Odonates in the Connecticut River

0 0.05 0.1 0.2 Miles

Figure 2.1-1c. Study Sites

Service Layer Credits: Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
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RELICENSING STUDY 3.3.10

Assess Operational Impacts on Emergence of State-listed Odonates in the Connecticut River

0 0.05 0.1 0.2 Miles

Figure 2.1-1d. Study Sites

Service Layer Credits: Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
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FirstLight™ GDF SUEZ

N

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

RELICENSING STUDY 3.3.10

Assess Operational Impacts on Emergence of State-listed Odonates in the Connecticut River

0 0.05 0.1 0.2 Miles

Figure 2.1-1e. Study Sites

Service Layer Credits: Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
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3 RESULTS

3.1 Odonate Survey Results

3.1.1 Species Assemblage

Table 3.1.1-1 lists the genera and species collected at each site. *Epitheca princeps*, a species common in lentic habitats, was the most common species collected at Sites 1-3. These sites in the lowermost portion of the Turners Falls Impoundment (Barton Cove) contain mostly lentic habitat with submerged and emergent vegetation. Sites 4-8 were generally more lotic; dominant taxa in these samples included *Gomphus* sp. (mostly *G. vastus*), *Ophiogomphus* (mostly *G. rupinsulensis*), *N. yamaskenensis*, *Boyeria vinosa*, and *Macromia illinoiensis*. There was very little variation in the odonate assemblage among sites 4-8. Species-level identification of some of the Gomphidae, especially *Gomphus* sp. and *Ophiogomphus* sp., is incomplete; this interim report will be updated when these data become available. Most of the target state-listed species for Sites 4-8 were in the genus *Gomphus*. Based on historic survey data, which were generally more complete for the Turners Falls Impoundment, several uncommon species likely occur in these areas but were undetected in 2014.

Table 3.1.1-1: Odonate species documented during the qualitative surveys of larvae and exuviae in June 2014.

	Survey Site							
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Arigomphus furcifer		X						
Boyeria vinosa	X			X	X	X	X	X
Epitheca princeps	X	X	X	X	X			
*Gomphus sp.**			X	X	X	X	X	X
Macromia illinoiensis	X	X	X	X	X	X	X	X
Neurocordulia yamaskenensis	X	X	X	X	X	X	X	X
*Ophiogomphus sp**				X	X	X	X	X
Stylurus spiniceps				X				

*Awaiting final species-level identification by Dr. David Wagner, University of Connecticut. Potential Species: *Gomphus fraternus, Gomphus ventricosus, Gomphus abbreviates, Gomphus vastus, Dromogomphus spinosus, Ophiogomphus rupinsulensis,Gomphus spicatus, Gomphus exilis, Gomphus descriptus, Gomphus lividus*

3.1.2 Emergence and Eclosure

Approximately 250 exuviae were collected across the eight survey sites. These were found on emergent aquatic vegetation only at sites 1 and 3, as this type of emergence substrate was not available at the other sites. Elsewhere, exuviae were found primarily on terrestrial herbaceous vegetation, soil, trees, coarse fallen wood, and rock (Table 3.1.2-1). They were found as high as nine feet above the water's surface (mean = 4.4) and as far as 42 feet from the edge of the water (mean = 12.7). Since these surveys were qualitative and only occurred during the month of June, these distances above the water and from the water's edge are biased, but do provide a range to consider in the next phase of work.

3.2 Habitat Characterization

Habitat parameters recorded at each site are provided in Table 3.2-1, and representative photographs are provided in Appendix A. The most common habitat feature of nearshore areas and streambanks was a

muddy slope of varying steepness, with lesser and variable amounts of sand, gravel, or cobble. Upslope, this mud transitioned into the riparian zone that was typically vegetated with trees (especially silver maple), low terrestrial herbaceous vegetation, moss, and vines, and contained varying amounts of large woody debris and detritus. The odonate surveys were typically done during periods of low flow, therefore relatively large amounts of the muddy bank were exposed and the distance from the water line to the interface between aquatic and terrestrial habitat was relatively great.

Less common nearshore habitat types included aquatic emergent vegetation and rock. Aquatic emergent vegetation was prevalent only in the more lentic habitats of Barton Cove (Site 1) and on the other side of Campground Point (Site 3). Elsewhere, aquatic emergent vegetation was either absent, or existed as a very sparse fringe of species that can tolerate daily exposure. Submerged aquatic vegetation, especially *Vallisneria*, was common in some areas but typically only as a narrow band in deeper waters.

Bare rock, an emergence substrate for odonates, is uncommon in the Connecticut River between the Deerfield River confluence and Route 116 Bridge. There are some isolated ledge outcrops, and the bridge abutments and areas near bridges often contained higher amounts of “unnatural” rock. The most “natural” rock is located in the Turners Falls bypass reach.

Table 3.1.2-1: Summary of distance traveled (height above water and distance from the edge of the water) and eclosure substrate for exuviae collected in June 2014.

	Survey Site*							
Parameter	**1**	**3**	**4**	**5****	**6**	**7**	**8**	**Total**
Sample Size	28	-	37	53	50	79	-	247
Vertical Height from Waters Surface (ft)								
Mean	1.5	-	4.1	5.1	5.4	4.1	-	4.4
Minimum	0.5	0.0	0.3	0.5	1.5	2.0	4.0	0
Maximum	3.0	3.0	7.0	9.0	8.5	8.0	8.0	9
Lateral Distance from Waters Edge (ft)								
Mean	14.0	-	13.8	17.8	5.8	7.9	-	12.7
Minimum	0.0	0.0	2.0	0.0	0.0	5.5	10.0	0
Maximum	15.0	3.0	23.0	42.0	8.0	20.0	25.0	42
Eclosure Substrate								
Aquatic Emergent Vegetation	25	X	0	0	0	0	0	25
Terrestrial Herbaceous Vegetation	0	0	23	10	18	48	X	99
Tree	0	0	4	33	0	3	X	40
Coarse Fallen Wood	3	X	3	2	1	2	X	11
Soil	0	0	6	7	31	25	X	69
Rock	0	0	1	1	0	1	X	3

*These data were not collected at Site 2.

**At least 200 more exuviae found at Site 5. Mostly 2-8 ft above water's surface and 4-7 ft from waters edge. Found mostly on low herbaceous vegetation and trees.

- Ranges and cursory descriptions were recorded at Site 3 and Site 8, thus sample size and means were not calculated.

X indicates that exuviae were found on that specific habitat type, 0 indicates that it was not. The reason X is used for Site 3 and Site 8 is because exuviae were not quantified at those two sites.

Table 3.2-1: Summary of habitat parameters recorded for each survey site.

Parameter	Survey Site							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Aquatic Habitat								
Max Depth Surveyed (ft)	2.0	2.5	2.5	4.0	2.5	2.5	4.0	4.0
Flow Velocity[1]	None	None	None	Light to Fast	Light to Moderate	Moderate to Fast	Light to Moderate	Moderate
Substrate (%)[2]								
SILT	50	10	80	20	40	15	25	20
SAND	45	0	5	20	30	15	15	20
GRAV	0	40	5	20	20	40	25	30
COBB	5	50	10	35	10	30	35	30
BEDR	0	0	0	5	0	0	0	0
Cover[3]								
%VEG	25	<5	10	<5	<5	10	<5	10
%FPOM	50	<5	75	5	20	<5	10	<5
%CPOM	10	<5	<5	10	20	<5	20	10
Aquatic Habitat Notes	Lentic habitat with littoral zone. Emergent vegetation common.	Lentic habitat, lacking littoral vegetation at time of survey.	Lentic habitat with narrow littoral zone. Emergent vegetation sparse at time of survey.	Mostly lotic-erosional habitat with nearshore depositional areas, subject to wide fluctuations.	Slow-flowing lotic habitat, sparse submerged and emergent vegetation, mostly fine substrates and detritus.	Lotic erosional; faster flows compared to nearby areas, but still with depositional areas near shoreline.	Steep muddy banks with one gravel/cobble point bar where small stream enters.	Variable conditions; rocky under bridge, gravelly near boat ramp, silt/mud along portions of shoreline.

Notes:

1. Qualitative, based on visual observations focused on the area within 30 meters of the shoreline.
2. Approximate percent cover of each substrate type throughout the site, recognizing significant small-scale variability. GRAV = gravel, COBB = Cobble, BEDR = bedrock.
3. Approximate percent cover of elements that provide cover, including submerged or emergent vegetation (VEG), detritus and fine particulate organic matter (FPOM), and woody debris/coarse particulate organic matter (CPOM)

Table 3.2-1: Summary of habitat parameters recorded for each survey site (continued).

Parameter	Survey Site 1	2	3	4	5	6	7	8
Riparian/Upland Habitat								
Bank Slope[4]	Very Gradual	Gradual	Moderate	Moderate to Vertical	Gradual to Moderate	Moderate to Steep	Moderate to Steep	Moderate to Steep
Bank Height[5]	-	2.0-3.0 ft	2.0-3.0 ft	Variable; to 10 ft	Variable; to 10 ft	Variable; to 12 ft	Variable; to 12 ft	Variable; to 15 ft
Bank Stability[6]	1	1	1	1-2	1	2-3	1-2	1-3
Land Use/Cover	Forest, Road	Forest	Forest	Forest	Forest, Cropland, Residential	Cropland, Forest, Residential	Cropland, Forest	Forest, Residential, Road
Riparian / Upland Habitat Notes	-	-	-	Some gradually sloping banks with floodplain forest upland, some steep bedrock outcrops and vertical rocky banks.	Mud/sand streambanks with overhanging silver maple. Agricultural land beyond narrow riparian buffer.	Riparian strip pf herbaceous and shrub species plus floodplain tree species. Some degree of bank instability.	Herbaceous lower bank, with silver maple floodplain forest higher. A lot of large woody debris.	Boat launch, bridge abutments, and upland development characterize this area.

Notes:

4. Qualitative. Biologists took representative photographs (Appendix A) to document nearshore and riparian habitats.

5. Qualitative. In practice, bank height was variable and difficult to measure, especially where there was a gradual transition from exposed riverbed to the toe and top of the bank. Photographs are likely more informative than these simple descriptors.

6. Informal, qualitative scoring: 1 = Stable, 2 = Moderately Stable, 3 = Moderately Unstable, 4 = Unstable

4 NEXT STEPS

4.1 Review Existing Information

Information on the odonate assemblage in the project-affected reaches of the Connecticut River will be gathered from publications, reports, and relevant case studies. Experts who were involved with the dragonfly studies in the Turners Falls Impoundment in the 2000s have been contacted to provide expert opinion and in some cases unpublished data. The life history and ecology, and particularly emergence and eclosure behavior, of these species and species groups will be summarized in the final report.

4.2 Quantitative Emergence and Eclosure Surveys

Prior to the 2015 quantitative fieldwork, another scientific collection permit will be obtained from the Massachusetts NHESP.

FirstLight proposes to conduct quantitative surveys at three sites, including one in the Turners Falls Impoundment, one in the Turner Falls bypass reach near Rock Dam, and one in in the Connecticut River below Cabot Station. The Revised Study Plan specified that the quantitative surveys would be conducted at four reaches. However, upon review of odonate data collected from 2001 to 2010 in the Turners Falls Impoundment, FirstLight believes that these studies provided ample data to meet the study objectives for all areas except Barton Cove, which was underrepresented in those studies. FirstLight will consult with NHESP on site locations but proposes the following three sites based on habitat diversity and accessibility: (1) Barton Cove/Campground Point, (2) Site 4 (Rock Dam) from this interim report, and (3) Site 8 (Route 116 Bridge) from this interim report.

Larvae may exit the water on a limited number of surfaces, such as emergent aquatic vegetation, sloped banks comprised of fine to coarse soils (e.g., mud, sand, gravel, cobble), or large rock (natural boulder or ledges, or unnatural riprap). Some larvae will stop to eclose on these surfaces, or travel farther upslope to eclose on herbaceous terrestrial vegetation, tree roots, or tree trunks. FirstLight proposes to establish transects perpendicular to the river that span the entire continuum from the water's edge into the upland terrestrial vegetation, and then determine where different species eclose along that continuum. Transects will be monumented with PVC pipe or rebar along their length. Each transect will be three meters wide, and will extend upslope from the water's edge approximately 12 meters. FirstLight has proposed increasing the transect width from what was proposed in the Revised Study Plan from 2 to 3 meters, or from $24m^2$ to $36m^2$, to increase the number of microhabitats and exuviae that occur within transects. Based on 2014 observations, it is likely that more than 100 (and possibly 300-500) exuviae will be collected per transect, per visit, during periods of peak emergence.

FERC's SPDL stated that the survey effort should be stratified in each reach to provide adequate replication of each habitat type (natural vegetation, gradually sloping mud/sand, and rock). Based on habitat characterization in 2014, some habitat types stated as being important in the SPDL were uncommon and it may not be necessary to sample these to accomplish overall objectives of this study. For example, emergent aquatic vegetation is very sparse in both the bypass reach and below Cabot Station. Barton Cove and Campground Point contain significant amounts of emergent aquatic vegetation along with other emergence habitats. More than 95 percent of the shoreline of the Connecticut River between the Deerfield River confluence and Route 116 Bridge is comprised of muddy/sandy slopes with low and variable amounts of embedded gravel and cobble, transitioning to roots and trunks of floodplain trees (especially silver maple), terrestrial herbaceous vegetation, and vines. This type of habitat is also prevalent in the bypass reach, although natural ledge outcroppings and cobble shorelines are more common. Based on habitat availability at each of the proposed survey sites, and the fact that every transect spans a continuum from the water's edge into adjacent uplands as far as odonates have been

documented to travel, FirstLight contends that the following replication (3 sites, 26 transects) is adequate to meet the objectives of the survey:

- Site 1 (Barton Cove/Campground Point): 9 transects (3 starting in emergent aquatic vegetation, 3 starting in ledge outcrop, and 3 starting in mud/sand/gravel).
- Site 2 (Site 4 from this interim report): 9 transects (3 starting in ledge outcrop, 3 starting in gravel/cobble, 3 starting in mud/sand) [there is no emergent aquatic vegetation at this site]
- Site 3 (Site 8 from this interim report): 8 transects (4 starting in gravel/cobble, 4 starting in mud/sand) [there is no ledge outcrop or emergent aquatic vegetation at this site]

The SPDL recommended a minimum of six 2-meter transects in each available habitat type (natural vegetation, gradual sloping mud/sand banks, and rock substrate) in each study reach. This effort could yield up to a potential of 72 2-meter transects per survey date or approximately 475 feet of the river bank. Our proposal would result in three to four transects per site (26 transects total), each transect being 3 meters wide. This proposed effort would survey approximately 256 feet of the river bank.

The following habitat data will be collected at each transect: GPS location of both ends, slope, elevation of the upslope and water ends, elevation of the mean high water mark, types and percent cover of each substrate type, substrate embeddedness, species composition and percent cover of aquatic and upland plants, and anything else noteworthy about conditions at each transect. All transects will be photo-documented.

Surveys for emerging larvae, exuviae, and tenerals will be conducted at each transect every two weeks from mid-May through late August, and will be timed to coincide with weather (warm air temperatures, dry and sunny days) and flow conditions (average to below-average flows, based on USGS streamflow data at the Montague City gage (01170500)) that are conducive to emergence, and during times that are generally considered peak emergence periods for target species that occur in these areas. Surveys will be conducted on weekday mornings when recreational use of the river is low. If possible, surveys will be coordinated with upstream hydropower operations to occur during a period of stable water levels to increase likelihood of collecting data on species that emerge very near the water line and might otherwise be washed away by daily flow fluctuations, and for similar reasons, will not be conducted within two days of heavy rainfall that might dislodge and wash away exuviae.

The time of day, weather, water level, and a qualitative assessment of boat traffic will be recorded at the time of each survey. For each exuvia and teneral, the vertical height above the water's surface, the horizontal distance from the water's edge, and its eclosure structure/substrate will be recorded. Each exuvia will be collected, stored in individual vials, labeled with site information and date, and preserved for later species identification.

4.3 Emergence and Eclosure Speed

Emerging larvae will be watched/tracked as they progress upslope, and the time it takes for them to stop, eclose, and fly away will be recorded. This is a time-intensive observation process that relies on seeing larvae before they stop and begin to eclose. Based on cursory observations in 2014 and discussions with other experts who have attempted these types of observations, it is feasible to accomplish this task for relatively common species (e.g., *G. vastus*, *N. yamaskanensis*, *S. spiniceps*, *M. illinoiensis*, *O. rupinsulensis*, *E. princeps*). However, it may not be possible to observe some rare species that may be outnumbered by common species by at least 1000:1 (e.g., *G. fraternus*, *G. ventricosus*, *G. abbreviatus*, *S. amnicola*). FirstLight concurs with FERCs SPDL that stated, "*We recommend FirstLight record a minimum of 10 observations per species or species group, provided that 10 individuals from each group are encountered during the emergence surveys*."

Observations will coincide with the quantitative exuvia surveys. Biologists will look for larvae exiting the water or crawling on land, and will focus on single individuals as they crawl upslope and come to rest to begin the eclosure process. The most critical period is the time from when larvae begin to eclose and when the teneral's wings have hardened and the adult flies away. Biologists will use a stopwatch to record the duration of this process, and photograph the teneral to help verify species-level identification. For each exuvia, the vertical height above the water's surface, the horizontal distance from the water's edge, and its eclosure structure/substrate will be recorded. Each exuvia will be collected, stored in individual vials, labeled with site information and date, and identified to species in the laboratory.

4.4 Water Fluctuation Impact Assessment

FirstLight will deploy a water level logger (with the capability to record temperature) set to record data at 15-minute intervals in each quantitative survey reach to accurately evaluate water levels, standardize field measurements, and describe temperature in relation to odonate emergence behavior. The loggers will be installed approximately mid-May, and remain in place for the duration of the survey.

In addition, hydraulic models, that have been developed for the whole study area independent of the odonate study, will be used to determine if water level fluctuations affect the emergence and eclosure success of state-listed odonates. The timing (i.e., when species emerge), distance travelled (both horizontal and vertical), and duration (i.e., speed) of eclosure for species and/or species groups will be used in concert with the hydraulic model to determine if, how, and when they are most vulnerable to fluctuating water levels.

APPENDIX A – PHOTOGRAPHS

Site 1: Barton's Cove

Site 1: Barton's Cove

Site 2: Barton's Cove

Site 2: Barton's Cove

Site 3: Campground Point

Site 3: Campground Point

Site 4: Bypass Reach

Site 4: Bypass Reach

Site 4: Bypass Reach

Site 4: Bypass Reach

Site 4: Bypass Reach

Site 5: Downstream of RR Bridge

Site 5: Downstream of RR Bridge

Site 6: Between RR Bridge and Third Island

Site 6: Between RR Bridge and Third Island

Site 7: Near Third Island

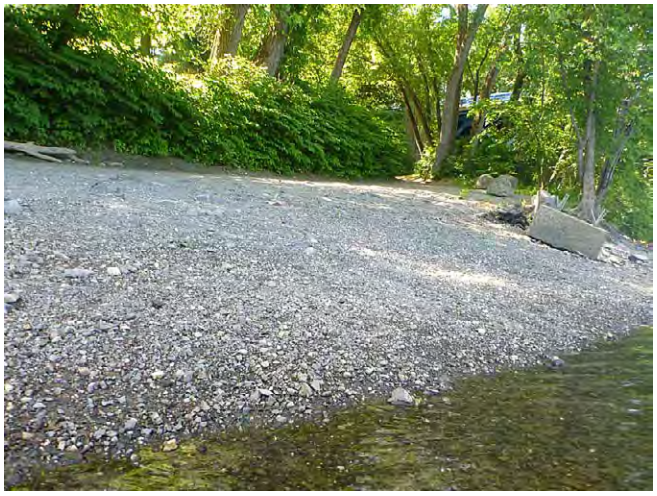
Site 7: Near Third Island

Site 7: Near Third Island

Site 7: Near Third Island

Site 8: Near Route 116 Bridge

Site 8: Near Route 116 Bridge



Site 8: Near Route 116 Bridge

APPENDIX B
CORRESPONDENCE RECORDS

From: Ethan Nedeau <ethan@biodrawversity.com>
Sent: Tuesday, May 12, 2015 10:36 AM
To: Hazelton, Peter (FWE)
Cc: Jason George
Subject: 2015 Odonate Field Study
Attachments: 2015 Odonate Field Study.docx

Hi Pete,
Just sending this updated field sampling plan for the odonate study. We intend to set up transects this week and check for any early emergence. We'll begin sampling next week if we need to, but we are hoping emergence holds off for another week. These warmer temperatures might be quickening things.

-Ethan

--
**New Address
Ethan Nedeau, Biodrawversity LLC
206 Pratt Corner Road, Leverett, MA 01054
Cell: (413) 253-6561 / Email: nedeau.ethan@gmail.com
Website: www.biodrawversity.com

2015 Odonate Field Study

1. Quantitative Emergence and Eclosure Surveys

FirstLight will conduct quantitative surveys at five sites in the Connecticut River. Concurrence on these five sites was reached during an April 28, 2015 meeting with NHESP. Precise locations of transects within these sites will be determined in the field.

1. Barton's Cove/Campground Point (Gill)
2. Downstream from the Rock Dam in the bypass reach (Montague)
3. Area from bike path bridge to Montague City Road, opposite the Deerfield River confluence (Montague)
4. DFW conservation lands on the eastern shore upstream from the Sawmill River confluence (Montague)
5. Eastern shore near the Route 116 Bridge (Sunderland)

At each site, FirstLight will establish six transects that are oriented perpendicular to the river that span the continuum from the water's edge into the upland terrestrial vegetation. Each transect will be three meters wide, and will extend upslope from the water's edge approximately 12 meters. Transects will be monumented with PVC pipe or rebar along their length. The benchmark elevations will be surveyed and geo-referenced with GPS, and benchmarked to Project (NGVD29) datum using a Real-Time Kinematic-Global Positioning System (RTK-GPS) unit.

Within and among the five sites, transects will be established to provide adequate representation of available habitat type (such as natural vegetation, gradually sloping mud/sand, and rock) and of varying bank slopes (i.e., steep versus shallow).

