

Relicensing Study 3.3.10

ASSESS OPERATIONAL IMPACTS ON EMERGENCE OF STATE-LISTED ODONATES IN THE CONNECTICUT RIVER

Updated Study Report Summary

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

Prepared for:



Prepared by:



SEPTEMBER 2015

1.1 Study Summary

This study has 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.
- 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, particularly state-listed species.

This is a two-year study. Phase 1, qualitative odonate surveys, were conducted in 2014 and Phase 2, quantitative studies are being conducted in 2015.

In 2014, odonate larvae and exuviae were surveyed between the Turners Falls Dam and the Route 116 Bridge in Sunderland, and in the Turners Falls Impoundment (TFI) near Barton's Cove, to establish a qualitative baseline for the odonate assemblage in these areas (Phase 1). Preceding the fieldwork, 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. The Phase 1 work was summarized in a report posted to FirstLight's website in April 2015 and is included herein as [Appendix A](#).

1.2 Study Progress Summary

Task 1: Review of Existing Information

Some existing information was gathered and reviewed to provide context for Phase 1 results and to help plan for Phase 2 fieldwork, but a more comprehensive review and synthesis will be completed in the period from October 2015 to February 2016 and provided in the final report.

Task 2: Finalize Study Plan and Attain Collection Permit

Survey site locations and the Phase 2 study plan were discussed in a meeting with NHESP and United State Fish and Wildlife Service (USFWS) on April 28, 2015. Concurrence was reached at the meeting, and a field 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.

Task 3: Qualitative Surveys for Larvae and Exuviae to Determine Species Presence (Phase 1)

Task 3 is complete. As noted above, a Phase 1 report summarizing Task 3 was included on FirstLight's website in April 2015 and is included herein as [Appendix A](#).

Task 4: Quantitative Surveys of Emergence/Eclosure Behavior (Phase 2)

Quantitative Emergence and Eclosure Surveys

FirstLight conducted quantitative surveys at five sites in the Connecticut River; the sites are listed below and shown in [Figure 1](#).

1. Barton's Cove (Gill)
2. 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)

Concurrence on the locations of these five sites, and for the field methods, was reached during an April 28, 2015 meeting with NHESP. Precise locations of transects within these sites were determined in the field.

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. Within and among the five sites, transects were 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). 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 location of both ends, slope, elevation of the upslope and water ends, 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 were photo-documented.

Surveys for emerging larvae, exuviae, and teneral were conducted at each transect approximately every two weeks beginning on May 26 and ending on September 3, 2015. In addition, biologists spent approximately seven additional days surveying within and outside of transects during the months of June and July to increase sample sizes for each species (focused on uncommon species) in a range of habitat types. 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 USGS streamflow data at the Montague City gage (01170500)). 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 emergence.

The time of day, weather, water level, and a qualitative assessment of boat traffic were 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 was recorded. Each exuvia and some teneral were collected, labeled with site information and date, and preserved for later species identification.

Emergence and Eclosure Speed

Biologists looked for larvae exiting the water or crawling on land, and focused on 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. Several of these events were recorded using time-lapse photography (using a GoPro).

In terms of replication, biologists attempted to record emergence/eclosure speed for 20 individuals of each species per site, with a focus on finding uncommon species (aiming for a minimum of 10 observations for each species). Observations coincided with the quantitative exuvia surveys, but biologists also spent seven additional days in June and July trying to gather additional emergence speed data within and outside of transects. This was done mainly in response to low emergence rates and low sample sizes within transects.

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

Identification of specimens, data entry and analysis for this task will commence in October of 2015.

