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Tighe&Bond

Holyoke Project FERC No. 2004

Rare Mussel Species Survey Report 2013

Prepared For:

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Section 1 Introduction

The 43.8 megawatt (MW) Holyoke Hydroelectric Project (FERC No. 2004) is located on the Connecticut River at mile 80 in Hampden, Hampshire, and Franklin counties, Massachusetts. The Connecticut River is the longest river in New England, originating 2,625 feet above sea level in the Fourth Connecticut Lake and accumulating water from several major tributaries as it flows south at a slope of about 6 feet per mile. The waterway serves as the boundary between New Hampshire and Vermont, then runs through Massachusetts and Connecticut before emptying into Long Island Sound, over 400 miles from its source. An area of about 8,309 square miles is drained by the river at the Holyoke dam. The main facilities of the Project are located in the City of Holyoke and the Town of South Hadley, Massachusetts.

Originally licensed in 1949, the Project consists of a 30-foot-high, 985-foot-long dam topped by five 3½ foot high inflatable rubber dam sections. The Project impounds a 2,290 acre reservoir with a normal maximum surface elevation of 100.6 feet National Geodetic Vertical Datum (NGVD). A three-level canal system extends through the lower areas of the City of Holyoke and provides water for industrial uses and hydropower generation. The Project includes six hydroelectric generating stations (five in the canal system and one at the dam) as well as upstream and downstream fish passage facilities. The canal system also provides water to nine other operational hydroelectric units. Of these, eight are owned by HG&E and one unit is privately owned.¹ HG&E is required to provide water to this private, non-project facility according to industrial water rights agreements.

The previous owner, Holyoke Water Power Company (HWP), was granted a new license by the Federal Energy Regulatory Commission (FERC) for the Holyoke Hydroelectric Project on August 20, 1999. By Order dated September 20, 2001, FERC approved the transfer of the Holyoke Project from HWP to HG&E, and the sale closed on December 14, 2001. This transfer of license ordered HG&E to comply with all license conditions and compliance plans associated with the new license.

HG&E filed the Threatened and Endangered Species Protection Plan (Plan) under License Article 416 for the Holyoke Project (88 FERC ¶ 61,186, 1999 License) in 2002. The Commission approved the Plan on June 6, 2003 (103 FERC ¶ 62,131). The Plan also referenced the implementation of the Fish and Aquatic Habitat Plan, as required under License Article 410 of the 1999 License that also addressed the monitoring of mussel habitat and populations within the Holyoke canal system.

The Plan was further reaffirmed in revised License Article 416 pursuant to the Commission's April 19, 2005, order approving a comprehensive settlement for the

¹ In 2004, HG&E acquired eight of the hydroelectric projects located in the canal system from Harris Energy and Realty Corporation (referred to jointly as the "Harris Projects"); approval of the transfer of the licenses for those projects was granted by FERC's "Order Approving Transfer of Licenses" issued October 29, 2004. In addition, by reason of the termination of a lease, HG&E became the owner and operator of Project No. 10806 (also known as Station No. 5); an application to transfer the license for that project to HG&E was approved by FERC order issued June 22, 2005 (111 FERC ¶ 62,317). As of November 2013, HG&E owns a total of 11 operational units (Riverside 4-7, Riverside 8, Beebe-Holbrook, Skinner, Boatlock, Chemical, Valley and City 1, City 2, City 3 and City 4).

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Project (111 FERC ¶ 61,106). In addition, the April 2005 order reaffirmed the Fish and Aquatic Habitat Plan requirements for mussel habitat and population, renumbering the original License Article 410 as revised License Article 409. Also pursuant to the April 2005 order, HG&E filed its revised Comprehensive Canal Operations Plan (CCOP) on June 20, 2005 (with a supplement filed on October 11, 2005) which includes a canal drawdown procedure which was implemented during the 2005 mussel study period. The revised CCOP was approved by the Commission on January 11, 2006 (114 FERC ¶ 62,017).

In accordance with the Plan, HG&E agreed to conduct semi-quantitative monitoring for mussel species in the impoundment, Holyoke canal system, and in an area downstream of the Holyoke Dam bypass. The protocol called for surveying these areas for rare mussel species including the alewife floater (*Anodonta implicata*), dwarf wedgemussel (*Alsimidonta heterodon*), and yellow lampmussel (*Lampsis carios*a) over a twelve year period (2003-2014), with interim reports provided every four years and a final report to be prepared in 2014.