The following habitat data will be collected for each transect: GPS location of both ends, slope, elevation of the upslope and water ends, elevation of the mean high water mark, types and percent cover of each substrate type, substrate embeddedness, species composition and percent cover of aquatic and upland plants, and anything else noteworthy about conditions at each transect. All transects will be photo-documented.

Surveys for emerging larvae, exuviae, and tenerals will be conducted at each transect every two weeks according to this tentative schedule:

- May 25-29
- June 8-12
- June 22-26
- July 6-10
- July 20-24
- August 3-7
- August 17-21
- August 31-September 4

Adjustments to this schedule may be necessary depending on weather and flow conditions; for example, it might begin a week earlier if emergence begins early. Surveys will be timed to coincide with weather (warm air temperatures, dry and sunny days) and flow conditions (average to below-average flows, based on USGS streamflow data at the Montague City gage (01170500)) that are conducive to emergence. If possible, surveys will be coordinated with upstream hydropower operations to occur

during a period of stable water levels to increase likelihood of collecting data on species that emerge very near the water line and might otherwise be washed away by daily flow fluctuations, and for similar reasons, will not be conducted within two days of heavy rainfall that might dislodge and wash away exuviae.

The time of day, weather, water level, and a qualitative assessment of boat traffic will be recorded at the time of each survey. For each exuvia and teneral, the vertical height above the water's surface, the horizontal distance from the water's edge, and its eclosure structure/substrate will be recorded. Each exuvia will be collected, stored in individual vials, labeled with site information and date, and preserved for later species identification.

2. Emergence and Eclosure Speed

Emerging larvae will be watched/tracked as they progress upslope, and the time it takes for them to stop, eclose, and fly away will be recorded.

Based on cursory observations in 2014 and discussions with other experts who have attempted these types of observations, it is feasible to accomplish this task for relatively common species (e.g., *G. vastus*, *N. yamaskanensis*, *S. spiniceps*, *M. illinoiensis*, *O. rupinsulensis*, *E. princeps*). However, it may not be possible to observe some rare species that may be outnumbered by common species by at least 1000:1 (e.g., *G. fraternus*, *G. ventricosus*, *G. abbreviatus*, *S. amnicola*).

In terms of replication, biologists will record emergence/eclosure speed for no more than 20 individuals of each species per site, and will try to focus on finding uncommon species (aiming for a minimum of 10 observations for each species). The main point of this is to avoid over-replicating observations for very common species, and to achieve at least some replication for uncommon species.

Observations will coincide with the quantitative exuvia surveys. Biologists will look for larvae exiting the water or crawling on land, and will focus on single individuals as they crawl upslope and come to rest to begin the eclosure process. The most critical period is the time from when larvae begin to eclose and when the teneral's wings have hardened and the adult flies away. Biologists will use a stopwatch to record the duration of this process.

For each exuvia, the vertical height above the water's surface, the horizontal distance from the water's edge, and its eclosure structure/substrate will be recorded. Each exuvia will be collected, stored in individual vials, labeled with site information and date, and identified to species in the laboratory. Up to 10 teneral/exuvia pairs, per species, will be collected for identification purposes.

3. Water Fluctuation Impact Assessment

A hydraulic model, which will be developed for the whole study area independent of the odonate study, will be used to determine if water level fluctuations affect the emergence and eclosure success of state-listed odonates. The timing (i.e., when species emerge), distance travelled (both horizontal and vertical), and duration (i.e., speed) of eclosure for species and/or species groups will be used in concert with the hydraulic model to determine if, how, and when they are most vulnerable to fluctuating water levels.

From: Grader, Melissa <melissa_grader@fws.gov>
Sent: Wednesday, May 13, 2015 10:30 AM
To: Leddick, Jesse (FWE)
Cc: Hazelton, Peter (FWE); Nedeau, Ethan; Jason George
Subject: Re: 2015 Odonate Field Study

Neither do I.

Melissa Grader
Fish and Wildlife Biologist
U.S. Fish and Wildlife Service - New England Field Office
103 East Plumtree Road
Sunderland, MA 01375
413-548-8002 x124
melissa_grader@fws.gov
~~~~~~
"Heaven is under our feet as well as over our heads" Henry David Thoreau

On Wed, May 13, 2015 at 10:21 AM, Leddick, Jesse (FWE) <jesse.leddick@state.ma.us> wrote:

> I don't have any additional comments, thanks.
>
> ... Jesse
> ---
> Jesse Leddick
> Endangered Species Review Biologist
> Natural Heritage & Endangered Species Program
> Massachusetts Division of Fisheries & Wildlife
> 1 Rabbit Hill Road, Westborough, MA, 01581
> Phone: 508-389-6386 | Fax: 508-389-7890
> www.mass.gov/masswildlife
>
> -----Original Message-----
> From: Hazelton, Peter (FWE)
> Sent: Tuesday, May 12, 2015 11:56 AM
> To: ethan@biodrawversity.com
> Cc: Leddick, Jesse (FWE); Grader, Melissa; jgeorge@gomezandsullivan.com
> Subject: FW: 2015 Odonate Field Study
>
> Ethan,
>
> The updated study design covers what we discussed at the meeting. The only thing I would request is to include a schedule for reporting data and delivering a report of field study to FERC.
>
> If Jesse and Melissa have no further comments, I think this study plan will accomplish the objectives of the
~~~~~~

Odonate study.

On a side note, I was out in the valley yesterday on an unrelated project and wanted to check out the access at the DFW CT River Access Site. Unfortunately I ran out of time and had to return east. Did you scope out the site? Is there anything else you need from me to help with access?

Pete

From: Ethan Nedeau [ethan@biodrawversity.com]
Sent: Tuesday, May 12, 2015 10:35 AM
To: Hazelton, Peter (FWE)
Cc: Jason George
Subject: 2015 Odonate Field Study

Hi Pete,
Just sending this updated field sampling plan for the odonate study. We intend to set up transects this week and check for any early emergence. We'll begin sampling next week if we need to, but we are hoping emergence holds off for another week. These warmer temperatures might be quickening things.

-Ethan

--
**New Address
Ethan Nedeau, Biodrawversity LLC
206 Pratt Corner Road, Leverett, MA 01054
Cell: (413) 253-6561 / Email: nedeau.ethan@gmail.com<mailto:nedeau.ethan@gmail.com>
Website: www.biodrawversity.com<http://www.biodrawversity.com>

Commonwealth of Massachusetts

Division of Fisheries & Wildlife

Jack Buckley, Director

Scientific Collection Permit

INVERTEBRATES

VALID

2015

BIODRAWVERSITY LLC
ETHAN NEDEAU
206 PRATT CORNER ROAD
LEVERETT, MA 01054

DATE: 6/18/2015
PERMIT# : 589.15WI
NHESP Tracking # : 11-30121

Subpermitee(s): CORBIN BRODY, MATTHEW SMITH

is (are) hereby authorized, in accordance with the provisions of Section 4, Chapter 131 and 131A of the Massachusetts General Laws, to remove from the wild within the Commonwealth, subject to conditions set forth below, the following species and numbers:

MAY HAND CAPTURE ALL SPECIES OF FRESHWATER MUSSELS AND ODONATES AS PART OF QUALITATIVE SURVEY. MUST FOLLOW THE NHESP ENDANGERED SPECIES SURVEY GUIDELINES FOR FRESHWATER MUSSELS AND APPROVED SCOPE OF WORK SUBMITTED WITH PERMIT APPLICATION. NHESP SPECIES OBSERVATION FORMS MUST BE SUBMITTED FOR ALL STATE-LISTED RARE SPECIES ENCOUNTERED. WITHIN 10 DAYS OF THE FIRST OBSERVATION OF A GIVEN STATE-LISTED SPECIES, A NHESP SPECIES OBSERVATION FORM MUST BE SUBMITTED TO THE NHESP. ALL OTHER NHESP OBSERVATION FORMS REPORTING SUBSEQUENT OBSERVATIONS OF A GIVEN SPECIES SHALL BE SUBMITTED BY DECEMBER 31.

The following method(s) of taking is (are) hereby authorized:

HAND CAPTURE, D-NETS OR OTHER APPROPRIATE NETS

Collection activites under this permit shall be restricted to the following locations, subject to the approval of private landowners

CONNECTICUT RIVER IN GILL, MONTAGUE AND SUNDERLAND, MA

All specimens secured under this permit shall be donated to the following institutions:

ALL LIVE SPECIMENS SHALL BE RELEASED. A REPRESENTATIVE COLLECTION OF SPENT SHELLS MAY BE COLLECTED AND SUBMITTED AS VOUCHER SPECIMEN TO NHESP WITH RAOFS; OTHERS MAY BE DONATED TO A UNIVERSITY OR RESEARCH INSTITUTION.

No specimen taken under the authority of this permit may be sold. No specimen may be transferred to another not duly licensed.

This permit of a copy thereof shall be carried at all times by the permittee and subpermittee(s) while engaged in the activities authorized herein.

This permit does not absolve the permittee from compliance in full with any and all other applicable federal, state and local requirements, including the acquisition of a federal endangered species permit if required.

Upon expiration of this permit, a complete report detailing all collection activities shall be filed with this office and must include a listing of all species taken, numbers of specimens, and the disposition of same.

This permit, unless sooner revoked for cause, shall expire on December 31 of the year of issue.

Jack Buckley

Jack Buckley, Director

Division of Fisheries and Wildlife *www.mass.gov/masswildlife*
Field Headquarters, One Rabbit Hill Road, Westborough, MA 01581 (508) 389-6300 Fax (508) 389-7890
An Agency of the Department of Fish and Game

APPENDIX C
SITE PHOTOS

Site 1 (Route 116 Bridge). Transect 1.

Site 1 (Route 116 Bridge). Transect 2.

Site 1 (Route 116 Bridge). Transect 3.

Site 1 (Route 116 Bridge). Transect 4.

Site 1 (Route 116 Bridge). Transect 5.

Site 1 (Route 116 Bridge). Transect 6.

Site 2 (MADFW Lands). Transect 1.

Site 2 (MADFW Lands). Transect 2.

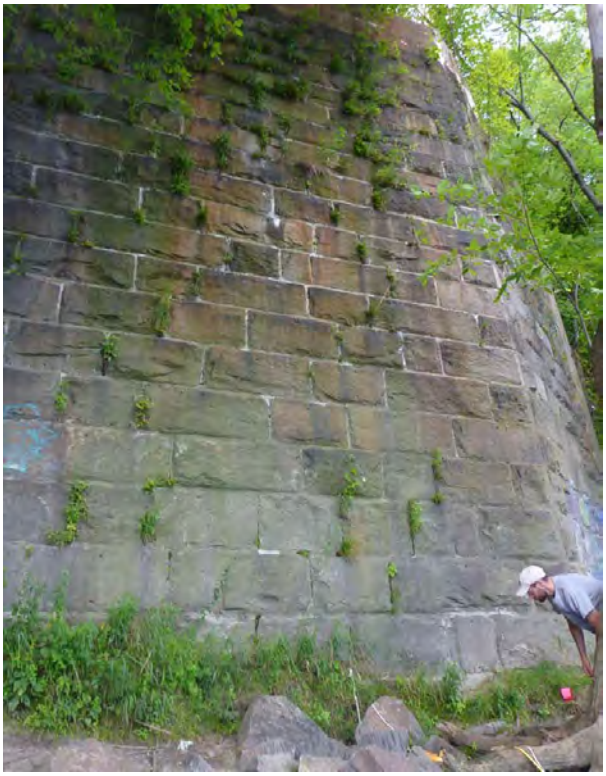
Site 2 (MADFW Lands). Transect 3.

Site 2 (MADFW Lands). Transect 4.

Site 2 (MADFW Lands). Transect 5.

Site 2 (MADFW Lands). Transect 6.

Site 3 (Poplar Street). Transect 1.

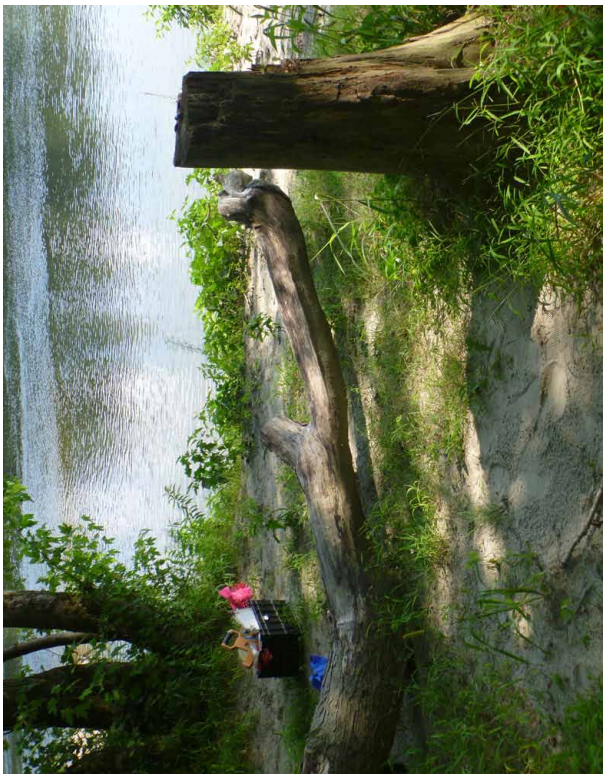


Site 3 (Poplar Street). Transect 2.

Site 3 (Poplar Street). Transect 3.

Site 3 (Poplar Street). Transect 4.

Site 3 (Poplar Street). Transect 5.

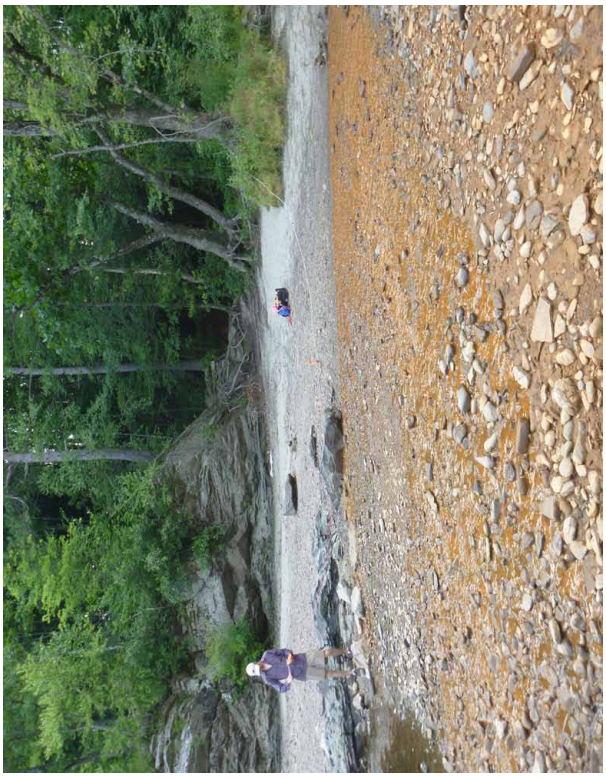


Site 3 (Poplar Street). Transect 6.

Site 4 (Rock Dam). Transect 1.

Site 4 (Rock Dam). Transect 2.

Site 4 (Rock Dam). Transect 3.



Site 4 (Rock Dam). Transect 4.

Site 4 (Rock Dam). Transect 5.

Site 4 (Rock Dam). Transect 6.

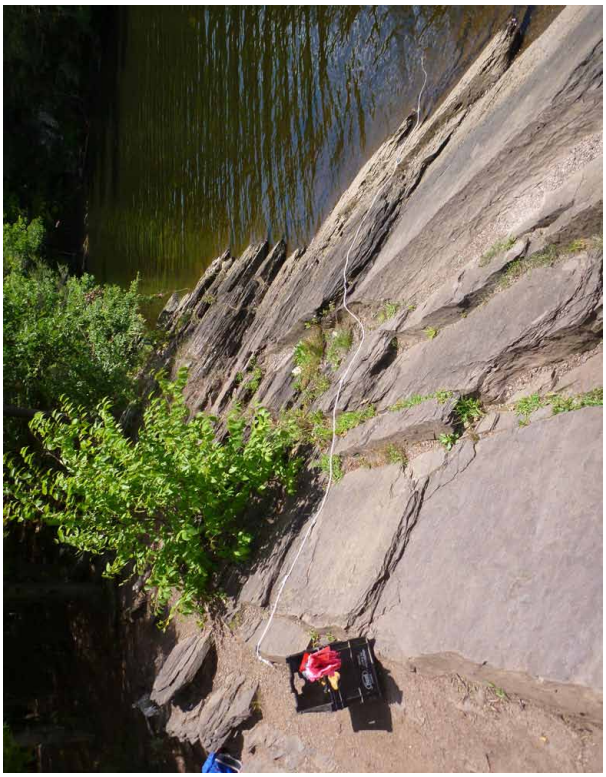
Site 5 (Barton Cove). Transect 1.

Site 5 (Barton Cove). Transect 2.

Site 5 (Barton Cove). Transect 3.

Site 5 (Barton Cove). Transect 4.

Site 5 (Barton Cove). Transect 1.



Site 5 (Barton Cove). Transect 2.

APPENDIX D
SPECIES COUNTS FOR THE PHASE 2 (2015) QUANTITATIVE SAMPLING BY SURVEY SITE, SAMPLING PERIOD, AND TRANSECT.

			Species																	
Site	Period	Trans	BaJa	BoVi	CoMa	DrSp	EpPr	GoAb	GoVa	HaBr	Lisp	Li	Mall	NeYa	OpRu	PeTe	StAm	StSp	Total Count	#Species
1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	4	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1
1	1	5	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
1	1	6	0	0	0	0	0	1	0	0	0	0	0	0	2	0	0	0	3	2
1	2	1	0	0	0	0	0	0	3	0	0	0	0	0	1	0	0	0	4	2
1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	2	3	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1
1	2	4	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	1
1	2	5	0	0	0	0	0	0	22	0	0	0	0	0	0	0	0	0	22	1
1	2	6	0	0	0	0	0	0	5	0	0	0	0	0	1	0	0	0	6	2
1	3	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
1	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	3	4	0	0	0	0	0	0	9	1	0	0	0	1	0	0	0	0	11	3
1	3	5	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	15	1
1	3	6	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	6	1
1	4	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	2	2
1	4	2	0	9	0	0	0	0	0	1	0	0	0	0	0	0	0	0	10	2
1	4	3	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	3	2
1	4	4	0	1	0	0	0	0	4	0	0	0	0	0	0	0	1	0	6	3
1	4	5	0	0	0	2	0	0	0	0	0	0	0	1	0	0	1	1	5	4
1	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
1	5	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1
1	5	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	2
1	5	3	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7	2
1	5	4	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1
1	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	1
1	5	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	1
1	6	1	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	2	16	2
1	6	2	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	2
1	6	3	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	1	8	2
1	6	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
1	6	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	1
1	6	6	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	4	2
1	7	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
1	7	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
1	7	3	0	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	4	2
1	7	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	7	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

			Species																	
Site	Period	Trans	BaJa	BoVi	CoMa	DrSp	EpPr	GoAb	GoVa	HaBr	Lisp	Li	Mall	NeYa	OpRu	PeTe	StAm	StSp	Total Count	#Species
1	8	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
1	8	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	8	3	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1
1	8	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	8	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	8	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	ALL	1	0	19	0	1	0	0	4	0	0	0	0	1	1	0	0	2	28	6
1	ALL	2	0	15	0	0	0	0	0	1	0	0	0	0	0	0	0	4	20	3
1	ALL	3	0	20	0	0	0	0	1	0	0	0	2	0	0	0	0	2	25	4
1	ALL	4	0	1	0	0	0	1	16	1	0	0	1	1	0	0	1	1	23	8
1	ALL	5	0	0	0	2	0	0	37	0	0	0	0	1	1	0	1	6	48	6
1	ALL	6	0	1	0	0	0	1	11	0	0	0	0	0	3	0	1	5	22	6
1	ALL	ALL	0	56	0	3	0	2	69	2	0	0	3	3	5	0	3	20	166	10
2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	1
2	1	2	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	5	1
2	1	3	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	1
2	1	4	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	5	1
2	1	5	0	0	0	0	0	3	0	0	0	0	0	0	1	0	0	0	4	2
2	1	6	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
2	2	1	0	0	0	0	0	0	27	0	0	0	0	0	3	0	0	0	30	2
2	2	2	0	0	0	0	0	1	10	0	0	0	0	0	0	0	0	0	11	2
2	2	3	0	0	0	0	0	0	9	0	0	0	0	1	1	0	0	0	11	3
2	2	4	0	0	0	0	0	0	16	0	0	0	0	1	0	0	0	0	17	2
2	2	5	0	0	0	0	0	0	28	0	0	0	0	2	0	0	0	0	30	2
2	2	6	0	0	0	0	0	0	21	0	0	0	0	2	0	0	0	0	23	2
2	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	3	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
2	3	3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1
2	3	4	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2	1
2	3	5	0	0	0	0	0	0	9	0	0	0	0	1	0	0	0	0	10	2
2	3	6	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1
2	4	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1
2	4	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1
2	4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
2	4	4	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	2	2
2	4	5	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1
2	4	6	0	0	0	2	0	0	1	0	0	0	0	0	0	0	1	1	5	4
2	5	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	5	6	2
2	5	2	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	2	4	3
2	5	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
2	5	4	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0	4	7	3
2	5	5	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	3	4	2