Task 5: Water Fluctuation Impact Assessment

The Federal Energy Regulatory Commission's (FERC's) February 21, 2014 Study Plan Determination Letter (SPDL) recommended that FirstLight deploy a water level logger (with temperature recording capability) to record data at 15-minute intervals for each quantitative survey reach in order to accurately evaluate water levels, standardize field measurements, and describe temperature in relation to odonate emergence behavior. As stated in the 2014 Revised Study Plan, "*the field data will be used to determine if water level fluctuations affect the emergence and eclosure success of state listed odonates.*"

Table 1 describes the location and installation date of each logger associated with the odonate study. All loggers collect data at 15 minute intervals. Water level/temperature loggers are shown in [Figure 1](#). FirstLight has a permanent water level logger at Turners Falls Dam in the vicinity of Barton's Cove which will provide impoundment water level data for Site 1. Temporary water level/temperature loggers were installed at each site for the duration of the quantitative surveys (as seen in [Figure 1](#)) to supplement data from the permanent gages at the Turners Falls Dam and the USGS Montague City gage. Temporary water level loggers were also installed at the Route 116 Bridge, and above and below Rock Dam.

Table 1. Water level/temperature monitoring locations and installation dates for quantitative odonate study

Site	Odonate Study Location	Logger Type	Logger Location (s)
1	Barton's Cove	Water Temp.	Boat Barrier – Water Quality Study Site 7
		Water Level	FirstLight permanent gage at TF Dam
2	Rock Dam	Water Level and Temp.	Temporary logger above Rock Dam
		Water Level and Temp.	Temporary logger below Rock Dam
3	Bike path bridge opposite the Deerfield River confluence	Water Temp.	Temporary logger
		Water Level	USGS Montague City Gage
4	Near Sawmill River confluence	Water Level and Temp.	Temporary logger near Third Island
5	Near Route 116 Bridge	Water Level and Temp.	Temporary logger near Route 116 Bridge

Task 6: Report

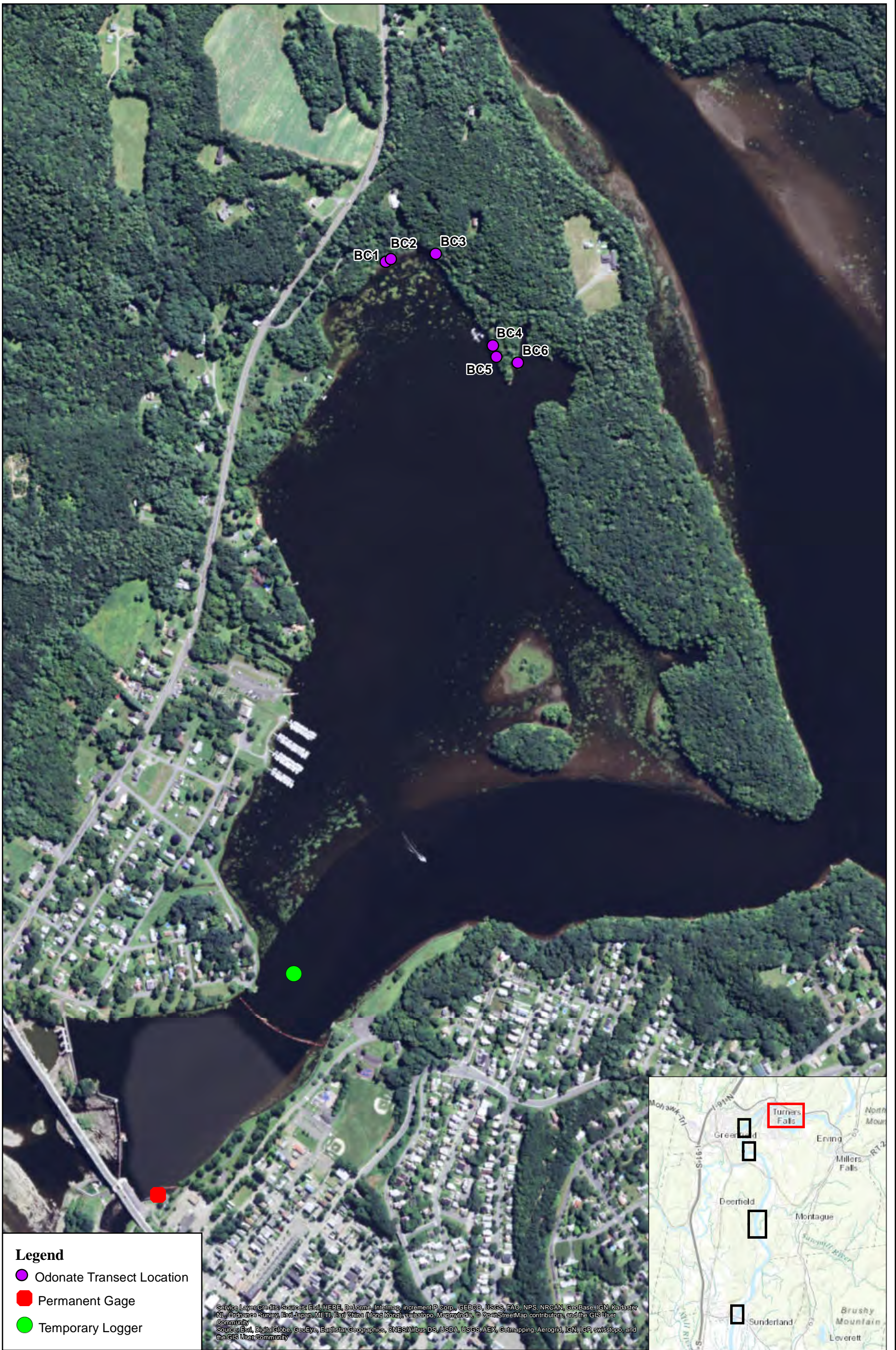
A study report will be completed in March 2016.