This document describes the 2013 mussel survey findings in the First and Second Level canals, the impoundment, and downstream of the dam bypass, based on the FERC-approved survey protocols as revised in 2008 (canals) and 2009 (impoundment). A summary of the 2011 canal survey results is also provided.

2.1 Impoundment and Downstream of Bypass Reach

For the purposes of the 2013 rare mussel species survey, the Connecticut River impoundment was divided into 15 study sites. Descriptions of each study site (depth, substrate, flow rate, mussel findings and transect location) are provided below. For additional details regarding the locations of these 15 study sites, please refer to Table 1 below and the orthophotographs on the following pages. Figure 1 in Appendix A also depicts these 15 study site locations.

2.1.1 Study Sites (15)

2.1.1.1 Site 1 (Downstream of Bypass Reach)

Survey: Bypass reach. Surveyors started at boat ramp on east side of river, swam upstream and across the channel toward the sandbar on the downstream end of the island, across the river, zigzagging from shore to 40 meters out. Approximately 70 meters upstream from the end of the island, surveyors headed toward the east bank, then downstream back to the boat ramp.

Depth: 2 to 3 meters.

Habitat: Sand and fine gravel near the island, with mostly large cobble and sand elsewhere, and boulders near the east bank.

Flow rate: Variable, generally moderate to strong

Mussel Findings: Eastern elliptio (200), yellow lampmussel (1).

2.1.1.2 Site 2

Transect: A 150-meter transect, 900 meters downstream of Brunelle's Marina on the west side of the river. This was a short snorkel survey in search of good habitat downstream of Brunelle's Marina. Surveyors zigzagged across the river, scanning nearby areas as far as 300 meters downstream from the starting point.

Depth: 2.5 meters; Steep drop-off from shore down to a maximum depth of 3.2 meters. The center of the channel was around 3 meters throughout, with some areas deeper than 5 meters.

Habitat: Thick silt and clay along the bank transitioning to silty gravel in deeper water. Further downstream, the substrate became predominantly bedrock.

Flow rate: Light to moderate.

Mussel Findings: Eastern elliptio (tens of thousands), no other species observed.

2.1.1.3 Site 3

Transect: A 125-meter transect located 75 meters away from, and parallel to, the east bank. The starting point is 280 meters upstream from the mouth of Stony Brook (which is located just upriver of Brunelle's Marina) and the ending point is located 350 meters downstream from the mouth of Bachelor Brook.

Depth: 1.75 meters; uniform.

Habitat: Primarily sand and gravel, with a moderate amount of woody debris.

Flow rate: Light to moderate.

Mussel Findings: Eastern elliptio (thousands) and yellow lampmussels (46).

2.1.1.4 Site 4

Transect: A 180-meter transect starting across the river and just upstream of the Mt. Tom power plant, running parallel to the left bank.

Depth: 2.7 meters average; maximum of 3.2 meters.

Habitat: Primarily sand, with high bedload and sharply defined dune-ripple topography in areas where current was stronger. Nearshore, sediment was sand and silty-sand, with large amounts of coarse woody debris.

Flow rate: Flows moderate at the downstream end of the transect and toward the outer edge of the survey area. Flows slower closer to the riverbank and at the upstream end of the transect.

Mussel Findings: Eastern elliptio and yellow lampmussels (77).

2.1.1.5 Site 5

Transect: 140-meter transect that closely parallels the eastern shoreline. The upstream end of the transect is located 350 meters from the downstream end of Mitch's Island.

Depth: 1.6 meters average, maximum of 1.8 meters.

Habitat: Substrate primarily thick silt and clay towards the bank, transitioned to siltygravel further offshore, very little sand. Submerged aquatic vegetation (mainly *Vallisneria* and *Elodea*) common near shore.

Flow rate: Light

Mussel Findings: Eastern elliptio (thousands) and yellow lampmussels (6).

2.1.1.6 Site 6

Transect: 205-meter transect that closely paralleled the eastern side of Mitch's Island. The transect started on shore, 190 meters upstream of the southern tip of the island and ended 355 meters downstream of the northern end of the island. One surveyor stayed within 10 meters of the bank and the other swam approximately one-third of the way toward the center of the channel.

Depth: 2.3 meters average, maximum of 3 meters.