			Species																	
Site	Period	Trans	BaJa	BoVi	CoMa	DrSp	EpPr	GoAb	GoVa	HaBr	Lisp	Li	Mall	NeYa	OpRu	PeTe	StAm	StSp	Total Count	#Species
2	5	6	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	4	2
2	6	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
2	6	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
2	6	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
2	6	4	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1
2	6	5	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	2	2
2	6	6	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	3	2
2	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	7	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	7	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	7	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	7	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	8	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	8	3	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1
2	8	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	8	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	8	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	ALL	1	0	2	0	1	0	0	27	0	0	0	0	0	5	0	0	5	40	5
2	ALL	2	0	1	0	2	0	1	10	0	0	0	0	1	5	0	0	3	23	7
2	ALL	3	0	0	0	1	0	0	9	0	0	0	1	1	3	0	0	3	18	6
2	ALL	4	0	0	0	2	0	0	20	1	0	0	1	1	5	0	0	4	34	7
2	ALL	5	0	0	0	0	0	3	40	0	0	0	0	3	1	0	0	4	51	5
2	ALL	6	0	0	0	4	0	0	23	0	0	0	0	2	1	0	1	6	37	6
2	ALL	ALL	0	3	0	10	0	4	129	1	0	0	2	8	20	0	1	25	203	10
3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	1	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	2	3	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
3	2	4	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1
3	2	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	2	6	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
3	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	3	2	0	0	0	0	0	0	0	1	0	0	2	0	0	0	0	0	3	2
3	3	3	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1
3	3	4	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	3	3

			Species																	
Site	Period	Trans	BaJa	BoVi	CoMa	DrSp	EpPr	GoAb	GoVa	HaBr	Lisp	Li	Mall	NeYa	OpRu	PeTe	StAm	StSp	Total Count	#Species
3	3	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	3	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	4	2	0	3	0	0	0	0	0	0	0	0	0	1	0	0	0	1	5	3
3	4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	4	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	5	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	2	4	3
3	5	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	5	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	1
3	5	4	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	2	2
3	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	5	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	6	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
3	6	2	0	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	4	2
3	6	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	2
3	6	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	6	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
3	6	6	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1
3	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	7	2	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1
3	7	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	7	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	7	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
3	8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	8	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	8	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	8	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	8	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	8	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	ALL	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	2	5	3
3	ALL	2	0	9	0	0	0	0	0	1	0	0	3	1	0	0	0	1	15	5
3	ALL	3	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	4	7	4
3	ALL	4	0	0	0	1	0	0	2	0	0	0	1	1	0	0	1	0	6	5
3	ALL	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
3	ALL	6	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	3	3
3	ALL	ALL	0	11	0	1	0	0	2	1	0	0	6	4	0	0	3	9	37	8
4	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	1	2	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	3	1
4	1	3	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	3	2

			Species																	
Site	Period	Trans	BaJa	BoVi	CoMa	DrSp	EpPr	GoAb	GoVa	HaBr	Lisp	Li	Mall	NeYa	OpRu	PeTe	StAm	StSp	Total Count	#Species
4	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	1	5	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	4	1
4	1	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	2	4	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	3	2
4	2	5	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4	1
4	2	6	0	0	0	0	0	3	6	0	0	0	0	1	0	0	0	0	10	3
4	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	3	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1
4	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	3	4	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	2	2
4	3	5	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1
4	3	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	4	5	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1
4	4	6	0	1	0	0	0	0	4	0	0	0	0	1	0	0	0	0	6	3
4	5	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	2	2
4	5	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1
4	5	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	5	4	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1
4	5	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
4	5	6	0	1	0	0	0	0	0	0	0	0	1	2	0	0	0	0	4	3
4	6	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	4	2
4	6	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
4	6	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	6	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	6	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	6	6	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1
4	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	7	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	7	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	7	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	7	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
4	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	8	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	8	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

			Species																	
Site	Period	Trans	BaJa	BoVi	CoMa	DrSp	EpPr	GoAb	GoVa	HaBr	Lisp	Li	Mall	NeYa	OpRu	PeTe	StAm	StSp	Total Count	#Species
4	8	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	8	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
4	8	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	ALL	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	4	6	3
4	ALL	2	0	0	0	0	1	3	0	0	0	0	1	0	0	0	0	1	6	4
4	ALL	3	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	3	2
4	ALL	4	0	0	0	0	0	1	4	0	0	0	0	1	0	0	0	0	6	3
4	ALL	5	0	3	0	1	0	5	4	0	0	0	0	0	0	0	0	0	13	4
4	ALL	6	0	2	0	1	0	3	10	0	0	0	1	4	0	0	0	0	21	6
4	ALL	ALL	0	6	1	2	1	14	18	0	0	0	2	6	0	0	0	5	55	9
5	1	1	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3	1
5	1	2	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3	1
5	1	3	1	0	0	0	23	0	0	0	0	0	0	0	0	0	0	0	24	2
5	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	1	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	2	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1
5	2	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	1
5	2	3	1	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	7	2
5	2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	2	5	0	0	0	0	3	0	0	0	0	0	0	1	0	0	0	0	4	2
5	2	6	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1
5	3	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1
5	3	2	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	3	2
5	3	3	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	11	1
5	3	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	3	5	0	0	0	1	6	0	0	0	0	0	0	0	0	0	0	0	7	2
5	3	6	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	1
5	4	1	0	0	0	0	1	0	0	0	0	3	0	0	0	0	0	0	4	2
5	4	2	0	0	0	0	3	0	0	0	1	2	0	0	0	1	0	0	7	4
5	4	3	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	8	1
5	4	4	0	0	0	0	4	0	0	0	0	0	0	1	0	3	0	0	8	3
5	4	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	4	6	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1
5	5	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1
5	5	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	1
5	5	3	0	0	0	0	2	0	0	0	2	1	0	0	0	1	0	0	6	4
5	5	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	1
5	5	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	6	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	1
5	6	2	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	3	1

			Species																	
Site	**Period**	**Trans**	**BaJa**	**BoVi**	**CoMa**	**DrSp**	**EpPr**	**GoAb**	**GoVa**	**HaBr**	**Lisp**	**Li**	**Mall**	**NeYa**	**OpRu**	**PeTe**	**StAm**	**StSp**	**Total Count**	**#Species**
5	6	3	0	0	0	0	5	0	0	0	0	2	0	0	0	9	0	0	16	3
5	6	4	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	1
5	6	5	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
5	6	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	7	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	7	3	0	0	0	0	7	0	0	0	2	0	0	0	0	1	0	0	10	3
5	7	4	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	1
5	7	5	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	3	2
5	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	8	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	8	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	8	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	8	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	8	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	ALL	1	0	0	0	0	9	0	0	0	0	3	0	0	0	0	0	0	12	2
5	ALL	2	0	0	0	0	10	0	0	0	1	5	0	0	0	4	0	0	20	4
5	ALL	3	2	0	0	0	62	0	0	0	4	3	0	0	0	11	0	0	82	5
5	ALL	4	0	0	0	0	6	0	0	0	0	0	0	1	0	5	0	0	12	3
5	ALL	5	0	0	0	1	11	0	0	0	0	0	0	1	0	4	0	0	17	4
5	ALL	6	0	0	0	0	3	0	0	0	0	0	1	0	0	0	0	0	4	2
5	ALL	ALL	2	0	0	1	101	0	0	0	5	11	1	2	0	24	0	0	147	8

APPENDIX E
SITE, TIME AND DATE, CRAWL DISTANCE, CRAWL HEIGHT, EMERGENCE/ECLOSURE SUBSTRATE, AND OTHER NOTES RECORDED FOR EACH OF THE EXUVIAE COLLECTED DURING THE PHASE 2 (2015) QUANTITATIVE SAMPLING (N = 622).

*Exuvia/tenerals found during qualitative searches outside of transects are listed as X-Site, with X referring to site number (1-5).

													Emergence/Eclosure Substrate										
Site-Trans*	Qual	Quant	Time	Date	ID	Species	Collect	Photo	Exuv	Tene	CrawlH	CrawlD	Silt	Sand	Grav	LRock	Root	CWood	Tree	Herb	AqHerb	Leaf	Detr
5-3		X	1:45	5/27/2015	11	BaJa	X	X	X		5.6	13.5					X						
5-3		X	10:15	6/8/2015	71	BaJa	X	X	X		7.4	13.8								X			
1-Site	X		12:54	6/25/2015	342	BoVi	X	X			2.0	4.8	X				X			X			
1-Site	X		10:18	6/30/2015	343	BoVi	X	X		X	2.3	5.2								X			
1-2		X	8:48	7/7/2015	364	BoVi	X	X	X		4.9	11.5	X										
1-2		X	8:48	7/7/2015	365	BoVi	X	X	X		5.5	12.8						X					
1-2		X	8:49	7/7/2015	366	BoVi	X	X	X		7.7	15.1						X					
1-2		X	8:49	7/7/2015	367	BoVi	X	X	X		7.7	15.2						X					
1-2		X	8:49	7/7/2015	368	BoVi	X	X	X		7.7	15.3						X					
1-2		X	8:49	7/7/2015	369	BoVi	X	X	X		6.8	14.8	X										
1-2		X	8:50	7/7/2015	370	BoVi	X	X	X		7.8	15.6						X					
1-2		X	8:55	7/7/2015	371	BoVi	X	X	X		11.9	-						X					
1-2		X	8:57	7/7/2015	372	BoVi	X	X	X		12.2	22.3	X										
3-2		X	12:47	7/9/2015	424	BoVi	X	X	X		5.1	8.9							X				
3-2		X	12:49	7/9/2015	425	BoVi	X	X	X		4.9	16.2				X							
3-2		X	12:53	7/9/2015	426	BoVi	X	X	X		9.0	20.7								X			
1-3		X	9:32	7/7/2015	375	BoVi	X	X	X		7.0	11.5			X								
1-3		X	9:35	7/7/2015	376	BoVi	X	X	X		6.1	11.8										X	
1-4		X	11:00	7/7/2015	384	BoVi	X	X	X		5.5	21.3	X										
4-6		X	11:49	7/9/2015	423	BoVi	X	X	X		5.4	12.5								X			
3-1		X	11:31	7/20/2015	449	BoVi	X	X	X		7.8	12.8							X				
2-1		X	8:56	7/21/2015	456	BoVi	X	X	X		0.3	1.5					X						
1-1		X	11:44	7/21/2015	482	BoVi	X	X	X		4.3	7.7							X				
1-1		X	11:45	7/21/2015	483	BoVi	X	X	X		4.3	7.7							X				
1-1		X	11:46	7/21/2015	484	BoVi	X	X	X		2.4	4.3								X			
2-2		X	9:20	7/21/2015	463	BoVi	X	X	X		1.2	2.1					X						
1-2		X	12:07	7/21/2015	487	BoVi	X	X	X		4.4	7.9	X							X			
1-2		X	12:10	7/21/2015	488	BoVi	X	X	X		13.8	18.7							X				
1-3		X	12:30	7/21/2015	490	BoVi	X	X	X		2.1	2.6					X		X				
1-3		X	12:32	7/21/2015	491	BoVi	X	X	X		0.7	1.5		X	X								
1-3		X	12:34	7/21/2015	492	BoVi	X	X	X		1.4	2.5	X	X				X					
1-3		X	12:35	7/21/2015	493	BoVi	X	X	X		1.5	2.6						X					
1-3		X	12:37	7/21/2015	494	BoVi	X	X	X		3.3	4.8								X			
1-3		X	12:39	7/21/2015	495	BoVi	X	X	X		5.0	8.2											

*Exuvia/tenerals found during qualitative searches outside of transects are listed as X-Site, with X referring to site number (1-5).

													Emergence/Eclosure Substrate										
Site-Trans*	Qual	Quant	Time	Date	ID	Species	Collect	Photo	Exuv	Tene	CrawlH	CrawlD	Silt	Sand	Grav	LRock	Root	CWood	Tree	Herb	AqHerb	Leaf	Detr
4-5		X	10:26	7/20/2015	441	BoVi	X	X	X		3.9	15.4					X						
4-6		X	10:41	7/20/2015	445	BoVi	X	X	X		5.7	12.1				X				X			
4-1		X	10:29	8/3/2015	516	BoVi	X	X	X		6.6	25.4	X										
3-1		X	12:52	8/3/2015	519	BoVi	X	X	X		4.5	8.5	X				X						
2-1		X	9:55	8/4/2015	530	BoVi	X	X	X		3.3	19.4					X						
1-1		X	2:09	8/5/2015	564	BoVi	X	X	X		5.0	22.5					X			X			
1-1		X	2:12	8/5/2015	565	BoVi	X	X	X		6.4	24.6					X			X			
1-1		X	2:15	8/5/2015	567	BoVi	X	X	X		6.5	24.6							X				
1-1		X	2:16	8/5/2015	568	BoVi	X	X	X		5.5	23.0	X							X			
1-1		X	2:16	8/5/2015	569	BoVi	X	X	X		6.6	25.1											
1-1		X	2:20	8/5/2015	570	BoVi	X	X	X		6.6	24.9											
1-1		X	2:22	8/5/2015	571	BoVi	X	X	X		6.9	25.6	X										
1-1		X	2:25	8/5/2015	572	BoVi	X	X	X		6.9	25.6	X										
1-1		X	2:29	8/5/2015	573	BoVi	X	X	X		8.9	27.6							X				
1-1		X	2:31	8/5/2015	574	BoVi	X	X	X		9.4	29.2	X										
1-1		X	2:40	8/5/2015	576	BoVi	X	X	X		5.0	22.1								X			
1-1		X	2:53	8/5/2015	577	BoVi	X	X	X		3.5	18.7	X										
1-1		X	2:54	8/5/2015	578	BoVi	X	X	X		6.3	24.3	X				X						
1-1		X	3:10	8/5/2015	579	BoVi	X	X	X		14.5	38.1	X										
3-2		X	1:08	8/3/2015	520	BoVi	X	X	X		5.0	13.5	X						X				
3-2		X	1:15	8/3/2015	521	BoVi	X	X	X		5.3	13.1								X			
3-2		X	1:17	8/3/2015	522	BoVi	X	X	X		4.9	13.5	X				X						
1-2		X	3:17	8/5/2015	580	BoVi	X	X	X		7.5	33.5	X										
1-2		X	3:20	8/5/2015	582	BoVi	X	X	X		10.8	38.1							X				
1-2		X	3:30	8/5/2015	584	BoVi	X	X	X		11.0	38.2	X										
1-3		X	4:03	8/5/2015	585	BoVi	X	X	X		4.9	17.1	X										
1-3		X	4:04	8/5/2015	586	BoVi	X	X	X		4.9	17.2	X										
1-3		X	4:05	8/5/2015	587	BoVi	X	X	X		6.0	19.4	X				X						
1-3		X	4:05	8/5/2015	588	BoVi	X	X	X		6.7	20.7	X				X						
1-3		X	4:06	8/5/2015	589	BoVi	X	X	X		8.4	22.3							X				
1-3		X	4:07	8/5/2015	590	BoVi	X	X	X		8.0	21.3							X				
1-3		X	4:08	8/5/2015	591	BoVi	X	X	X		10.5	26.6	X		X								
1-6		X	4:38	8/5/2015	594	BoVi	X	X	X		9.1	26.9	X							X			

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													Emergence/Eclosure Substrate										
Site-Trans*	Qual	Quant	Time	Date	ID	Species	Collect	Photo	Exuv	Tene	CrawlH	CrawlD	Silt	Sand	Grav	LRock	Root	CWood	Tree	Herb	AqHerb	Leaf	Detr
1-1		X	10:35	8/20/2015	621	BoVi	X	X	X		4.0	18.5								X			
3-2		X	1:49	8/19/2015	617	BoVi	X	X	X		3.3	9.2	X				X						
3-2		X	1:50	8/19/2015	618	BoVi	X	X	X		3.4	11.0	X				X						
3-2		X	1:53	8/19/2015	619	BoVi	X	X	X		5.1	12.0							X				
1-2		X	11:00	8/20/2015	622	BoVi	X	X	X		9.6	58.9							X				
1-3		X	11:24	8/20/2015	624	BoVi	X	X	X		5.1	17.1					X						
1-3		X	11:26	8/20/2015	625	BoVi	X	X	X		6.8	20.0				X							
1-3		X	11:33	8/20/2015	628	BoVi	X	X	X		4.2	14.4	X			X							
4-5		X	12:31	8/19/2015	616	BoVi	X	X	X		2.0	16.1							X				
1-1		X	3:11	9/1/2015	631	BoVi	X	X	X		4.6	22.3				X							
1-3		X	4:31	9/1/2015	632	BoVi	X	X	X		4.1	17.1							X				
1-3		X	4:31	9/1/2015	633	BoVi	X	X	X		4.1	17.1							X				
4-5		X	1:51	8/31/2015	629	BoVi	X	X	X		6.7	10.8								X			
4-3		X	3:34	5/29/2015	38	CoMa	X	X	X		5.0	10.2							X				
2-3		X	9:48	6/23/2015	327	DrSp	X	X	X		0.2	0.7	X										
5-5		X	10:53	6/19/2015	276	DrSp	X	X	X	X	2.7	8.7					X						
2-6		X	10:51	6/23/2015	341	DrSp		X			0.1	11.2					X						
2-1		X	10:41	7/6/2015	351	DrSp	X	X	X		2.5	14.1					X						
1-1		X	8:26	7/7/2015	362	DrSp	X	X	X	X	2.5	8.4								X			
2-2		X	10:52	7/6/2015	352	DrSp	X	X	X		8.8	21.3	X										
1-5		X	10:25	7/7/2015	380	DrSp	X	X	X		12.4	19.4	X										
1-5		X	10:25	7/7/2015	381	DrSp	X	X	X		13.3	22.3	X										
4-5		X	11:37	7/9/2015	417	DrSp	X	X	X		11.4	10.2										X	
2-6		X	12:28	7/6/2015	358	DrSp	X	X	X		6.4	16.6	X										
2-6		X	12:41	7/6/2015	361	DrSp	X	X	X		10.8	24.6					X						
5-Site	X		12:52	7/2/2015	350	DrSp	X	X	X	X	0.1	0.3				X							
2-2		X	9:15	7/21/2015	460	DrSp	X	X	X		0.8	2.6	X										
3-4		X	12:24	7/20/2015	453	DrSp	X	X	X		5.6	12.5					X			X			
2-4		X	9:50	7/21/2015	466	DrSp	X	X	X		1.8	3.4	X										
2-4		X	10:05	7/21/2015	470	DrSp	X	X	X		10.5	16.1	X										
2-6		X	10:45	7/21/2015	479	DrSp	X	X	X		2.4	4.4					X						
4-6		X	12:14	8/3/2015	518	DrSp	X	X	X		4.7	9.5	X			X				X			
5-1		X	12:15	5/27/2015	1	EpPr	X	X	X		4.9	39.4						X					

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													Emergence/Eclosure Substrate									
Site-Trans*	Qual	Quant	Time	Date	ID	Species	Collect	Photo	Exuv	Tene	CrawlH	CrawlD	Silt	Sand	Grav	LRock	Root	CWood	Tree	Herb	AqHerb	Leaf	Detr
5-1		X	12:15	5/27/2015	2	EpPr	X	X	X		4.5	39.4								X			
5-1		X	12:15	5/27/2015	3	EpPr	X	X	X		4.0	36.1									X		
5-2		X	1:00	5/27/2015	4	EpPr	X	X	X		5.0	28.2									X		
5-2		X	1:00	5/27/2015	5	EpPr		X	X		4.6	21.3									X		
5-2		X	1:00	5/27/2015	6	EpPr	X	X		X	4.6	21.3									X		
5-3		X	1:45	5/27/2015	7	EpPr	X	X	X	X	3.3	7.9				X							
5-3		X	1:45	5/27/2015	8	EpPr	X		X		5.5	11.8								X			
5-3		X	1:45	5/27/2015	9	EpPr	X		X		5.6	11.8								X			
5-3		X	1:45	5/27/2015	10	EpPr	X	X	X		6.5	11.5								X			
5-3		X	1:45	5/27/2015	12	EpPr	X		X		5.5	12.1								X			
5-3		X	1:45	5/27/2015	13	EpPr	X		X		6.1	12.5								X			
5-3		X	1:45	5/27/2015	14	EpPr	X	X	X		6.1	12.8								X			
5-3		X	1:45	5/27/2015	15	EpPr	X	X	X		6.1	12.8								X			
5-3		X	1:45	5/27/2015	16	EpPr	X	X	X		6.5	12.8								X			
5-3		X	1:45	5/27/2015	17	EpPr	X	X	X		6.2	12.8								X			
5-3		X	1:45	5/27/2015	18	EpPr	X	X	X		6.5	13.1								X			
5-3		X	1:45	5/27/2015	19	EpPr	X	X	X		6.6	13.1								X			
5-3		X	1:45	5/27/2015	20	EpPr	X	X	X		6.6	13.1								X			
5-3		X	1:45	5/27/2015	21	EpPr	X	X	X		6.8	13.1								X			
5-3		X	1:45	5/27/2015	22	EpPr	X	X	X		7.0	13.1								X			
5-3		X	1:45	5/27/2015	23	EpPr	X	X	X		6.6	10.8								X			
5-3		X	1:45	5/27/2015	24	EpPr	X	X	X		6.3	12.8								X			
5-3		X	1:45	5/27/2015	25	EpPr	X		X		6.7	13.1								X			
5-3		X	1:45	5/27/2015	26	EpPr	X		X		6.6	12.8								X			
5-3		X	1:45	5/27/2015	27	EpPr	X		X		6.6	14.4								X			
5-3		X	1:45	5/27/2015	28	EpPr	X		X		8.1	16.4								X			
5-3		X	1:45	5/27/2015	29	EpPr	X		X		6.5	14.1								X			
5-3		X	1:45	5/27/2015	30	EpPr	X		X		9.4	17.1								X			
5-1		X	11:05	6/8/2015	72	EpPr	X	X	X		1.1	1.5									X		
5-2		X	11:31	6/8/2015	73	EpPr	X	X	X		0.6	0.3						X					
5-2		X	11:35	6/8/2015	74	EpPr	X	X	X		0.9	3.3								X			
5-3		X	10:01	6/8/2015	65	EpPr	X	X	X		0.8	3.9											X
5-3		X	10:02	6/8/2015	66	EpPr	X	X	X		1.0	4.6											X

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													Emergence/Eclosure Substrate										
Site-Trans*	Qual	Quant	Time	Date	ID	Species	Collect	Photo	Exuv	Tene	CrawlH	CrawlD	Silt	Sand	Grav	LRock	Root	CWood	Tree	Herb	AqHerb	Leaf	Detr
5-3		X	10:04	6/8/2015	67	EpPr	X	X	X		3.2	6.2								X			
5-3		X	10:06	6/8/2015	68	EpPr	X	X	X		3.3	8.9								X			
5-3		X	10:06	6/8/2015	69	EpPr	X	X	X		3.4	7.9								X			
5-3		X	10:15	6/8/2015	70	EpPr	X	X	X		2.5	6.2								X			
5-5		X	12:25	6/8/2015	75	EpPr	X	X	X		1.7	8.2				X							
5-5		X	12:26	6/8/2015	76	EpPr	X	X	X		5.3	13.0				X							
5-5		X	12:26	6/8/2015	77	EpPr	X	X	X		5.4	13.1				X							
5-1		X	9:38	6/19/2015	261	EpPr	X	X	X		3.2	3.3									X		
5-2		X	8:57	6/19/2015	259	EpPr	X	X	X		2.0	1.6									X		
5-2		X	9:01	6/19/2015	260	EpPr	X	X	X		0.7	7.5	X										
4-2		X	9:51	6/22/2015	315	EpPr	X	X	X		10.0	36.7							X				
5-3		X	8:11	6/19/2015	262	EpPr	X	X	X		2.6	9.8					X						
5-3		X	8:11	6/19/2015	263	EpPr	X	X	X		1.7	8.9					X						
5-3		X	8:12	6/19/2015	264	EpPr	X	X	X		1.8	8.9					X						
5-3		X	8:12	6/19/2015	265	EpPr	X	X	X		2.1	9.8	X										
5-3		X	8:12	6/19/2015	266	EpPr	X	X	X		2.1	9.8	X										
5-3		X	8:13	6/19/2015	267	EpPr	X	X	X		3.1	10.5								X			
5-3		X	8:14	6/19/2015	268	EpPr	X	X	X		3.2	10.7								X			
5-3		X	8:15	6/19/2015	269	EpPr	X	X	X		2.6	9.5					X						
5-3		X	8:19	6/19/2015	270	EpPr	X	X	X		4.9	12.8	X										
5-3		X	8:20	6/19/2015	271	EpPr	X	X	X		9.0	20.7	X		X								
5-3		X	8:20	6/19/2015	272	EpPr	X	X	X		3.0	10.2								X			
5-5		X	10:50	6/19/2015	273	EpPr	X	X	X		2.6	4.9				X							
5-5		X	10:51	6/19/2015	274	EpPr	X	X	X		2.4	6.9				X							
5-5		X	10:53	6/19/2015	275	EpPr	X	X	X		2.4	7.5	X										
5-5		X	10:55	6/19/2015	277	EpPr	X	X	X		4.6	8.5					X						
5-5		X	10:54	6/19/2015	278	EpPr	X	X	X		5.4	10.2							X				
5-5		X	10:53	6/19/2015	279	EpPr	X	X	X		4.2	8.2					X						
5-6		X	11:17	6/19/2015	280	EpPr	X	X	X		3.7	9.2				X							
5-6		X	11:19	6/19/2015	281	EpPr	X	X	X		3.8	9.5								X			
5-1		X	11:35	7/8/2015	405	EpPr	X	X	X		4.1	4.1									X		
5-2		X	10:54	7/8/2015	398	EpPr	X	X	X		3.9	7.2									X		
5-2		X	10:55	7/8/2015	400	EpPr	X	X	X		4.2	9.5									X		

*Exuvia/tenerals found during qualitative searches outside of transects are listed as X-Site, with X referring to site number (1-5).