1.3 Variances from Study Plan and Schedule

To date, the only notable variance was the addition of approximately seven days of fieldwork to collect additional information on emergence behavior within and outside of transects at each study site, in an attempt to increase sample sizes (especially for rare species). This was done in response to generally lower than expected emergence rates in June and July.

1.4 Remaining Activities

- Fieldwork is being completed by early September of 2015.
- Office-based work, including synthesis of existing information, identification of samples, data entry and analysis, the water fluctuation impact assessment, and preparation of the report will be completed from October 2015 to March 2016.



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

UPDATED STUDY REPORT SUMMARY
RELICENSING STUDY 3.3.10

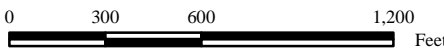


Figure 1: 2015 Quantitative Odonate Survey Sites
Site 1 (Bartons Cove)



Legend

- Odonate Transect Location
- Permanent Gage
- Temporary Logger

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UPDATED STUDY REPORT SUMMARY
 RELICENSING STUDY 3.3.10

0 150 300 600 Feet

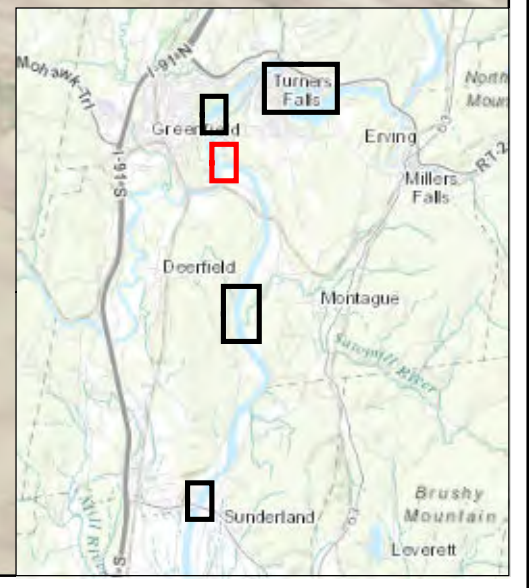
Figure 1: 2015 Quantitative Odonate Survey Sites
 Site 2 (Rock Dam)