													Emergence/Eclosure Substrate										
Site-Trans*	Qual	Quant	Time	Date	ID	Species	Collect	Photo	Exuv	Tene	CrawlH	CrawlD	Silt	Sand	Grav	LRock	Root	CWood	Tree	Herb	AqHerb	Leaf	Detr
5-2		X	10:55	7/8/2015	401	EpPr	X	X	X		5.6	11.2									X		
5-3		X	10:20	7/8/2015	389	EpPr	X	X	X		3.5	13.1								X			
5-3		X	10:20	7/8/2015	390	EpPr	X	X	X		2.6	12.1			X								
5-3		X	10:21	7/8/2015	391	EpPr	X	X	X		3.4	12.8								X			
5-3		X	10:21	7/8/2015	392	EpPr	X	X	X		2.3	11.2			X								
5-3		X	10:22	7/8/2015	393	EpPr	X	X	X		3.0	12.8								X			
5-3		X	10:24	7/8/2015	394	EpPr	X	X	X		2.5	12.3								X			
5-3		X	10:24	7/8/2015	395	EpPr	X	X	X		4.5	14.9								X			
5-3		X	10:32	7/8/2015	396	EpPr	X	X	X		7.6	19.9								X			
5-4		X	12:22	7/8/2015	410	EpPr	X	X	X		1.4	5.2				X				X			
5-4		X	12:22	7/8/2015	411	EpPr	X	X	X		1.8	3.6								X			
5-4		X	12:26	7/8/2015	414	EpPr	X	X	X		4.9	16.2				X				X			
5-4		X	12:34	7/8/2015	415	EpPr	X	X	X		0.9	2.8								X			
5-6		X	12:54	7/8/2015	416	EpPr	X	X	X		1.1	6.7				X							
5-1		X	10:51	7/25/2015	508	EpPr	X	X	X		0.8	5.9						X					
5-3		X	10:00	7/25/2015	505	EpPr	X	X	X		5.9	14.3								X			
5-3		X	10:08	7/25/2015	507	EpPr	X	X	X		7.7	17.1								X			
5-1		X	11:10	8/5/2015	555	EpPr	X	X	X		1.8	29.9		X									X
5-1		X	11:16	8/5/2015	556	EpPr	X	X	X		1.9	30.2						X					
5-3		X	10:10	8/5/2015	548	EpPr	X	X	X		5.4	19.0										X	X
5-3		X	10:11	8/5/2015	549	EpPr	X	X	X		5.4	18.9										X	X
5-3		X	10:19	8/5/2015	550	EpPr	X	X	X		5.6	19.5										X	X
5-3		X	10:19	8/5/2015	551	EpPr	X	X	X		5.6	19.7										X	X
5-3		X	10:20	8/5/2015	553	EpPr	X	X	X		6.6	20.3										X	X
5-4		X	12:04	8/5/2015	560	EpPr	X	X	X		4.1	4.3								X			
5-4		X	12:07	8/5/2015	561	EpPr	X	X	X		3.9	3.8				X							
5-3		X	12:03	8/18/2015	601	EpPr	X	X	X		1.7	7.9											X
5-3		X	12:05	8/18/2015	603	EpPr	X	X	X		3.7	11.2								X			
5-3		X	12:06	8/18/2015	604	EpPr	X	X	X		3.3	10.7								X			X
5-3		X	12:08	8/18/2015	605	EpPr	X	X	X		2.2	9.2										X	X
5-3		X	12:12	8/18/2015	606	EpPr	X	X	X		4.0	12.1								X			
5-3		X	12:20	8/18/2015	608	EpPr	X	X	X		4.0	11.8										X	X
5-3		X	12:33	8/18/2015	610	EpPr	X	X	X		8.2	18.4										X	

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													Emergence/Eclosure Substrate										
Site-Trans*	Qual	Quant	Time	Date	ID	Species	Collect	Photo	Exuv	Tene	CrawlH	CrawlD	Silt	Sand	Grav	LRock	Root	CWood	Tree	Herb	AqHerb	Leaf	Detr
5-5		X	2:30	8/18/2015	614	EpPr	X	X	X		2.3	7.9				X							
5-5		X	2:32	8/18/2015	615	EpPr	X	X	X		1.4	7.4											X
4-2		X	11:15	5/29/2015	31	GoAb	X	X	X		5.2	11.8						X					
4-2		X	11:15	5/29/2015	32	GoAb	X	X	X		8.9	23.3	X										
4-2		X	11:15	5/29/2015	33	GoAb	X	X	X		9.7	27.6	X										
4-3		X	3:35	5/29/2015	39	GoAb	X	X	X		5.2	8.6	X										
4-3		X	3:37	5/29/2015	40	GoAb	X	X	X		7.1	7.9					X						
1-4		X	4:39	5/30/2015	64	GoAb	X	X	X		4.7	20.7	X										
4-5		X	12:13	5/29/2015	34	GoAb	X	X	X		7.8	3.9							X				
4-5		X	12:13	5/29/2015	35	GoAb	X	X	X		6.1	3.3							X				
4-5		X	12:13	5/29/2015	36	GoAb	X	X	X	X	5.1	1.0							X				
4-5		X	12:13	5/29/2015	37	GoAb	X	X	X		7.7	1.6							X				
2-5		X	11:37	5/30/2015	43	GoAb	X	X	X		7.0	23.0	X	X									
2-5		X	11:38	5/30/2015	44	GoAb	X	X	X		9.3	30.5	X										
2-5		X	11:41	5/30/2015	45	GoAb	X	X	X		10.8	33.1	X										
1-6		X	3:59	5/30/2015	62	GoAb	X	X	X		13.8	27.6	X										
2-2		X	3:30	6/11/2015	217	GoAb	X	X	X		3.0	2.8	X										
4-4		X	10:32	6/11/2015	118	GoAb	X		X		3.4	6.9	X	X									
4-6		X	11:20	6/11/2015	123	GoAb	X	X	X		3.5	1.8				X							
4-6		X	11:25	6/11/2015	127	GoAb	X	X	X		8.5	3.4				X							
4-6		X	11:27	6/11/2015	130	GoAb	X	X	X		7.8	7.4				X							
4-5		X	11:00	6/22/2015	318	GoAb	X	X	X		7.0	10.5	X										
1-1		X	9:35	6/10/2015	80	GoVa	X	X	X		3.7	9.2					X						
1-1		X	9:37	6/10/2015	82	GoVa	X	X	X		6.0	11.5							X				
1-1		X	9:39	6/10/2015	83	GoVa	X	X	X		8.9	13.5							X				
2-1		X	4:06	6/11/2015	225	GoVa	X	X	X		0.3	0.8					X						
2-1		X	4:06	6/11/2015	226	GoVa	X	X	X		0.9	1.1					X						
2-1		X	4:06	6/11/2015	227	GoVa	X	X	X		2.8	3.6					X						
2-1		X	4:07	6/11/2015	228	GoVa	X	X	X		2.7	5.9							X				
2-1		X	4:07	6/11/2015	229	GoVa	X	X	X		3.7	6.9							X				
2-1		X	4:08	6/11/2015	230	GoVa	X	X	X		4.8	8.2							X				
2-1		X	4:09	6/11/2015	232	GoVa	X	X	X		8.9	14.4							X				
2-1		X	4:09	6/11/2015	233	GoVa	X	X	X		4.9	4.9	X										

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													Emergence/Eclosure Substrate										
Site-Trans*	Qual	Quant	Time	Date	ID	Species	Collect	Photo	Exuv	Tene	CrawlH	CrawlD	Silt	Sand	Grav	LRock	Root	CWood	Tree	Herb	AqHerb	Leaf	Detr
2-1		X	4:09	6/11/2015	234	GoVa	X	X	X		0.8	1.0					X						
2-1		X	4:10	6/11/2015	236	GoVa	X	X	X		5.9	8.5							X				
2-1		X	4:10	6/11/2015	237	GoVa	X	X	X		4.1	5.6	X										
2-1		X	4:10	6/11/2015	238	GoVa	X	X	X		4.8	5.4	X										
2-1		X	4:10	6/11/2015	239	GoVa	X	X	X		5.3	6.2	X										
2-1		X	4:10	6/11/2015	240	GoVa	X	X	X		5.8	7.1	X										
2-1		X	4:11	6/11/2015	242	GoVa	X	X	X		6.9	9.5					X						
2-1		X	4:11	6/11/2015	243	GoVa	X	X	X		6.7	9.2					X						
2-1		X	4:11	6/11/2015	244	GoVa	X	X	X		6.6	9.0	X										
2-1		X	4:11	6/11/2015	245	GoVa	X	X	X		7.7	10.5					X						
2-1		X	4:11	6/11/2015	246	GoVa	X	X	X		7.9	11.2					X						
2-1		X	4:12	6/11/2015	247	GoVa	X	X	X		7.8	10.8					X						
2-1		X	4:12	6/11/2015	248	GoVa	X	X	X		7.9	10.8					X						
2-1		X	4:12	6/11/2015	249	GoVa	X	X	X		8.0	11.0					X						
2-1		X	4:12	6/11/2015	250	GoVa	X	X	X		7.8	11.5					X						
2-1		X	4:15	6/11/2015	251	GoVa	X	X	X		8.1	12.0					X						
2-1		X	4:15	6/11/2015	252	GoVa	X	X	X		9.4	14.8	X										
2-1		X	4:15	6/11/2015	253	GoVa	X	X	X		9.8	15.7	X										
2-1		X	4:16	6/11/2015	254	GoVa	X	X	X		7.9	11.5					X						
2-2		X	3:29	6/11/2015	214	GoVa	X	X	X		0.0	0.5					X						
2-2		X	3:29	6/11/2015	215	GoVa	X	X	X		1.8	0.8					X						
2-2		X	3:30	6/11/2015	216	GoVa	X	X	X		2.2	2.6							X				
2-2		X	3:31	6/11/2015	218	GoVa	X	X	X		2.2	1.6	X										
2-2		X	3:31	6/11/2015	219	GoVa	X	X	X		5.0	7.1	X										
2-2		X	3:31	6/11/2015	220	GoVa	X	X	X		6.9	8.9	X										
2-2		X	3:34	6/11/2015	221	GoVa	X	X	X		8.0	11.3	X										
2-2		X	3:35	6/11/2015	222	GoVa	X	X	X		8.0	11.4	X										
2-2		X	3:36	6/11/2015	223	GoVa	X	X	X		7.9	11.5					X						
2-2		X	3:40	6/11/2015	224	GoVa	X	X	X		8.3	12.1							X				
1-3		X	10:20	6/10/2015	84	GoVa	X	X	X		4.2	9.8			X								
2-3		X	3:03	6/11/2015	203	GoVa	X	X	X		0.0	0.7	X										
2-3		X	3:05	6/11/2015	205	GoVa	X	X	X		4.0	7.2	X										
2-3		X	3:06	6/11/2015	207	GoVa	X	X	X		4.6	7.7	X										

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													Emergence/Eclosure Substrate										
Site-Trans*	Qual	Quant	Time	Date	ID	Species	Collect	Photo	Exuv	Tene	CrawlH	CrawlD	Silt	Sand	Grav	LRock	Root	CWood	Tree	Herb	AqHerb	Leaf	Detr
2-3		X	3:07	6/11/2015	208	GoVa	X	X	X		4.6	7.7	X										
2-3		X	3:07	6/11/2015	209	GoVa	X	X	X		6.2	10.8	X										
2-3		X	3:08	6/11/2015	210	GoVa	X	X	X		8.7	14.8	X										
2-3		X	3:09	6/11/2015	211	GoVa	X	X	X		9.5	17.1	X										
2-3		X	3:09	6/11/2015	212	GoVa	X	X	X		10.0	18.7	X										
2-3		X	3:15	6/11/2015	213	GoVa	X	X	X		2.0	4.3	X										
1-4		X	11:54	6/10/2015	113	GoVa	X	X	X		5.2	16.6							X				
1-4		X	11:57	6/10/2015	114	GoVa	X	X	X		4.9	17.7	X										
1-4		X	12:03	6/10/2015	115	GoVa	X	X	X		8.5	23.3	X										
4-4		X	10:29	6/11/2015	116	GoVa	X		X		3.9	11.2					X						
4-4		X	10:30	6/11/2015	117	GoVa	X		X		3.8	10.8		X									
2-4		X	2:20	6/11/2015	186	GoVa	X	X	X		2.3	3.0					X						
2-4		X	2:20	6/11/2015	188	GoVa	X	X	X		2.8	3.3	X										
2-4		X	2:20	6/11/2015	189	GoVa	X	X	X		3.0	3.6	X										
2-4		X	2:21	6/11/2015	190	GoVa	X	X	X		4.1	4.9	X										
2-4		X	2:21	6/11/2015	191	GoVa	X	X	X		3.5	5.6	X										
2-4		X	2:21	6/11/2015	192	GoVa	X	X	X		3.8	6.1	X										
2-4		X	2:21	6/11/2015	193	GoVa	X	X	X		4.8	6.6	X										
2-4		X	2:22	6/11/2015	194	GoVa	X	X	X		5.4	7.5					X						
2-4		X	2:22	6/11/2015	195	GoVa	X	X	X		4.8	5.6					X						
2-4		X	2:22	6/11/2015	196	GoVa	X	X	X		5.5	8.5					X						
2-4		X	2:23	6/11/2015	197	GoVa	X	X	X		5.6	8.7					X						
2-4		X	2:24	6/11/2015	198	GoVa	X	X	X		6.5	9.5	X										
2-4		X	2:25	6/11/2015	199	GoVa	X	X	X		7.7	10.8							X				
2-4		X	2:25	6/11/2015	200	GoVa	X	X	X		7.1	11.2	X										
2-4		X	2:26	6/11/2015	201	GoVa	X	X	X		8.6	12.8					X						
2-4		X	2:27	6/11/2015	202	GoVa	X	X	X		9.8	14.4	X										
3-4		X	11:40	6/12/2015	256	GoVa	X	X	X		7.1	10.2								X			
1-5		X	11:18	6/10/2015	91	GoVa	X	X	X		4.6	10.2	X										
1-5		X	11:18	6/10/2015	92	GoVa	X	X	X		4.6	10.2	X										
1-5		X	11:18	6/10/2015	93	GoVa	X	X	X		4.6	10.5	X										
1-5		X	11:18	6/10/2015	94	GoVa	X	X	X		5.8	12.1	X										
1-5		X	11:18	6/10/2015	95	GoVa	X	X	X		6.1	13.1	X										

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													Emergence/Eclosure Substrate										
Site-Trans*	Qual	Quant	Time	Date	ID	Species	Collect	Photo	Exuv	Tene	CrawlH	CrawlD	Silt	Sand	Grav	LRock	Root	CWood	Tree	Herb	AqHerb	Leaf	Detr
1-5		X	11:19	6/10/2015	96	GoVa	X	X	X		7.0	13.1	X										
1-5		X	11:19	6/10/2015	97	GoVa	X	X	X		7.3	14.1							X				
1-5		X	11:19	6/10/2015	98	GoVa	X	X	X		7.3	13.1							X				
1-5		X	11:19	6/10/2015	99	GoVa	X	X	X		9.1	15.1							X				
1-5		X	11:19	6/10/2015	100	GoVa	X	X	X		9.3	15.1							X				
1-5		X	11:20	6/10/2015	101	GoVa	X	X	X		8.6	14.4							X				
1-5		X	11:20	6/10/2015	102	GoVa	X	X	X		10.8	18.7							X				
1-5		X	11:20	6/10/2015	103	GoVa	X	X	X		9.1	16.1							X				
1-5		X	11:20	6/10/2015	104	GoVa	X	X	X		10.4	16.4							X				
1-5		X	11:20	6/10/2015	105	GoVa	X	X	X		11.3	18.7							X				
1-5		X	11:21	6/10/2015	106	GoVa	X	X	X		13.1	20.0							X				
1-5		X	11:22	6/10/2015	107	GoVa	X	X	X		7.1	13.1							X				
1-5		X	11:25	6/10/2015	108	GoVa	X	X	X		9.0	15.4							X				
1-5		X	11:27	6/10/2015	109	GoVa	X	X	X		8.8	15.4							X				
1-5		X	11:34	6/10/2015	110	GoVa	X	X	X		11.3	18.7							X				
1-5		X	11:34	6/10/2015	111	GoVa	X	X	X		9.8	15.7							X				
1-5		X	11:35	6/10/2015	112	GoVa	X	X	X		4.8	9.8	X										
4-5		X	11:00	6/11/2015	119	GoVa	X	X	X		3.5	1.3	X										
4-5		X	11:00	6/11/2015	120	GoVa	X	X	X		3.7	4.4							X				
4-5		X	11:02	6/11/2015	121	GoVa	X	X	X		7.2	2.1	X										
4-5		X	11:05	6/11/2015	122	GoVa	X	X	X		7.5	8.7								X			
2-5		X	1:30	6/11/2015	156	GoVa	X	X	X		1.5	3.0	X										
2-5		X	1:30	6/11/2015	157	GoVa	X	X	X		1.6	3.3	X										
2-5		X	1:31	6/11/2015	158	GoVa	X	X	X		0.6	2.0	X										
2-5		X	1:31	6/11/2015	159	GoVa	X	X	X		1.7	3.0	X										
2-5		X	1:32	6/11/2015	160	GoVa	X	X	X		2.4	4.6	X										
2-5		X	1:32	6/11/2015	161	GoVa	X	X	X		5.6	8.2					X						
2-5		X	1:32	6/11/2015	162	GoVa	X	X	X		4.6	7.4								X			
2-5		X	1:32	6/11/2015	163	GoVa	X	X	X		4.6	7.4					X						
2-5		X	1:32	6/11/2015	164	GoVa	X	X	X		3.8	7.2	X										
2-5		X	1:32	6/11/2015	165	GoVa	X	X	X		4.1	7.9	X										
2-5		X	1:32	6/11/2015	166	GoVa	X	X	X		4.2	8.0	X										
2-5		X	1:33	6/11/2015	167	GoVa	X	X	X		4.6	8.5					X						

*Exuvia/tenerals found during qualitative searches outside of transects are listed as X-Site, with X referring to site number (1-5).