Legend

- Odonate Transect Location
- Permanent Gage
- Temporary Logger

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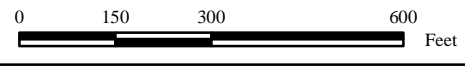
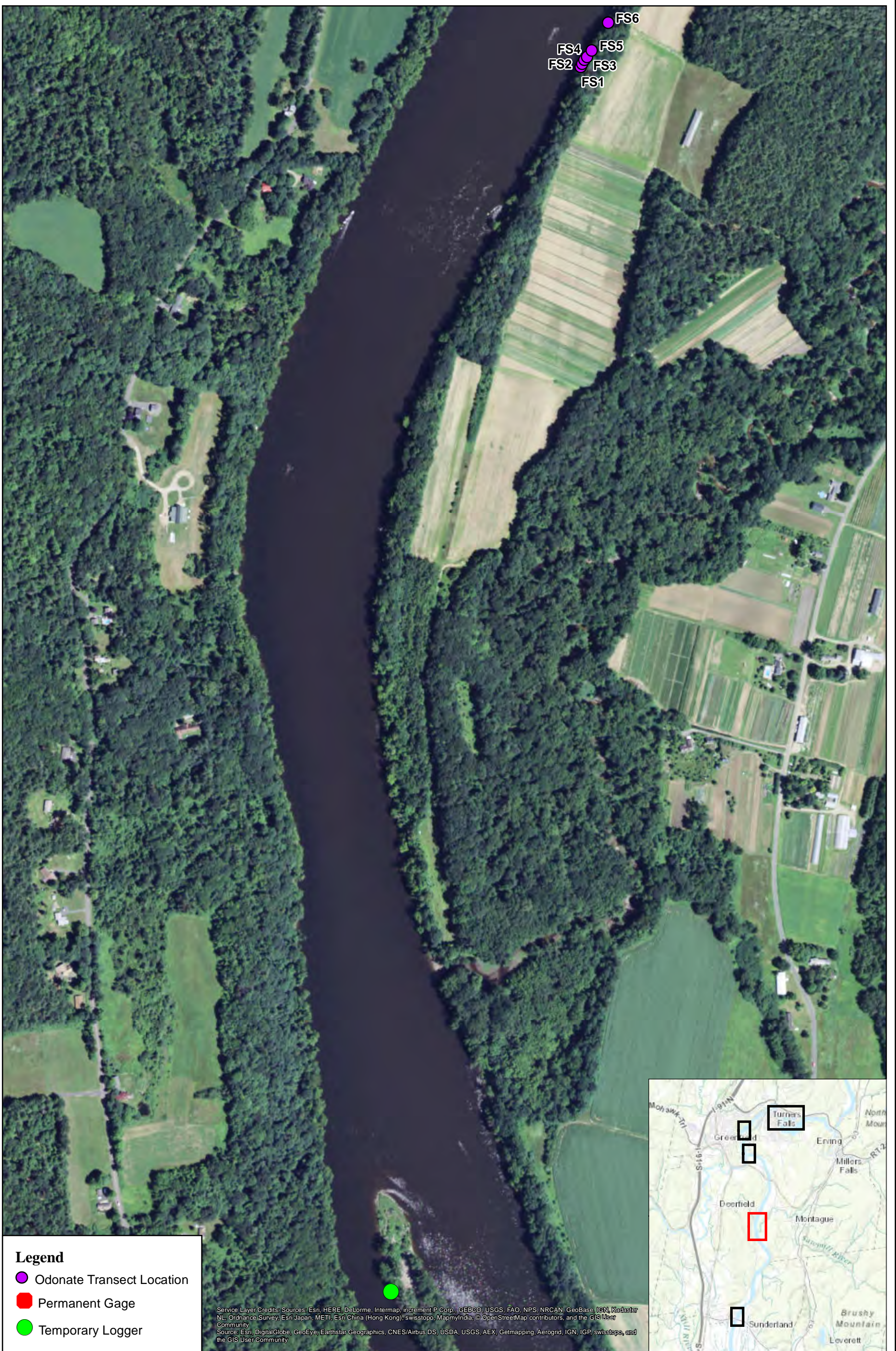


Figure 1: 2015 Quantitative Odonate Survey Sites
 Site 3 (Opposite Deerfield River Confluence)