													Emergence/Eclosure Substrate										
Site-Trans*	Qual	Quant	Time	Date	ID	Species	Collect	Photo	Exuv	Tene	CrawlH	CrawlD	Silt	Sand	Grav	LRock	Root	CWood	Tree	Herb	AqHerb	Leaf	Detr
2-5		X	1:33	6/11/2015	168	GoVa	X	X	X		6.1	9.2					X						
2-5		X	1:33	6/11/2015	169	GoVa	X	X	X		5.6	9.2								X			
2-5		X	1:34	6/11/2015	171	GoVa	X	X	X		6.2	9.5	X										
2-5		X	1:35	6/11/2015	172	GoVa	X	X	X		6.8	10.2	X										
2-5		X	1:35	6/11/2015	173	GoVa	X	X	X		6.6	9.8					X						
2-5		X	1:35	6/11/2015	174	GoVa	X	X	X		6.4	10.0					X						
2-5		X	1:35	6/11/2015	175	GoVa	X	X	X		6.6	9.8	X										
2-5		X	1:35	6/11/2015	176	GoVa	X	X	X		7.6	10.5	X										
2-5		X	1:35	6/11/2015	177	GoVa	X	X	X		6.8	10.2					X						
2-5		X	1:36	6/11/2015	178	GoVa	X	X	X		8.1	11.8	X										
2-5		X	1:36	6/11/2015	179	GoVa	X	X	X		9.4	13.6	X										
2-5		X	1:36	6/11/2015	180	GoVa	X	X	X		9.3	13.8	X										
2-5		X	1:36	6/11/2015	181	GoVa	X	X	X		9.4	13.8	X										
2-5		X	1:37	6/11/2015	183	GoVa	X	X	X		9.8	14.3					X						
2-5		X	1:38	6/11/2015	184	GoVa	X	X	X		10.3	14.6					X						
2-5		X	1:38	6/11/2015	185	GoVa	X	X	X		10.6	14.6					X						
1-6		X	10:40	6/10/2015	85	GoVa	X	X	X		9.3	13.6							X				
1-6		X	10:40	6/10/2015	86	GoVa	X	X	X		9.5	17.1	X										
1-6		X	10:42	6/10/2015	88	GoVa	X	X	X		11.7	19.9	X										
1-6		X	10:43	6/10/2015	89	GoVa	X	X	X		12.3	20.3	X										
1-6		X	10:43	6/10/2015	90	GoVa	X	X	X		12.3	20.3	X										
4-6		X	11:22	6/11/2015	124	GoVa	X	X	X		3.3	1.3	X										
4-6		X	11:22	6/11/2015	125	GoVa	X	X	X		4.4	2.6								X			
4-6		X	11:25	6/11/2015	128	GoVa	X	X	X		6.4	4.4				X							
4-6		X	11:26	6/11/2015	129	GoVa	X	X	X		7.3	6.1				X							
4-6		X	11:28	6/11/2015	131	GoVa	X	X	X		8.5	8.7				X							
4-6		X	11:32	6/11/2015	132	GoVa	X	X	X		6.2	3.8							X				
2-6		X	12:41	6/11/2015	133	GoVa	X	X	X		0.2	0.5	X										
2-6		X	12:41	6/11/2015	134	GoVa	X	X	X		0.2	0.2					X						
2-6		X	12:41	6/11/2015	135	GoVa	X	X	X		0.3	0.7					X						
2-6		X	12:42	6/11/2015	137	GoVa	X	X	X		1.7	2.0	X										
2-6		X	12:42	6/11/2015	138	GoVa	X	X	X		1.9	3.0	X										
2-6		X	12:43	6/11/2015	139	GoVa	X	X	X		2.5	3.0	X										

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													Emergence/Eclosure Substrate										
Site-Trans*	Qual	Quant	Time	Date	ID	Species	Collect	Photo	Exuv	Tene	CrawlH	CrawlD	Silt	Sand	Grav	LRock	Root	CWood	Tree	Herb	AqHerb	Leaf	Detr
2-6		X	12:43	6/11/2015	140	GoVa	X	X	X		2.4	3.1	X										
2-6		X	12:44	6/11/2015	141	GoVa	X	X	X		2.9	3.4	X										
2-6		X	12:44	6/11/2015	142	GoVa	X	X	X		3.1	3.6	X										
2-6		X	12:45	6/11/2015	143	GoVa	X	X	X		3.1	3.6	X										
2-6		X	12:48	6/11/2015	144	GoVa	X	X	X		5.8	6.1							X				
2-6		X	12:48	6/11/2015	145	GoVa	X	X	X		5.8	6.2							X				
2-6		X	12:48	6/11/2015	147	GoVa	X	X	X		3.4	6.6	X										
2-6		X	12:49	6/11/2015	148	GoVa	X	X	X		4.4	7.7	X										
2-6		X	12:49	6/11/2015	149	GoVa	X	X	X		4.6	7.9	X										
2-6		X	12:49	6/11/2015	150	GoVa	X	X	X		4.7	7.5	X										
2-6		X	12:50	6/11/2015	151	GoVa	X	X	X		4.9	7.7	X										
2-6		X	12:50	6/11/2015	152	GoVa	X	X	X		6.1	10.2	X										
2-6		X	12:51	6/11/2015	153	GoVa	X	X	X		7.3	12.0	X										
2-6		X	12:51	6/11/2015	154	GoVa	X	X	X		7.3	12.1	X										
2-6		X	12:52	6/11/2015	155	GoVa	X	X	X		8.0	13.3	X										
1-4		X	12:25	6/20/2015	304	GoVa	X	X	X		3.9	19.2	X										
1-4		X	12:26	6/20/2015	305	GoVa	X	X	X		4.0	19.3	X										
1-4		X	12:27	6/20/2015	306	GoVa	X	X	X		4.0	19.3	X										
1-4		X	12:27	6/20/2015	307	GoVa	X	X	X		4.0	19.5	X										
1-4		X	12:21	6/20/2015	309	GoVa	X	X	X		6.5	27.9	X										
1-4		X	12:22	6/20/2015	310	GoVa	X	X	X		12.0	37.1					X						
1-4		X	12:32	6/20/2015	312	GoVa	X	X	X		12.0	37.1	X										
1-4		X	12:33	6/20/2015	313	GoVa	X	X	X		11.8	36.4	X										
1-4		X	12:33	6/20/2015	314	GoVa	X	X	X		11.5	35.8	X										
4-4		X	10:44	6/22/2015	317	GoVa	X	X	X		5.5	25.3								X			
3-4		X	1:18	6/22/2015	324	GoVa	X	X	X		11.0	16.7								X			
2-4		X	10:05	6/23/2015	329	GoVa	X	X	X		1.0	1.0	X										
2-4		X	10:13	6/23/2015	330	GoVa	X	X	X		1.3	6.9					X						
1-5		X	11:41	6/20/2015	289	GoVa	X	X	X		7.6	17.7	X										
1-5		X	11:41	6/20/2015	290	GoVa	X	X	X		8.9	19.9	X										
1-5		X	11:44	6/20/2015	291	GoVa	X	X	X		8.6	19.2	X										
1-5		X	11:44	6/20/2015	292	GoVa	X	X	X		9.2	20.0	X										
1-5		X	11:44	6/20/2015	293	GoVa	X	X	X		12.6	24.1	X										

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													Emergence/Eclosure Substrate										
Site-Trans*	Qual	Quant	Time	Date	ID	Species	Collect	Photo	Exuv	Tene	CrawlH	CrawlD	Silt	Sand	Grav	LRock	Root	CWood	Tree	Herb	AqHerb	Leaf	Detr
1-5		X	11:44	6/20/2015	294	GoVa	X	X	X		12.6	24.3	X										
1-5		X	11:44	6/20/2015	295	GoVa	X	X	X		12.8	25.1	X										
1-5		X	11:44	6/20/2015	296	GoVa	X	X	X		13.5	26.9	X										
1-5		X	11:45	6/20/2015	297	GoVa	X	X	X		13.6	27.1	X										
1-5		X	11:45	6/20/2015	298	GoVa	X	X	X		13.8	28.4	X										
1-5		X	11:46	6/20/2015	299	GoVa	X	X	X		12.6	24.4	X										
1-5		X	11:46	6/20/2015	300	GoVa	X	X	X		12.7	24.8	X										
1-5		X	11:47	6/20/2015	301	GoVa	X	X	X		12.8	25.1	X										
1-5		X	11:48	6/20/2015	302	GoVa	X	X	X		12.8	25.3	X										
1-5		X	11:49	6/20/2015	303	GoVa	X	X	X		12.8	25.4								X			
2-5		X	10:30	6/23/2015	331	GoVa	X	X	X	X	6.3	7.5	X										
2-5		X	10:25	6/23/2015	332	GoVa	X	X	X		4.0	4.6	X										
2-5		X	10:35	6/23/2015	333	GoVa	X	X	X		9.5	11.8								X			
2-5		X	10:35	6/23/2015	334	GoVa	X	X	X		9.5	12.0								X			
2-5		X	10:36	6/23/2015	335	GoVa	X	X	X		9.6	12.3						X					
2-5		X	10:37	6/23/2015	336	GoVa	X	X	X		9.7	12.8					X						
2-5		X	10:38	6/23/2015	337	GoVa	X	X	X		9.7	12.8					X						
2-5		X	10:54	6/23/2015	339	GoVa	X	X	X		12.6	5.6							X				
2-5		X	10:54	6/23/2015	340	GoVa	X	X	X		8.3	10.5							X				
1-6		X	11:20	6/20/2015	283	GoVa	X	X	X		11.8	24.8	X										
1-6		X	11:21	6/20/2015	284	GoVa	X	X	X		13.0	26.9	X										
1-6		X	11:25	6/20/2015	285	GoVa	X	X	X		13.3	27.6	X										
1-6		X	11:26	6/20/2015	286	GoVa	X	X	X		13.6	27.9	X										
1-6		X	11:27	6/20/2015	287	GoVa	X	X	X		14.9	29.5	X										
1-6		X	11:30	6/20/2015	288	GoVa	X	X	X		15.1	30.2	X										
1-1		X	8:31	7/7/2015	363	GoVa	X	X	X		10.3	21.7					X						
2-4		X	11:43	7/6/2015	355	GoVa	X	X	X		12.0	26.6	X										
1-4		X	11:02	7/7/2015	385	GoVa	X	X	X		10.6	28.5					X						
1-4		X	11:04	7/7/2015	386	GoVa	X	X	X		10.9	28.9	X										
1-4		X	11:05	7/7/2015	387	GoVa	X	X	X		11.1	29.9					X						
1-4		X	11:08	7/7/2015	388	GoVa	X	X	X		8.9	26.9	X										
2-5		X	12:08	7/6/2015	356	GoVa	X	X	X		10.0	25.3					X						
2-6		X	12:31	7/6/2015	359	GoVa	X	X	X		7.4	16.7							X				

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													Emergence/Eclosure Substrate										
Site-Trans*	Qual	Quant	Time	Date	ID	Species	Collect	Photo	Exuv	Tene	CrawlH	CrawlD	Silt	Sand	Grav	LRock	Root	CWood	Tree	Herb	AqHerb	Leaf	Detr
4-6		X	11:48	7/9/2015	418	GoVa	X	X	X		4.7	11.5										X	
4-6		X	11:48	7/9/2015	419	GoVa	X	X	X		4.8	11.6										X	
4-6		X	11:49	7/9/2015	420	GoVa	X	X	X		4.8	11.6										X	
4-6		X	11:49	7/9/2015	421	GoVa	X	X	X		4.9	11.8										X	
4-4		X	9:59	7/20/2015	440	GoVa	X	X	X		10.4	36.4							X				
2-5		X	10:16	7/21/2015	474	GoVa	X	X	X		3.8	11.3	X				X						
1-Site	X		11:53	7/18/2015	433	GoVa	X	X		X	8.2	30.8							X				
2-4		X	11:18	8/4/2015	533	GoVa	X	X	X		3.2	14.4							X				
2-5		X	11:52	8/4/2015	534	GoVa	X	X	X		12.7	29.5	X										
2-6		X	12:45	8/4/2015	538	GoVa	X	X	X		6.8	17.7	X										
3-2		X	12:34	6/22/2015	319	HaBr	X	X	X		0.1	0.5	X										
1-4		X	12:28	6/20/2015	308	HaBr	X	X	X		4.4	21.3	X										
1-2		X	9:02	7/7/2015	373	HaBr	X	X	X		10.8	20.0	X										
2-4		X	11:30	7/6/2015	354	HaBr	X	X	X		7.3	20.3	X										
5-2		X	11:09	7/8/2015	403	Lisp	X	X	X		2.2	18.4									X		
5-Site	X		10:27	7/2/2015	347	Lisp	X	X		X	0.5	11.5		X									
5-3		X	9:59	7/25/2015	504	Lisp	X	X	X		3.2	9.2								X			
5-3		X	10:05	7/25/2015	506	Lisp	X	X	X		5.9	13.6										X	
5-3		X	12:15	8/18/2015	607	Lisp	X	X	X		4.0	11.8								X			
5-3		X	12:32	8/18/2015	609	Lisp	X	X	X		5.4	14.3								X			
5-1		X	11:32	7/8/2015	404	Li	X	X	X		4.1	4.3									X		
5-1		X	11:35	7/8/2015	406	Li	X	X	X		3.5	3.6									X		
5-1		X	11:40	7/8/2015	407	Li	X	X	X		2.4	3.8									X		
5-2		X	10:54	7/8/2015	397	Li	X	X	X		2.5	4.3									X		
5-2		X	10:54	7/8/2015	399	Li	X	X	X		3.1	7.9									X		
5-Site	X		9:36	7/2/2015	346	Li	X	X		X	6.6	4.3								X			
5-3		X	9:55	7/25/2015	502	Li	X	X	X		1.5	7.4								X			
5-2		X	11:31	8/5/2015	557	Li	X	X	X		3.0	10.8									X		
5-2		X	11:46	8/5/2015	558	Li	X	X	X		1.4	21.7	X								X		X
5-2		X	11:44	8/5/2015	559	Li	X	X	X		1.8	24.9						X			X		X
5-3		X	9:52	8/5/2015	542	Li	X	X	X		2.8	12.8								X			X
5-3		X	9:56	8/5/2015	546	Li	X	X	X		2.7	13.0											X
5-6		X	12:49	6/8/2015	79	Mall	X	X	X		3.7	9.5				X							

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													Emergence/Eclosure Substrate										
Site-Trans*	Qual	Quant	Time	Date	ID	Species	Collect	Photo	Exuv	Tene	CrawlH	CrawlD	Silt	Sand	Grav	LRock	Root	CWood	Tree	Herb	AqHerb	Leaf	Detr
3-2		X	12:35	6/22/2015	320	Mall	X	X	X		0.2	1.3	X										
3-2		X	12:41	6/22/2015	321	Mall	X	X	X		1.0	5.9	X										
3-3		X	12:58	6/22/2015	322	Mall	X	X	X		3.3	5.7	X										
3-4		X	1:19	6/22/2015	325	Mall	X	X	X		11.1	17.1								X			
1-3		X	9:30	7/7/2015	374	Mall	X	X	X		7.0	10.5			X								
4-2		X	9:20	7/20/2015	439	Mall	X	X	X		7.7	35.8	X										
2-4		X	9:51	7/21/2015	467	Mall	X	X	X		2.9	5.2	X										
1-4		X	1:59	7/21/2015	501	Mall	X	X	X		5.5	15.4	X							X			
4-6		X	10;39	7/20/2015	442	Mall	X	X	X		12.9	19.9				X							
3-2		X	1:19	8/3/2015	523	Mall	X	X	X		6.9	3.3								X			
3-6		X	2:47	8/3/2015	529	Mall	X	X	X		8.1	31.5	X	X									
1-3		X	11:29	8/20/2015	627	Mall	X	X	X		11.7	26.7											X
2-3		X	12:15	9/1/2015	630	Mall	X	X	X		17.5	43.3								X			
2-3		X	3:04	6/11/2015	204	NeYa	X	X	X		2.7	5.1						X					
3-3		X	11:16	6/12/2015	255	NeYa	X	X	X		4.2	3.9							X				
2-4		X	2:20	6/11/2015	187	NeYa	X	X	X		2.7	3.1	X										
5-5		X	12:28	6/8/2015	78	NeYa	X	X	X		1.7	8.2				X							
2-5		X	1:34	6/11/2015	170	NeYa	X	X	X		6.4	9.7								X			
2-5		X	1:37	6/11/2015	182	NeYa	X	X	X		9.8	14.3					X						
4-6		X	11:23	6/11/2015	126	NeYa	X	X	X		3.8	1.8				X							
2-6		X	12:42	6/11/2015	136	NeYa	X	X	X		0.2	0.7							X				
2-6		X	12:48	6/11/2015	146	NeYa	X	X	X		5.9	6.4							X				
3-6		X	12:10	6/12/2015	257	NeYa	X	X	X		6.8	20.0							X				
1-1		X	10:27	6/20/2015	282	NeYa	X	X	X		4.7	20.7	X										
2-2		X	9:34	6/23/2015	326	NeYa	X	X	X		1.1	1.6	X										
1-4		X	12:32	6/20/2015	311	NeYa	X	X	X		12.0	37.1	X										
4-4		X	10:40	6/22/2015	316	NeYa	X	X	X		8.9	28.5							X				
3-4		X	1:18	6/22/2015	323	NeYa	X	X	X		10.9	16.4								X			
2-5		X	10:53	6/23/2015	338	NeYa	X	X	X		4.5	0.8	X										
3-2		X	12:55	7/9/2015	427	NeYa	X	X	X		17.5	29.2				X							
5-4		X	12:21	7/8/2015	409	NeYa	X	X	X		1.7	8.0				X				X			
1-5		X	10:28	7/7/2015	382	NeYa	X	X	X		15.7	22.0							X				
4-6		X	11:49	7/9/2015	422	NeYa	X	X	X		5.2	12.1										X	

*Exuvia/tenerals found during qualitative searches outside of transects are listed as X-Site, with X referring to site number (1-5).

													Emergence/Eclosure Substrate										
Site-Trans*	Qual	Quant	Time	Date	ID	Species	Collect	Photo	Exuv	Tene	CrawlH	CrawlD	Silt	Sand	Grav	LRock	Root	CWood	Tree	Herb	AqHerb	Leaf	Detr
4-1		X	9:03	7/20/2015	438	NeYa	X	X	X		12.9	28.7							X				
4-6		X	10:40	7/20/2015	443	NeYa	X	X	X		5.6	12.1				X				X			
4-6		X	10:40	7/20/2015	444	NeYa	X	X	X		6.1	12.8								X			
2-1		X	1:27	5/30/2015	58	OpRu	X	X	X		1.5	6.9			X								
2-1		X	1:28	5/30/2015	59	OpRu	X	X	X		2.4	12.1	X										
2-2		X	12:57	5/30/2015	53	OpRu	X	X	X		0.9	3.6			X								
2-2		X	12:58	5/30/2015	54	OpRu	X	X	X		1.1	4.1			X								
2-2		X	12:58	5/30/2015	55	OpRu	X	X	X		1.2	5.2			X								
2-2		X	12:58	5/30/2015	56	OpRu	X	X	X	X	1.3	6.6			X								
2-2		X	1:09	5/30/2015	57	OpRu	X	X	X		3.5	18.7											
2-3		X	12:34	5/30/2015	51	OpRu	X	X	X	X	3.7	16.7								X		X	
2-3		X	12:38	5/30/2015	52	OpRu	X	X	X	X	4.7	28.5											
2-4		X	11:55	5/30/2015	46	OpRu	X	X	X	X	5.4	20.7	X										
2-4		X	12:00	5/30/2015	47	OpRu	X	X	X	X	3.3	8.5			X								
2-4		X	12:01	5/30/2015	48	OpRu	X	X	X	X	3.5	11.5	X										
2-4		X	12:02	5/30/2015	49	OpRu	X	X	X	X	4.0	13.5	X										
2-4		X	12:02	5/30/2015	50	OpRu	X	X	X		4.2	14.8	X										
2-5		X	11:36	5/30/2015	42	OpRu	X	X	X		4.3	12.5	X										
1-5		X	4:08	5/30/2015	63	OpRu	X	X	X		0.8	4.6	X										
2-6		X	11:17	5/30/2015	41	OpRu		X	X	X	3.3	12.1						X					
1-6		X	3:53	5/30/2015	60	OpRu	X	X	X		0.4	0.0	X										
1-6		X	3:54	5/30/2015	61	OpRu	X	X	X		0.4	0.0	X										
1-1		X	9:35	6/10/2015	81	OpRu	X	X	X		5.8	11.2							X				
2-1		X	4:09	6/11/2015	231	OpRu	X	X	X		5.1	8.2	X										
2-1		X	4:10	6/11/2015	235	OpRu	X	X	X		1.1	2.0					X						
2-1		X	4:11	6/11/2015	241	OpRu	X	X	X		5.8	7.1	X										
2-3		X	3:05	6/11/2015	206	OpRu	X	X	X		3.7	7.1	X										
1-6		X	10:41	6/10/2015	87	OpRu	X	X	X		11.5	19.7	X										
5-2		X	8:55	6/19/2015	258	PeTe	X	X	X		1.5	1.3									X		
5-2		X	10:59	7/8/2015	402	PeTe	X	X	X		1.9	7.2									X		
5-4		X	12:21	7/8/2015	408	PeTe	X	X	X		0.9	4.6				X				X			
5-4		X	12:24	7/8/2015	412	PeTe	X	X	X		1.9	3.6				X				X			
5-4		X	12:24	7/8/2015	413	PeTe	X	X	X		1.9	2.8				X				X			

*Exuvia/tenerals found during qualitative searches outside of transects are listed as X-Site, with X referring to site number (1-5).