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Legend

- Odonate Transect Location
- Permanent Gage
- Temporary Logger

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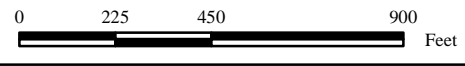


Figure 1: 2015 Quantitative Odonate Survey Sites
 Site 4 (Near Sawmill River)



Legend

- Odonate Transect Location
- Permanent Gage
- Temporary Logger

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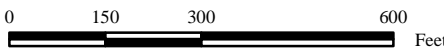


Figure 1: 2015 Quantitative Odonate Survey Sites
 Site 5 (Near Route 116 Bridge)

Appendix A

Report of 2014 Field Survey

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:



Prepared by:



APRIL 2015

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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 proposed¹. 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

Biodiversity 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

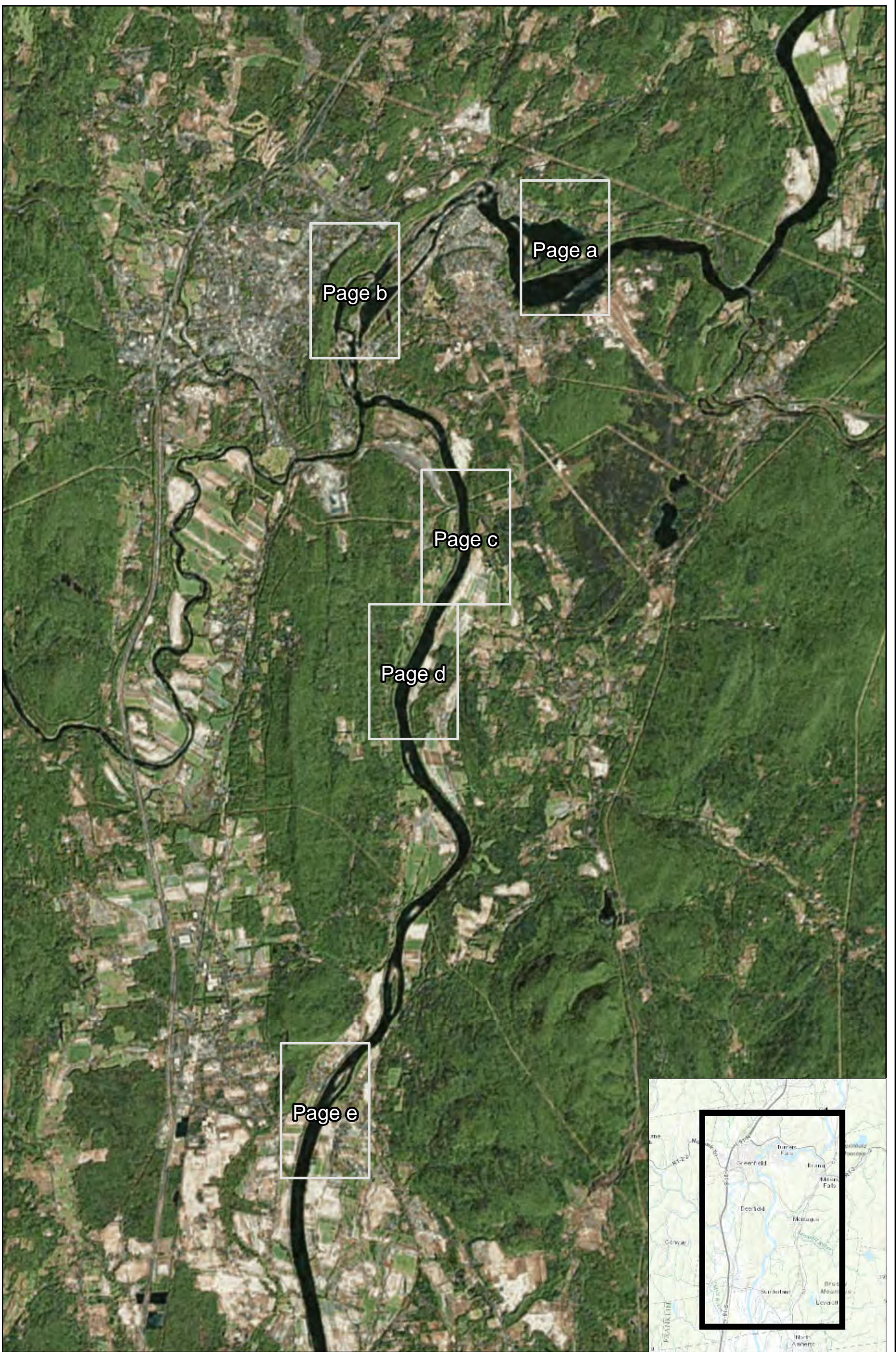
Collection methods for larvae included aquatic D-nets and hand picking odonates in the water or on land. Collections were made while wading, snorkeling, and while walking along the riverbank. If present, teneral or exuviae were collected on the riverbank. For teneral or exuvia, biologists recorded the 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.