													Emergence/Eclosure Substrate										
Site-Trans*	Qual	Quant	Time	Date	ID	Species	Collect	Photo	Exuv	Tene	CrawlH	CrawlD	Silt	Sand	Grav	LRock	Root	CWood	Tree	Herb	AqHerb	Leaf	Detr
5-Site	X		9:20	7/2/2015	345	PeTe	X	X		X	4.6	5.2							X				
5-Site	X		9:55	7/2/2015	348	PeTe	X	X	X	X	2.5	3.3									X		
5-Site	X		9:57	7/2/2015	349	PeTe	X	X	X	X	2.8	3.6									X		
5-2		X	11:02	7/25/2015	509	PeTe	X	X	X		1.6	2.0									X		
5-2		X	11:08	7/25/2015	510	PeTe	X	X	X		0.3	3.6						X					
5-3		X	9:56	7/25/2015	503	PeTe	X	X	X		1.9	8.9											
5-5		X	11:40	7/25/2015	511	PeTe	X	X	X		2.2	7.1					X						
5-5		X	11:49	7/25/2015	512	PeTe	X	X	X		2.1	6.6								X			
5-3		X	9:50	8/5/2015	539	PeTe	X	X	X		2.1	9.2				X							
5-3		X	9:51	8/5/2015	540	PeTe	X	X	X		2.9	13.1											X
5-3		X	9:51	8/5/2015	541	PeTe	X	X	X		2.9	13.3											X
5-3		X	9:55	8/5/2015	543	PeTe	X	X	X		2.5	11.8											X
5-3		X	9:55	8/5/2015	544	PeTe	X	X	X		2.6	12.5				X							X
5-3		X	9:55	8/5/2015	545	PeTe	X	X	X		2.6	12.8			X								X
5-3		X	10:05	8/5/2015	547	PeTe	X	X	X		2.4	10.8				X							X
5-3		X	10:20	8/5/2015	552	PeTe	X	X	X		5.7	19.9										X	X
5-3		X	10:21	8/5/2015	554	PeTe	X	X	X		6.5	20.0										X	X
5-5		X	12:31	8/5/2015	562	PeTe	X	X	X		3.3	4.4				X							
5-3		X	12:05	8/18/2015	602	PeTe	X	X	X		1.7	7.9											X
5-4		X	2:04	8/18/2015	611	PeTe	X	X	X		2.8	2.3				X							
5-4		X	2:07	8/18/2015	612	PeTe	X	X	X		2.7	2.1				X				X			
5-5		X	2:29	8/18/2015	613	PeTe	X	X	X		1.4	6.7											X
1-4		X	10:58	7/7/2015	383	StAm	X	X		X	1.0	18.7	X										
1-5		X	10:24	7/7/2015	379	StAm	X	X	X		5.1	9.2	X										
2-6		X	12:32	7/6/2015	360	StAm	X	X	X		6.4	15.9	X										
1-6		X	10:08	7/7/2015	377	StAm	X	X	X		7.2	12.8	X										
3-Site	X		1:08	7/9/2015	429	StAm		X		X	2.5	1.1					X						
3-Site	X		2:10	7/9/2015	430	StAm		X		X	2.4	0.7					X						
3-1		X	11:25	7/20/2015	448	StAm	X	X	X		2.9	4.1	X							X			
3-4		X	12:23	7/20/2015	452	StAm	X	X	X		0.0	0.0					X						
3-3		X	1:36	8/3/2015	524	StAm	X	X	X		1.0	4.4	X										
3-2		X	1:04	7/9/2015	428	StSp		X	X		22.2	33.8				X							
2-3		X	11:20	7/6/2015	353	StSp	X	X	X		5.0	16.9	X										

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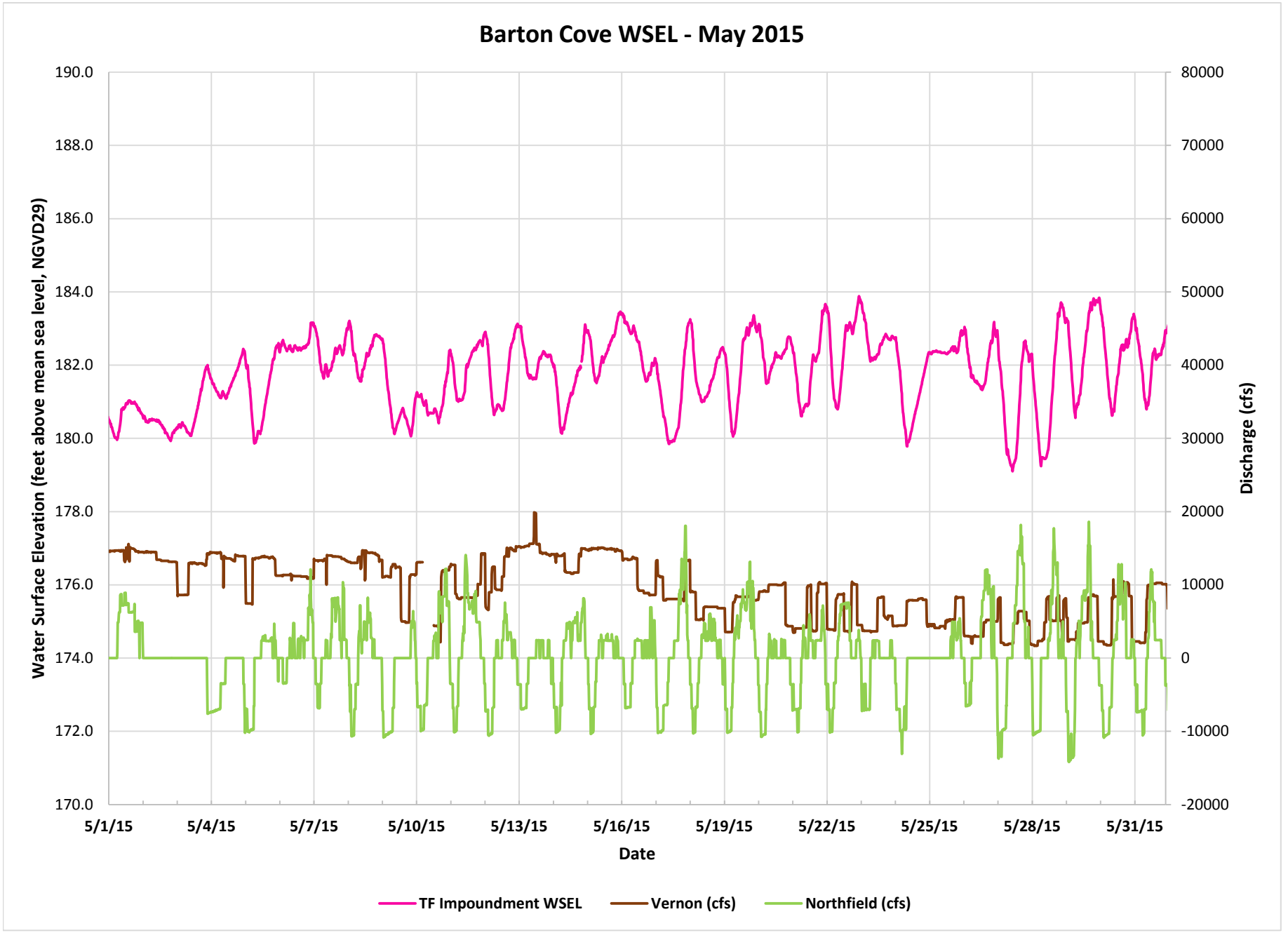
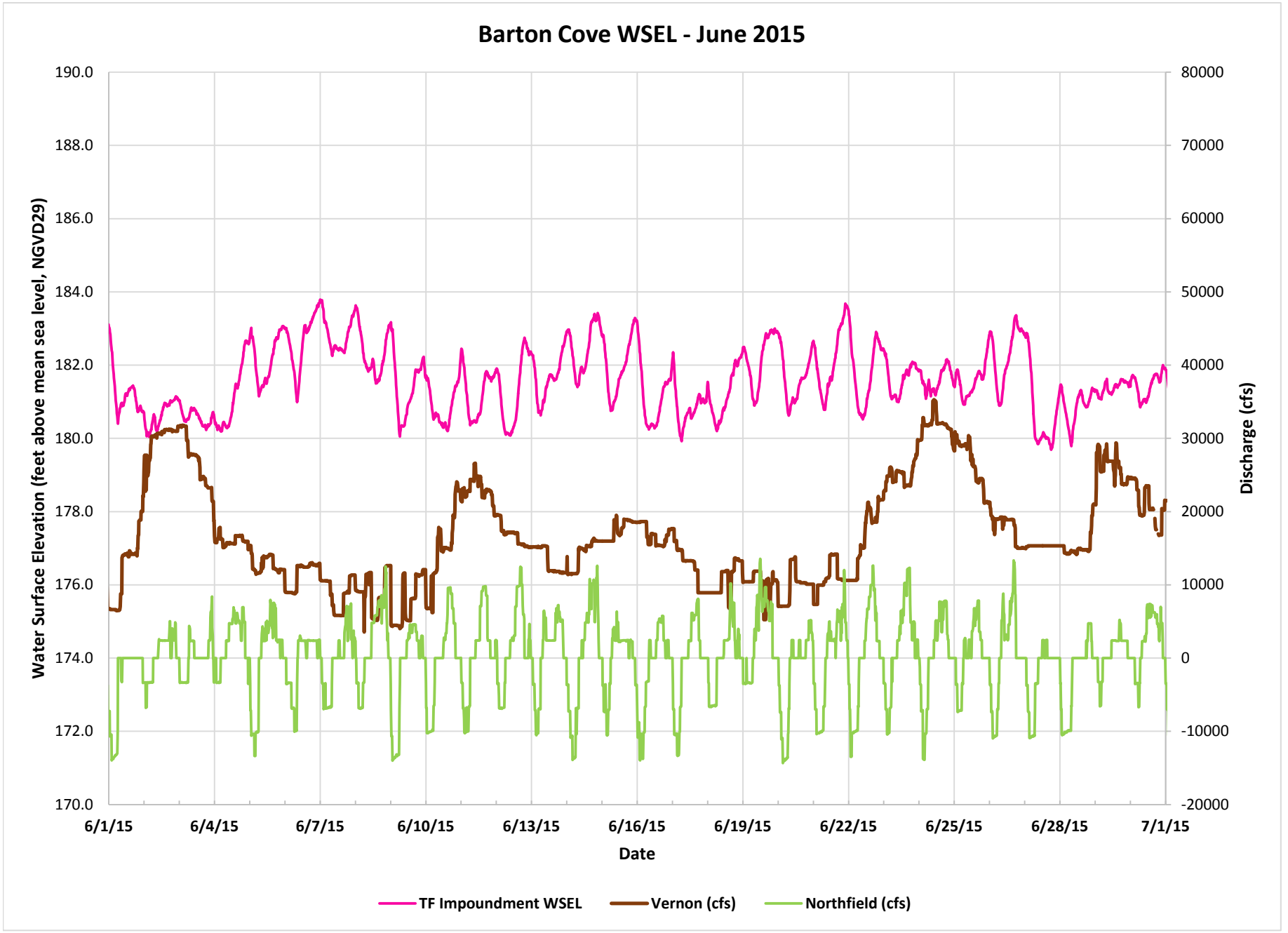
													Emergence/Eclosure Substrate										
Site-Trans*	Qual	Quant	Time	Date	ID	Species	Collect	Photo	Exuv	Tene	CrawlH	CrawlD	Silt	Sand	Grav	LRock	Root	CWood	Tree	Herb	AqHerb	Leaf	Detr
1-5		X	10:19	7/7/2015	378	StSp	X	X	X		8.7	13.8	X										
2-6		X	12:27	7/6/2015	357	StSp	X	X	X		7.0	17.4	X										
4-1		X	9:00	7/20/2015	437	StSp	X	X	X		7.4	19.7	X										
3-1		X	11:21	7/20/2015	446	StSp	X	X	X		0.2	0.3	X										
3-1		X	11:21	7/20/2015	447	StSp	X	X	X		2.3	29.5					X			X			
2-1		X	8:55	7/21/2015	454	StSp	X	X	X		0.4	1.5					X						
2-1		X	8:55	7/21/2015	455	StSp	X	X	X		0.7	2.5	X										
2-1		X	8:57	7/21/2015	457	StSp	X	X	X		0.3	1.8					X						
2-1		X	8:58	7/21/2015	458	StSp	X	X	X		0.0	0.0	X										
2-1		X	9:03	7/21/2015	459	StSp	X	X	X		0.9	1.8					X						
2-2		X	9:17	7/21/2015	461	StSp	X	X	X		0.1	1.0	X										
2-2		X	9:18	7/21/2015	462	StSp	X	X	X		2.2	4.1					X						
1-2		X	12:02	7/21/2015	485	StSp	X	X	X		2.1	3.8	X										
1-2		X	12:05	7/21/2015	486	StSp	X	X	X		4.2	7.5	X										
3-3		X	11:57	7/20/2015	450	StSp	X	X	X		2.5	3.9							X				
3-3		X	12:00	7/20/2015	451	StSp	X	X	X		2.4	3.0	X				X						
2-3		X	9:38	7/21/2015	464	StSp	X	X	X		3.8	7.9	X				X						
1-3		X	12:27	7/21/2015	489	StSp	X	X	X		0.2	1.0	X				X						
2-4		X	9:49	7/21/2015	465	StSp	X	X	X		1.3	2.1	X										
2-4		X	9:51	7/21/2015	468	StSp	X	X	X		3.3	6.1	X										
2-4		X	9:52	7/21/2015	469	StSp	X	X	X		5.8	11.5	X										
2-4		X	10:08	7/21/2015	471	StSp	X	X	X		11.3	16.6	X										
2-5		X	10:12	7/21/2015	472	StSp	X	X	X		1.9	6.1		X	X								
2-5		X	10:14	7/21/2015	473	StSp	X	X	X		3.4	10.7					X						
2-5		X	10:20	7/21/2015	475	StSp	X	X	X		13.3	24.1					X			X			
1-5		X	1:31	7/21/2015	498	StSp	X	X	X		0.2	0.8	X				X						
1-5		X	1:31	7/21/2015	499	StSp	X	X	X		0.4	1.0	X				X						
1-5		X	1:40	7/21/2015	500	StSp	X	X	X		8.0	12.0	X							X			
2-6		X	10:39	7/21/2015	476	StSp	X	X	X		0.1	0.1					X						
2-6		X	10:41	7/21/2015	477	StSp	X	X	X		1.1	1.8								X			
2-6		X	10:43	7/21/2015	478	StSp	X	X	X		2.5	3.9	X				X						
1-6		X	1:14	7/21/2015	496	StSp	X	X	X		5.2	8.8	X										
1-6		X	1:15	7/21/2015	497	StSp	X	X	X		5.3	9.0	X										

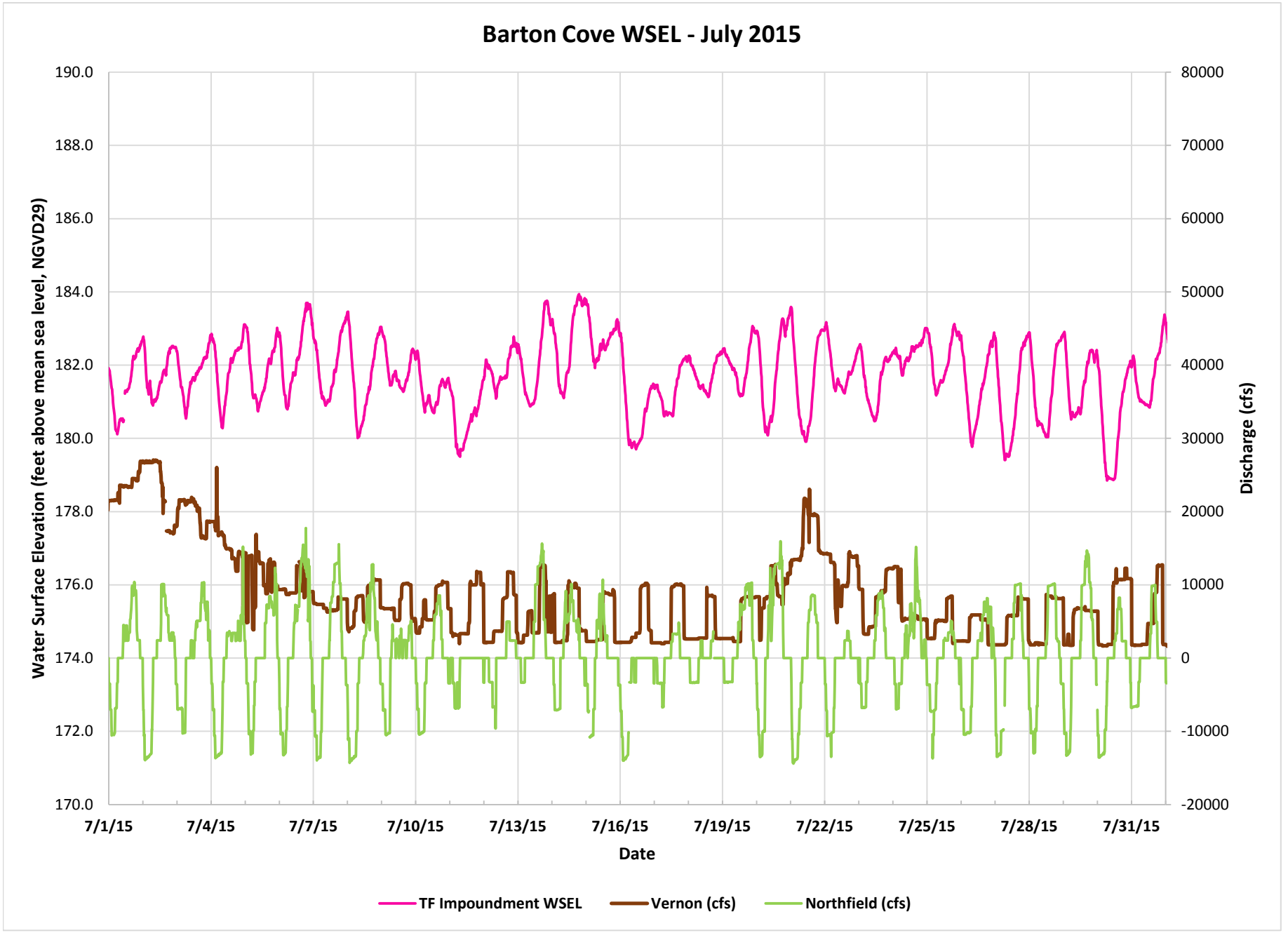
*Exuvia/tenerals found during qualitative searches outside of transects are listed as X-Site, with X referring to site number (1-5).

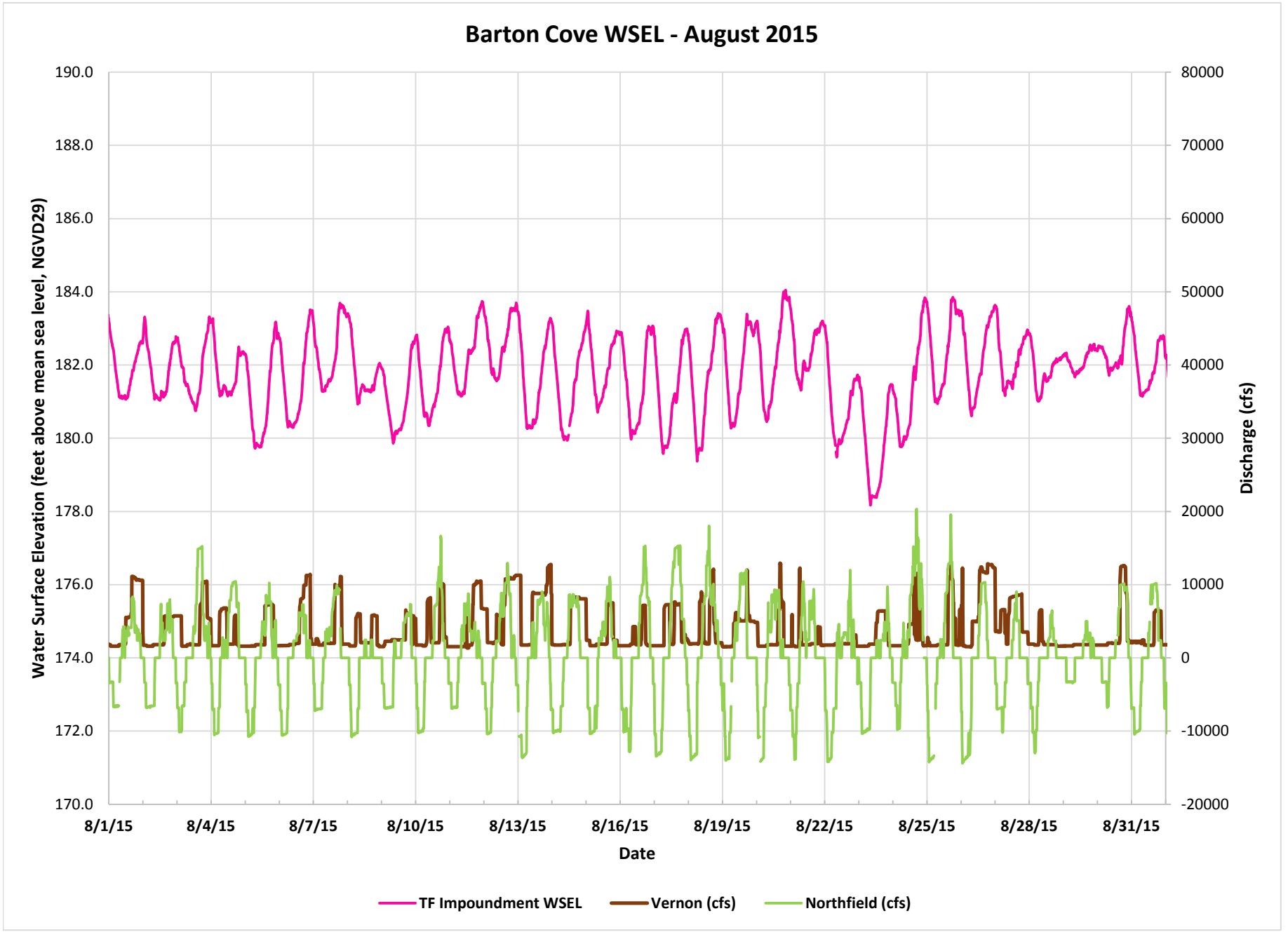
													Emergence/Eclosure Substrate										
Site-Trans*	Qual	Quant	Time	Date	ID	Species	Collect	Photo	Exuv	Tene	CrawlH	CrawlD	Silt	Sand	Grav	LRock	Root	CWood	Tree	Herb	AqHerb	Leaf	Detr
1-Site	X		12:01	7/18/2015	434	StSp	X	X		X	4.6	21.7	X							X			
1-Site	X		1:04	7/18/2015	435	StSp	X	X		X	5.9	26.9	X										
1-Site	X		1:50	7/18/2015	436	StSp	X	X		X	5.3	25.3	X										
4-1		X	10:25	8/3/2015	513	StSp	X	X	X		3.7	18.2	X										
4-1		X	10:26	8/3/2015	514	StSp	X	X	X		6.0	23.0	X										
4-1		X	10:28	8/3/2015	515	StSp	X	X	X		6.1	23.5	X										
1-1		X	2:14	8/5/2015	566	StSp	X	X	X		4.9	22.1	X										
1-1		X	2:35	8/5/2015	575	StSp	X	X	X		4.0	20.0	X				X						
4-2		X	10:56	8/3/2015	517	StSp	X	X	X		1.2	31.0	X										
2-2		X	10:27	8/4/2015	531	StSp	X	X	X		3.9	19.0					X						
1-2		X	3:18	8/5/2015	581	StSp	X	X	X		8.2	34.3	X										
3-3		X	1:37	8/3/2015	525	StSp	X	X	X		3.4	6.7					X						
3-3		X	1:37	8/3/2015	526	StSp	X	X	X		3.2	6.9	X				X						
2-3		X	10:53	8/4/2015	532	StSp	X	X	X		4.4	18.7	X										
1-3		X	4:14	8/5/2015	592	StSp	X	X	X		10.8	27.2	X		X								
1-4		X	5:31	8/5/2015	600	StSp	X	X	X		4.8	22.0								X			
3-5		X	2:21	8/3/2015	528	StSp	X	X	X		3.0	28.2	X				X						
2-5		X	12:06	8/4/2015	535	StSp	X	X	X		5.6	20.3					X						
1-5		X	5:00	8/5/2015	598	StSp	X	X	X		5.9	23.6					X			X			
1-5		X	5:04	8/5/2015	599	StSp	X	X	X		4.4	20.3	X				X			X			
2-6		X	12:25	8/4/2015	536	StSp	X	X	X		2.2	9.2					X						
2-6		X	12:32	8/4/2015	537	StSp	X	X	X		2.3	9.4					X						
1-6		X	4:37	8/5/2015	593	StSp	X	X	X		2.8	15.4	X										
1-6		X	4:41	8/5/2015	595	StSp	X	X	X		9.2	27.2	X										
1-6		X	4:43	8/5/2015	596	StSp	X	X	X		9.2	27.2	X										
1-2		X	11:11	8/20/2015	623	StSp	X	X	X		9.3	58.1	X										
3-6		X	3:16	8/19/2015	620	StSp	X	X	X		8.2	32.0	X										

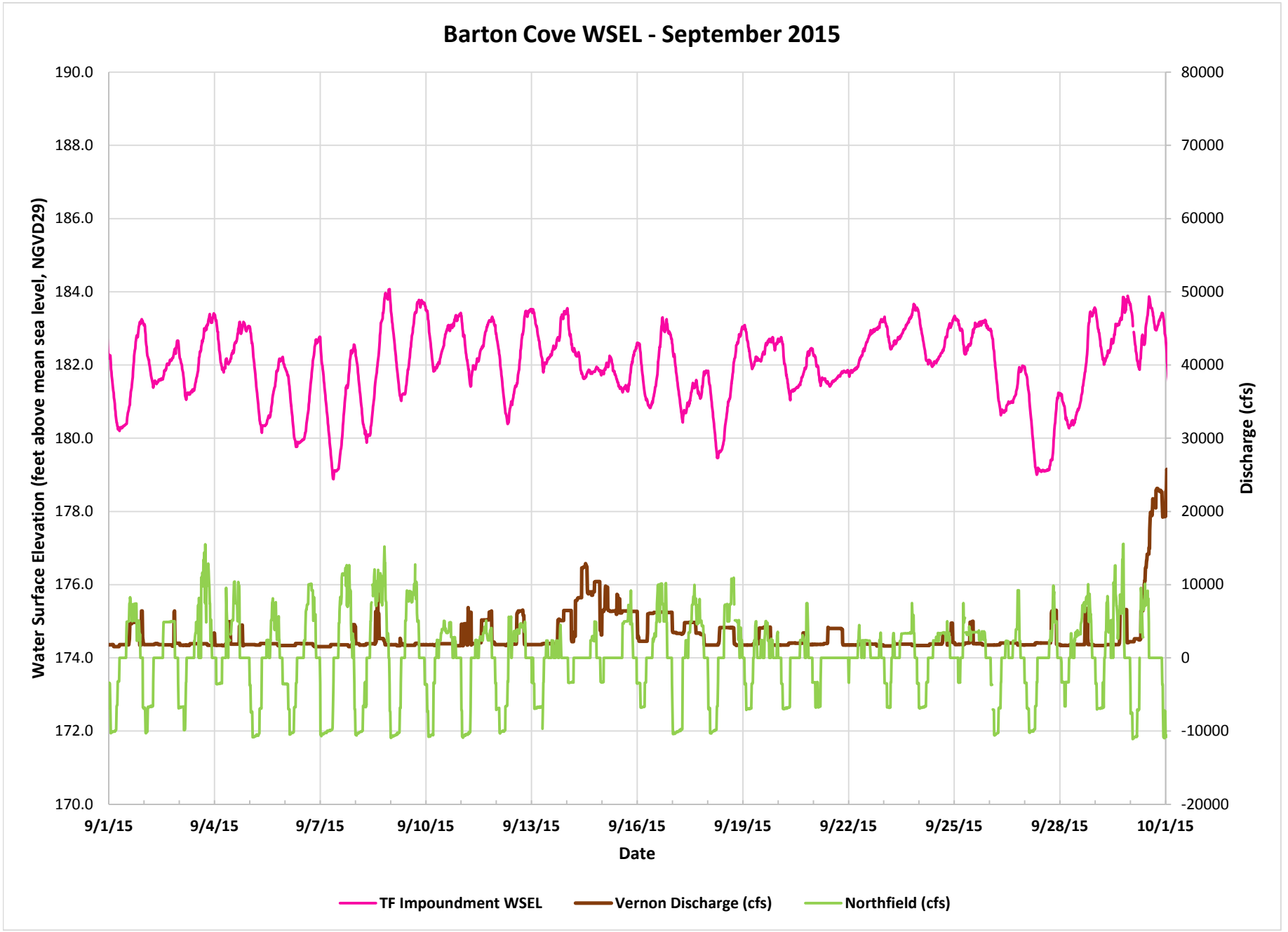
APPENDIX F
MONTHLY WATER LEVEL CHARTS FROM ALL SITES

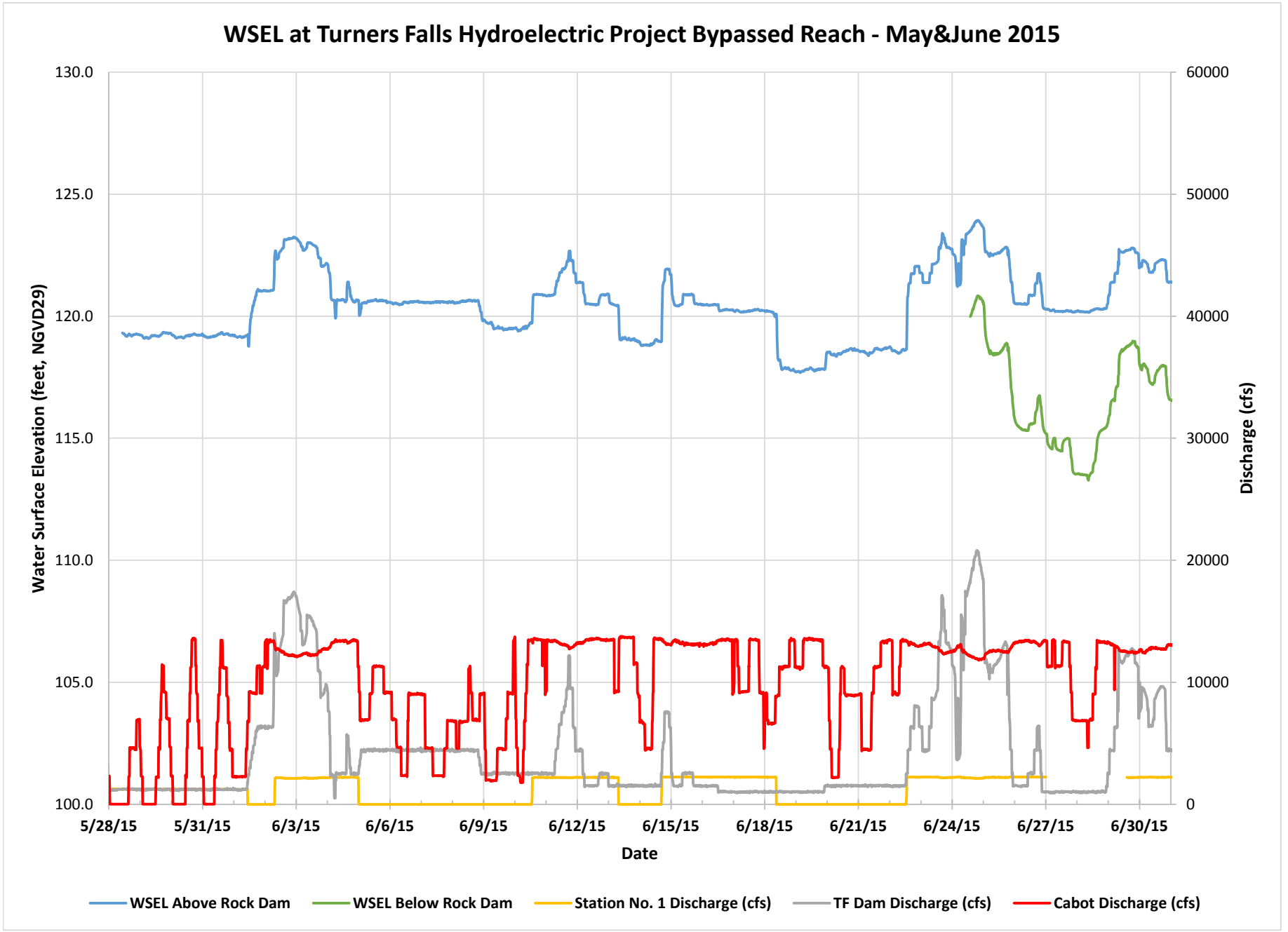

Barton Cove WSEL - May 2015
Water Surface Elevation (feet above mean sea level, NGVD29)
190.0
188.0
186.0
184.0
182.0
180.0
178.0
176.0
174.0
172.0
170.0
Discharge (cfs)
80000
70000
60000
50000
40000
30000
20000
10000
0
-10000
-20000
5/1/15
5/4/15
5/7/15
5/10/15
5/13/15
5/16/15
5/19/15
5/22/15
5/25/15
5/28/15
5/31/15
Date
TF Impoundment WSEL
Vernon (cfs)
Northfield (cfs)

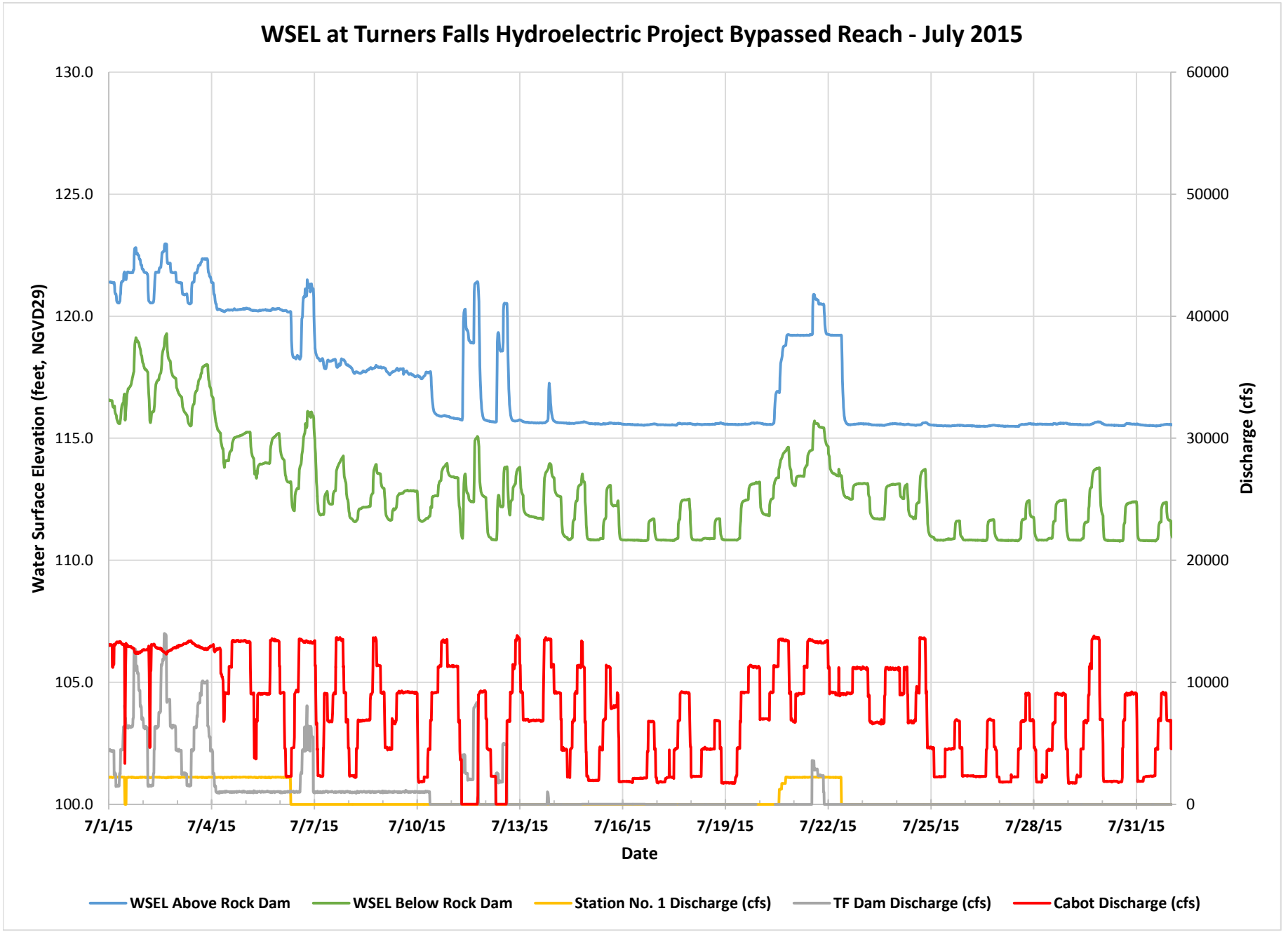

Barton Cove WSEL - June 2015
Water Surface Elevation (feet above mean sea level, NGVD29)
Discharge (cfs)
190.0
188.0
186.0
184.0
182.0
180.0
178.0
176.0
174.0
172.0
170.0
80000
70000
60000
50000
40000
30000
20000
10000
0
-10000
-20000
6/1/15
6/4/15
6/7/15
6/10/15
6/13/15
6/16/15
6/19/15
6/22/15
6/25/15
6/28/15
7/1/15
Date
TF Impoundment WSEL
Vernon (cfs)
Northfield (cfs)

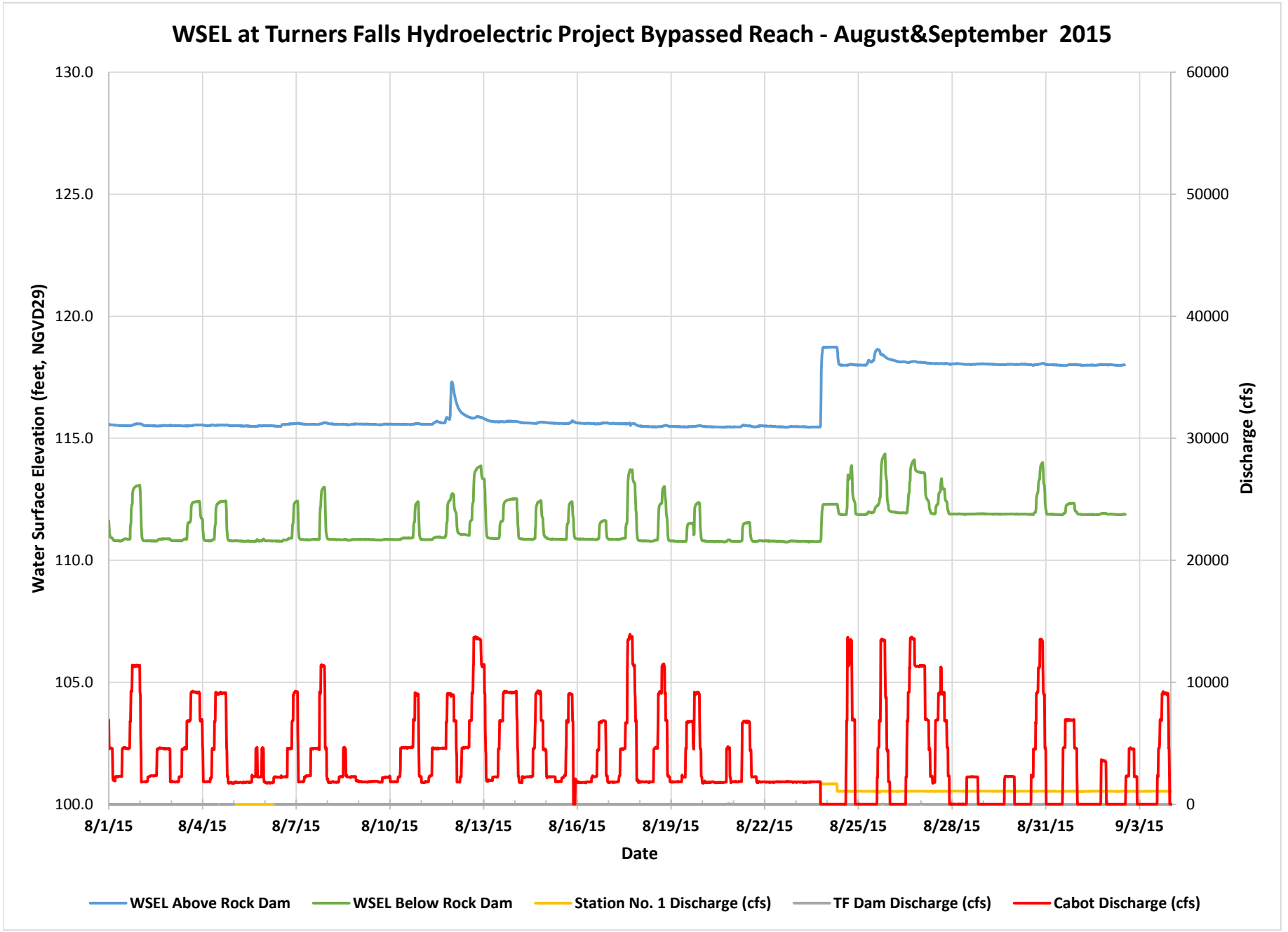

Barton Cove WSEL - July 2015
Water Surface Elevation (feet above mean sea level, NGVD29)
Discharge (cfs)
190.0
188.0
186.0
184.0
182.0
180.0
178.0
176.0
174.0
172.0
170.0
80000
70000
60000
50000
40000
30000
20000
10000
0
-10000
-20000
7/1/15
7/4/15
7/7/15
7/10/15
7/13/15
7/16/15
7/19/15
7/22/15
7/25/15
7/28/15
7/31/15
Date
TF Impoundment WSEL
Vernon (cfs)
Northfield (cfs)

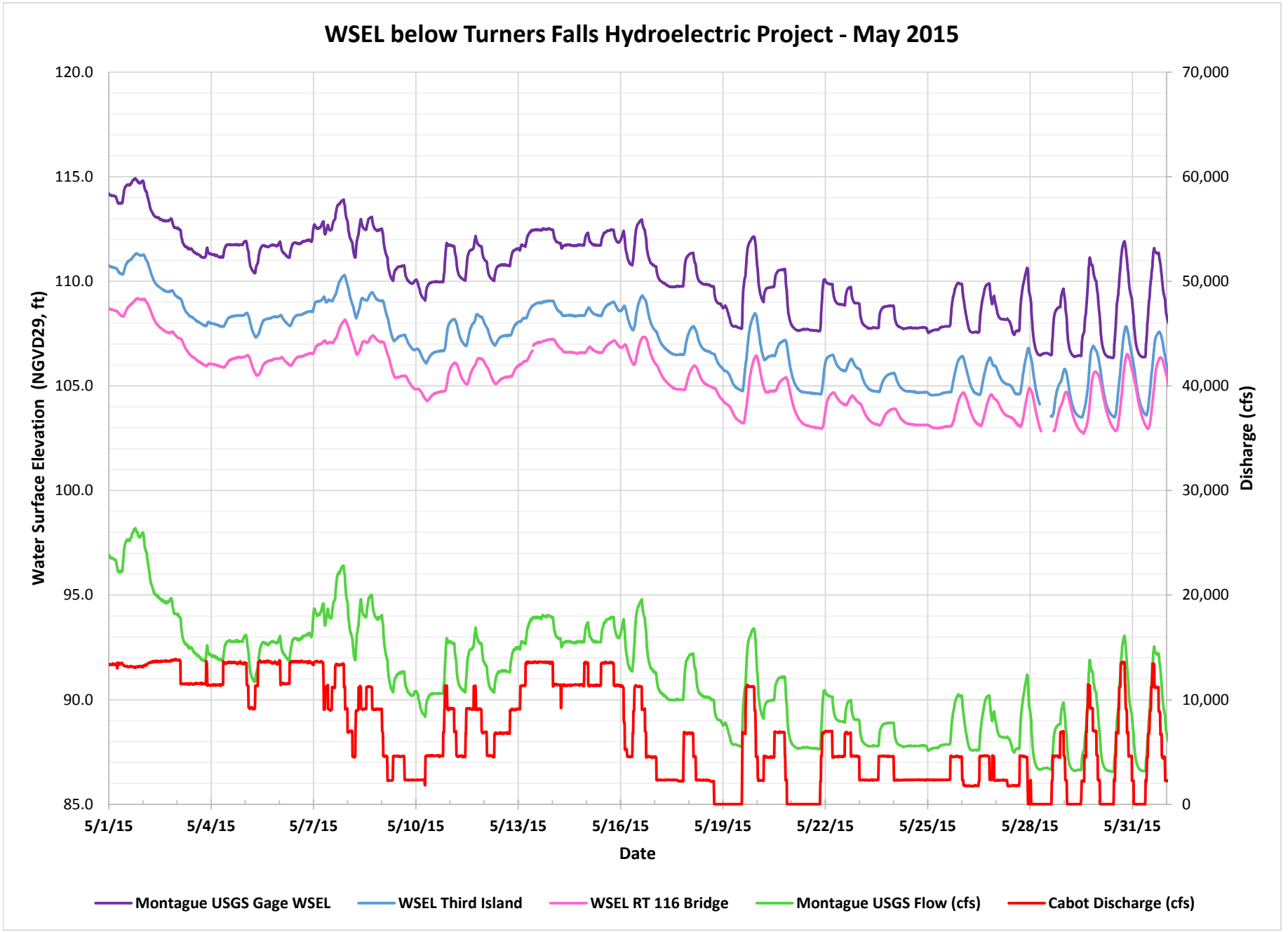

Barton Cove WSEL - August 2015
Water Surface Elevation (feet above mean sea level, NGVD29)
190.0
188.0
186.0
184.0
182.0
180.0
178.0
176.0
174.0
172.0
170.0
Discharge (cfs)
80000
70000
60000
50000
40000
30000
20000
10000
0
-10000
-20000
8/1/15
8/4/15
8/7/15
8/10/15
8/13/15
8/16/15
8/19/15
8/22/15
8/25/15
8/28/15
8/31/15
Date
TF Impoundment WSEL
Vernon (cfs)
Northfield (cfs)