Northfield Mountain Pumped Storage Project (No. 2485) and Turners Falls Hydroelectric Project (No. 1889)
 ASSESS OPERATIONAL IMPACTS ON EMERGENCE OF STATE-LISTED ODONATES IN THE CONNECTICUT RIVER

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

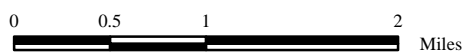



Figure 2.1-1 Index. Study Sites

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Legend
 Survey Sites



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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 2.1-1a. Study Sites

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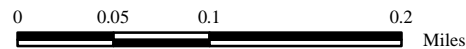
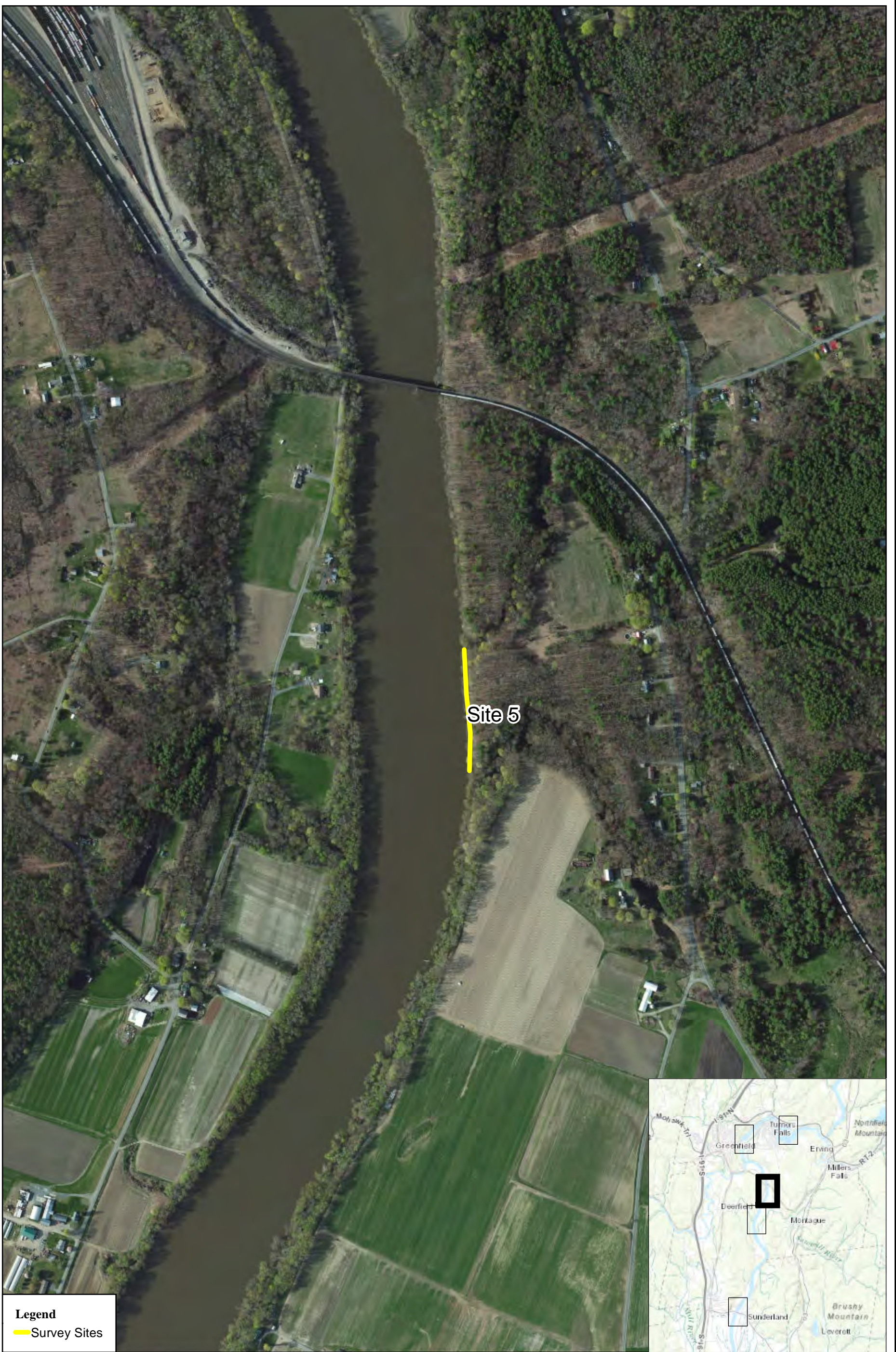


Figure 2.1-1b. Study Sites

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0 0.05 0.1 0.2
 Miles

Figure 2.1-1c. Study Sites

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 State-listed Odonates in the Connecticut River

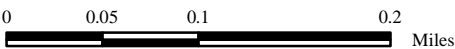


Figure 2.1-1d. Study Sites

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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Legend
 — Survey Sites



**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

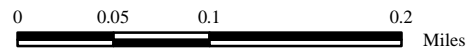


Figure 2.1-1e. Study Sites

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.

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

ASSESS OPERATIONAL IMPACTS ON EMERGENCE OF STATE-LISTED ODONATES IN THE
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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.

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 ASSESS OPERATIONAL IMPACTS ON EMERGENCE OF STATE-LISTED ODONATES IN THE CONNECTICUT RIVER

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

Parameter	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.

**At least 200 more exuvia 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 exuvia 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 exuvia were not quantified at those two sites.

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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 Velocity¹	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
Cover³								
%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)

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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 Slope⁴	Very Gradual	Gradual	Moderate	Moderate to Vertical	Gradual to Moderate	Moderate to Steep	Moderate to Steep	Moderate to Steep
Bank Height⁵	-	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 Stability⁶	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 of 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 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 24m² to 36m², 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

ASSESS OPERATIONAL IMPACTS ON EMERGENCE OF STATE-LISTED ODONATES IN THE
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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 teneral adults 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. illinoensis*, *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 FERC's 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."

ASSESS OPERATIONAL IMPACTS ON EMERGENCE OF STATE-LISTED ODONATES IN THE
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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

Consultation

From: Ethan Nedeau <ethan@biodrawiversity.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, Biodrawiversity LLC

206 Pratt Corner Road, Leverett, MA 01054

Cell: (413) 253-6561 / Email: nedeau.ethan@gmail.com

Website: www.biodrawiversity.com

2015 Odonate Field Study

1. Quantitative Emergence and Ecdysis 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 teneral adults 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](mailto: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](http://www.mass.gov/masswildlife)

-----Original Message-----

From: Hazelton, Peter (FWE)  
Sent: Tuesday, May 12, 2015 11:56 AM  
To: [ethan@biodrawversity.com](mailto:ethan@biodrawversity.com)  
Cc: Leddick, Jesse (FWE); Grader, Melissa; [jgeorge@gomezandsullivan.com](mailto: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

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From: Ethan Nedeau [[ethan@biodrawiversity.com](mailto:ethan@biodrawiversity.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

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\*\*New Address

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