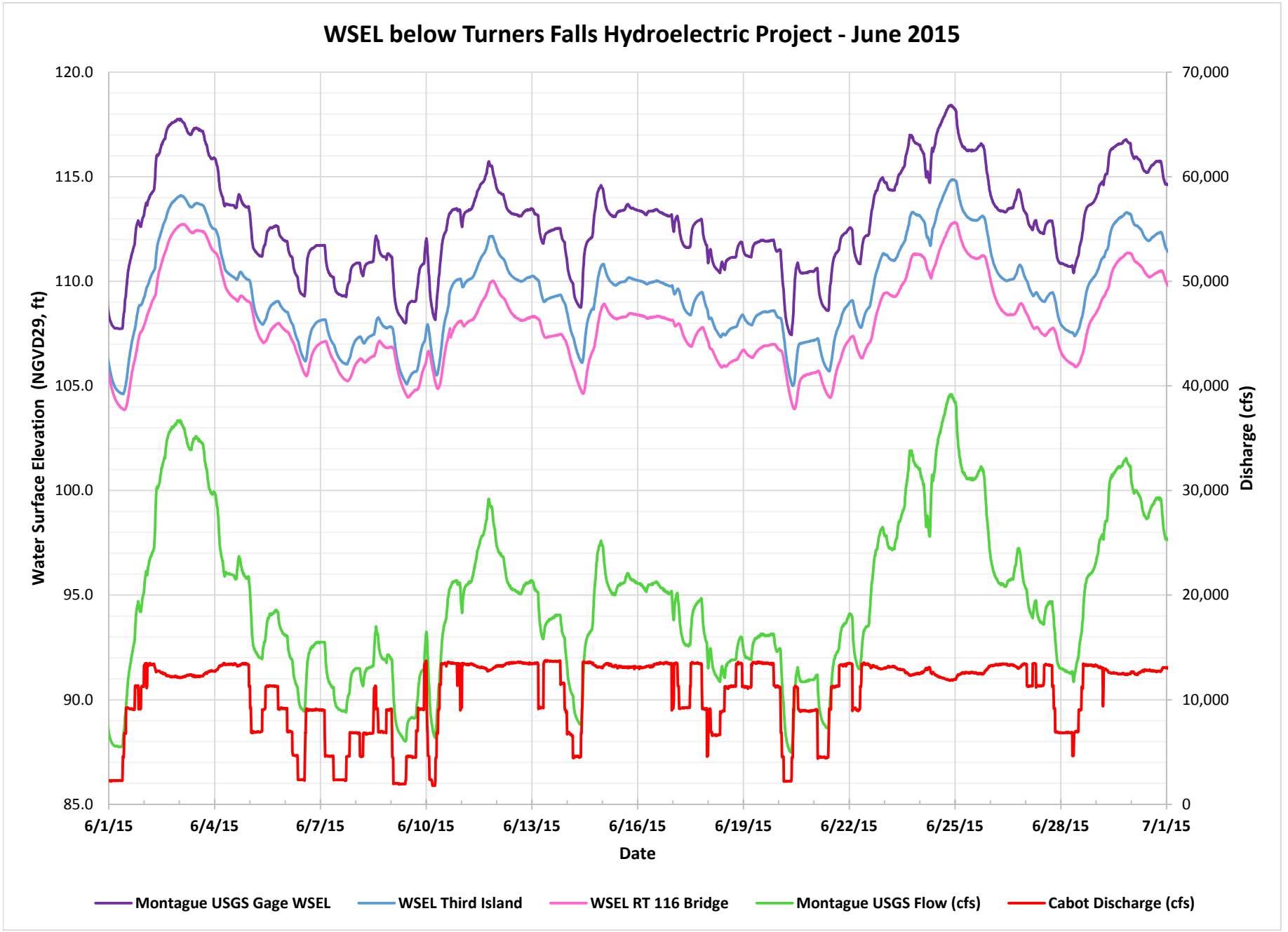

Barton Cove WSEL - September 2015
Water Surface Elevation (feet above mean sea level, NGVD29)
Discharge (cfs)
190.0
188.0
186.0
184.0
182.0
180.0
178.0
176.0
174.0
172.0
170.0
80000
70000
60000
50000
40000
30000
20000
10000
0
-10000
-20000
9/1/15
9/4/15
9/7/15
9/10/15
9/13/15
9/16/15
9/19/15
9/22/15
9/25/15
9/28/15
10/1/15
Date
TF Impoundment WSEL
Vernon Discharge (cfs)
Northfield (cfs)

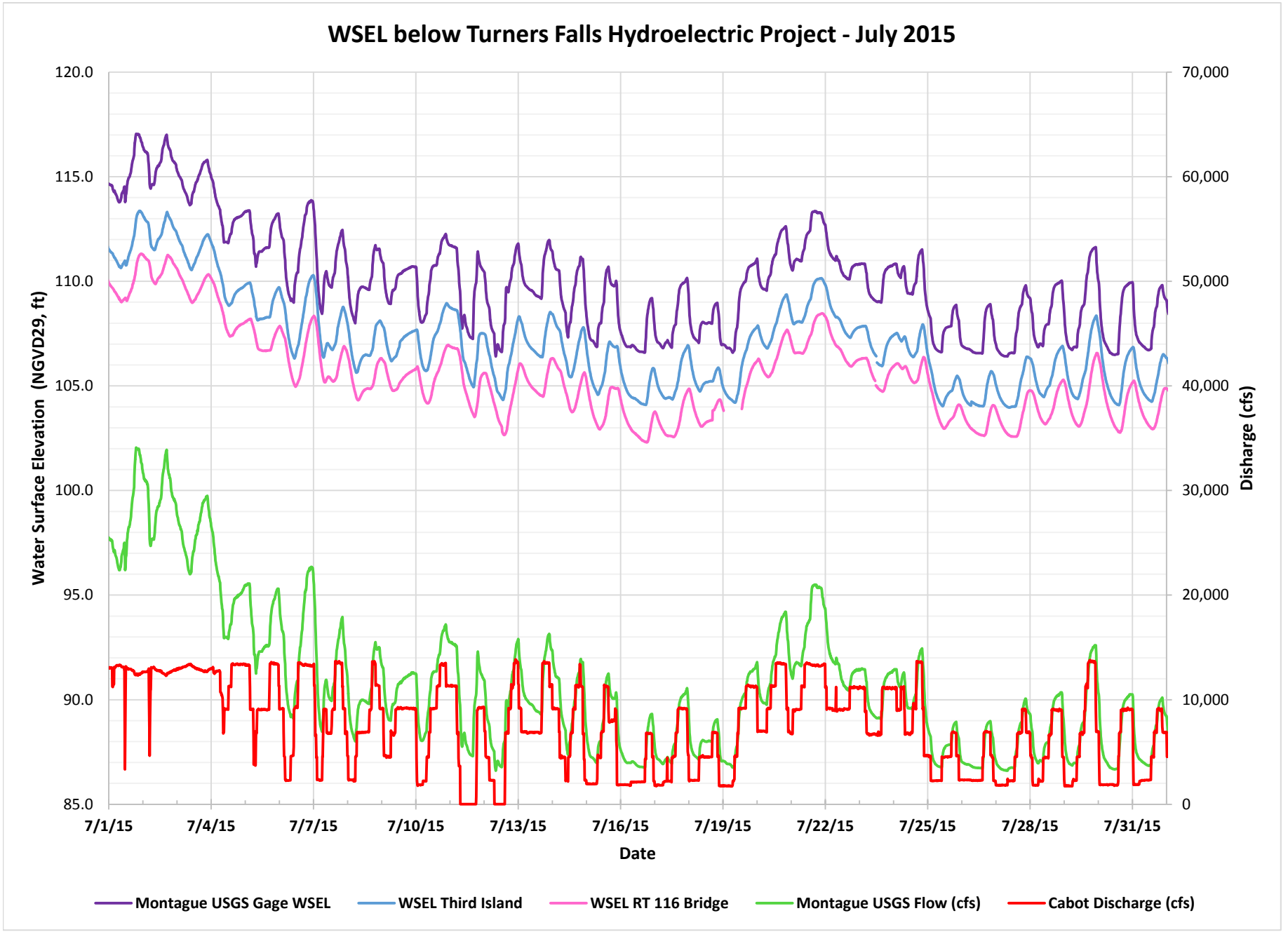

WSEL at Turners Falls Hydroelectric Project Bypassed Reach - May&June 2015
Water Surface Elevation (feet, NGVD29)
130.0
125.0
120.0
115.0
110.0
105.0
100.0
Discharge (cfs)
60000
50000
40000
30000
20000
10000
0
5/28/15
5/31/15
6/3/15
6/6/15
6/9/15
6/12/15
6/15/15
6/18/15
6/21/15
6/24/15
6/27/15
6/30/15
Date
WSEL Above Rock Dam
WSEL Below Rock Dam
Station No. 1 Discharge (cfs)
TF Dam Discharge (cfs)
Cabot Discharge (cfs)

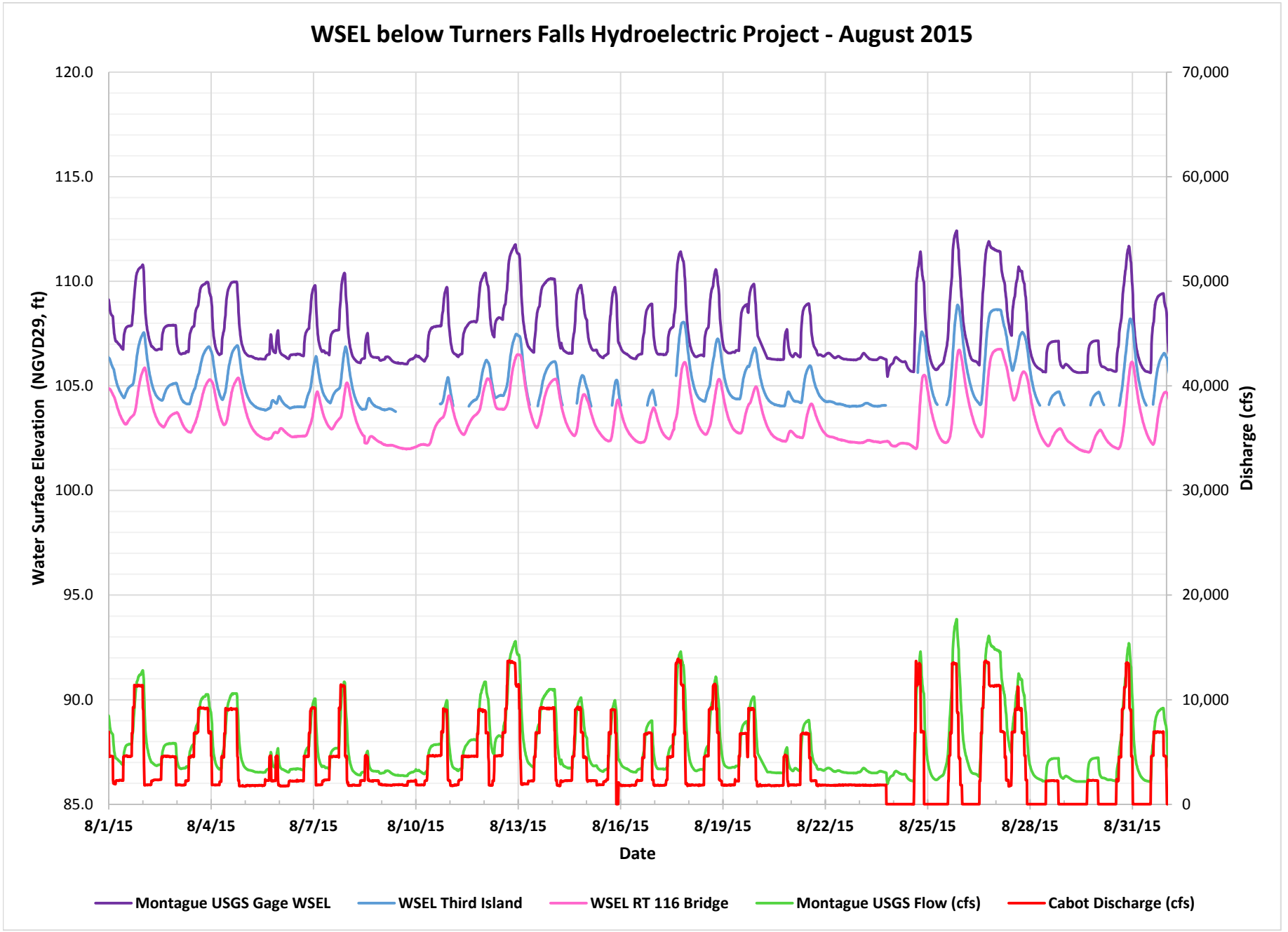

WSEL at Turners Falls Hydroelectric Project Bypassed Reach - July 2015
Water Surface Elevation (feet, NGVD29)
130.0
125.0
120.0
115.0
110.0
105.0
100.0
Discharge (cfs)
60000
50000
40000
30000
20000
10000
0
7/1/15
7/4/15
7/7/15
7/10/15
7/13/15
7/16/15
7/19/15
7/22/15
7/25/15
7/28/15
7/31/15
Date
WSEL Above Rock Dam
WSEL Below Rock Dam
Station No. 1 Discharge (cfs)
TF Dam Discharge (cfs)
Cabot Discharge (cfs)

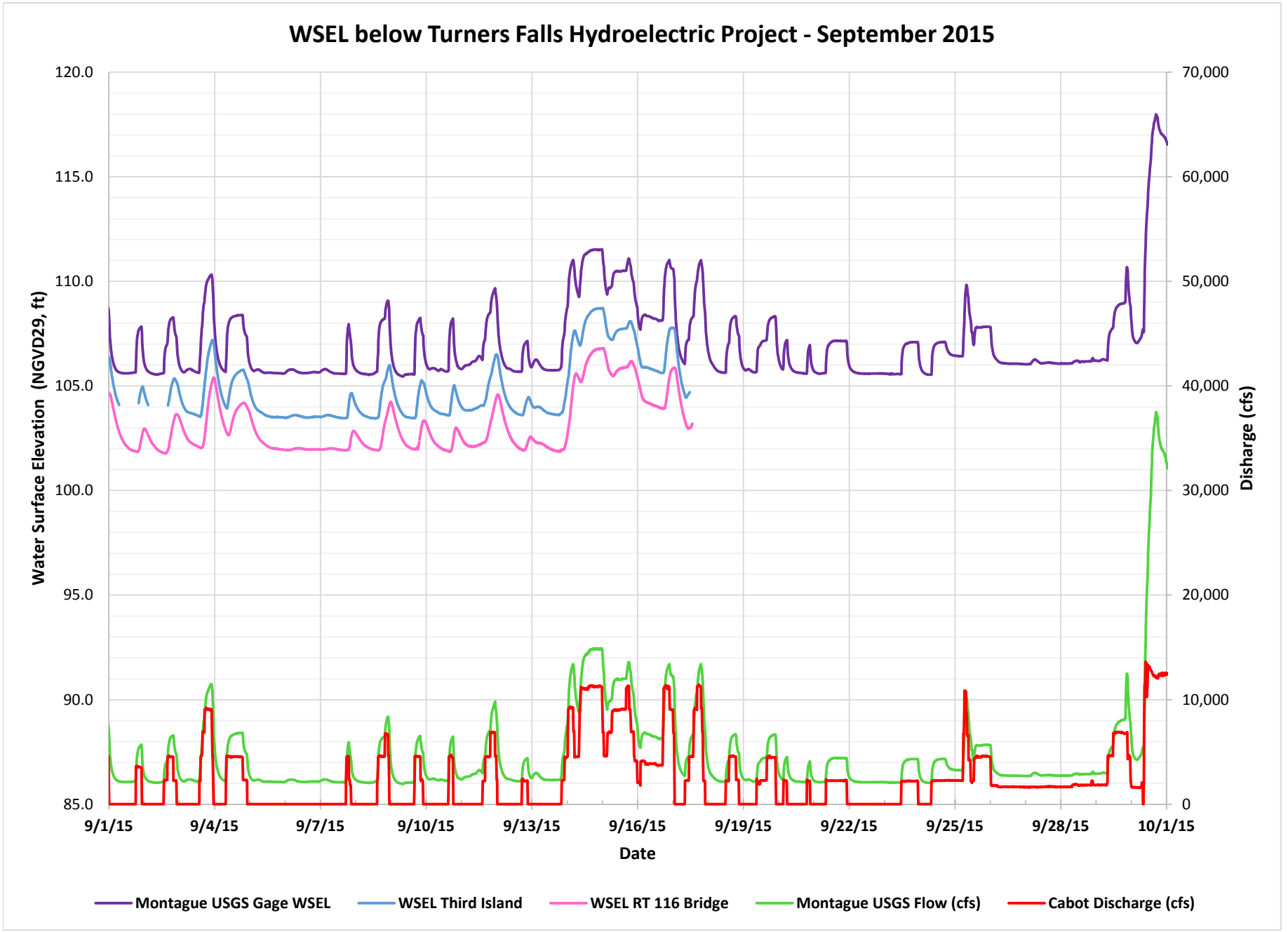

WSEL at Turners Falls Hydroelectric Project Bypassed Reach - August&September 2015
Water Surface Elevation (feet, NGVD29)
130.0
125.0
120.0
115.0
110.0
105.0
100.0
Discharge (cfs)
60000
50000
40000
30000
20000
10000
0
8/1/15
8/4/15
8/7/15
8/10/15
8/13/15
8/16/15
8/19/15
8/22/15
8/25/15
8/28/15
8/31/15
9/3/15
Date
WSEL Above Rock Dam
WSEL Below Rock Dam
Station No. 1 Discharge (cfs)
TF Dam Discharge (cfs)
Cabot Discharge (cfs)


WSEL below Turners Falls Hydroelectric Project - May 2015
Water Surface Elevation (NGVD29, ft)
Disharge (cfs)
120.0
115.0
110.0
105.0
100.0
95.0
90.0
85.0
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
5/1/15
5/4/15
5/7/15
5/10/15
5/13/15
5/16/15
5/19/15
5/22/15
5/25/15
5/28/15
5/31/15
Date
Montague USGS Gage WSEL
WSEL Third Island
WSEL RT 116 Bridge
Montague USGS Flow (cfs)
Cabot Discharge (cfs)


WSEL below Turners Falls Hydroelectric Project - June 2015
Water Surface Elevation (NGVD29, ft)
120.0
115.0
110.0
105.0
100.0
95.0
90.0
85.0
Disharge (cfs)
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
6/1/15
6/4/15
6/7/15
6/10/15
6/13/15
6/16/15
6/19/15
6/22/15
6/25/15
6/28/15
7/1/15
Date
Montague USGS Gage WSEL
WSEL Third Island
WSEL RT 116 Bridge
Montague USGS Flow (cfs)
Cabot Discharge (cfs)


WSEL below Turners Falls Hydroelectric Project - July 2015
Water Surface Elevation (NGVD29, ft)
Disharge (cfs)
120.0
115.0
110.0
105.0
100.0
95.0
90.0
85.0
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
7/1/15
7/4/15
7/7/15
7/10/15
7/13/15
7/16/15
7/19/15
7/22/15
7/25/15
7/28/15
7/31/15
Date
Montague USGS Gage WSEL
WSEL Third Island
WSEL RT 116 Bridge
Montague USGS Flow (cfs)
Cabot Discharge (cfs)


WSEL below Turners Falls Hydroelectric Project - August 2015
Water Surface Elevation (NGVD29, ft)
Disharge (cfs)
120.0
115.0
110.0
105.0
100.0
95.0
90.0
85.0
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
8/1/15
8/4/15
8/7/15
8/10/15
8/13/15
8/16/15
8/19/15
8/22/15
8/25/15
8/28/15
8/31/15
Date
Montague USGS Gage WSEL
WSEL Third Island
WSEL RT 116 Bridge
Montague USGS Flow (cfs)
Cabot Discharge (cfs)


WSEL below Turners Falls Hydroelectric Project - September 2015
Water Surface Elevation (NGVD29, ft)
Disharge (cfs)
120.0
115.0
110.0
105.0
100.0
95.0
90.0
85.0
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
9/1/15
9/4/15
9/7/15
9/10/15
9/13/15
9/16/15
9/19/15
9/22/15
9/25/15
9/28/15
10/1/15
Date
Montague USGS Gage WSEL
WSEL Third Island
WSEL RT 116 Bridge
Montague USGS Flow (cfs)
Cabot Discharge (cfs)