Habitat: Primarily sand with some gravel, silty-sand and woody debris present closer to the island.

Flow Rate: Light

Mussel Findings: Eastern elliptio (hundreds), juvenile alewife floater (1), and yellow lampmussels (38).

2.1.1.7 Site 7

Transect: A 50x150 meter study plot located parallel to Mitch's Marina.

Depth: 2.0-2.2 meters throughout.

Habitat: Substrate almost entirely pure sand with only slight topographic variation.

Flow Rate: Light

Mussel Findings: Eastern Elliptio (mostly smaller animals and juveniles), Asian clams, and yellow lampmussels (158).

2.1.1.8 Site 8

Transect: 160-meter transect that began approximately 250 meters upstream from the former mouth of the Fort River.

Depth: 1.9 meters average, maximum of 3 meters.

Habitat: Mix of sand, silty-sand, clay, and gravel; submerged aquatic vegetation densities were high (within 30 meters of the shoreline). Mix of sand and gravel, with moderate amounts of embedded large woody debris 10-30 meters further offshore.

Flow Rate: Light (More topographic variation toward the outer edge of the survey area.)

Mussel Findings: Eastern elliptio (thousands), eastern lampmussels (a few), triangle floater (1), eastern pondmussels (85, which were concentrated in a band from 5-10m of the shoreline, mostly in silt and clay), yellow lampmussels (30), and tidewater mucket (1).

2.1.1.9 Site 9

Transect: 50x150 meter area located approximately 680 meters west of the mouth of the Fort River and 140 meters south of the northern shoreline. Surveyors swam a rectangular pattern from the starting point.

Depth: 1.7 meters average, maximum of 2.2 meters. Much of the channel to the northwest of the survey area gets very shallow and possibly dewatered during low-flow periods.

Habitat: Primarily sand and fine gravel.

Flow rate: Light to moderate. Sharply defined dune-ripple topography and high bedload.

Mussel Findings: Eastern elliptio (hundreds), juvenile alewife floater (1), and yellow lampmussels (10).

2.1.1.10 Site 10

Transect: A 190-meter transect located within the narrow inside channel to the west of Elwell Island. The transect started at the bicycle (former railroad) bridge. Surveyors zigzagged from bank to bank to seek best habitat, although all yellow lampmussels were found toward the middle of the channel.

Depth: 1.0 to 2.4 meters with an average of 1.8 meters.

Habitat: Primarily silty-sand and fine gravel, with more coarse gravel and woody debris towards banks.

Flow rate: Light to moderate.

Mussel Findings: Eastern elliptio (abundant) and yellow lampmussels (5).

2.1.1.11 Site 11

Transect: A 65x40 meter area along the shoreline that began downstream and extended just upstream of the mouth of the Mill River in Hatfield. The starting point was 470 meters northwest of the downstream end of the Hadley Dike.

Depth: Average 0.8 meters, maximum of 2.2 meters.

Habitat: Primarily silty-sand with some patches of gravel, with moderate woody debris cover. There was a sharply defined dune-ripple topography, sandy crests often 1-1.5 meters higher than the gravelly troughs. Mussels were generally more common in the troughs.

Flow rate: Light, but became strong further from shore.

Mussel Findings: Eastern elliptio (dozens), adult yellow lampmussel (1).

2.1.1.12 Site 12

Transect: A 60x40 meter area along the West shoreline, just upstream of the broad bend in the river upstream of the Hadley Dike.

Depth: Average 1.8 meters, maximum of 2.5 meters.

Habitat: Clay and silt along the shoreline transitioning to gravel and cobble further out, with some sandy patches. Sparse submerged aquatic vegetation.

Flow rate: Moderate.

Mussel Findings: Eastern ellipto (thousands); no other species observed.

2.1.1.13 Site 13

Transect: A 70x100 meter area adjacent to the mouth of the Mill River in Hadley, covering the eastern shoreline out to 100 meters towards the center of the river, one mile downstream of the Hatfield boat launch.

Depth: Average 1.9 meters, maximum of 2.4 meters.

Habitat: Primarily a mix of sand, gravel, and cobble, which transitioned to sand near the mouth of the Mill River. Abundant submerged aquatic vegetation just offshore of the east bank.

Flow rate: Light to moderate.

Mussel Findings: Eastern ellipto (abundant); no other species observed.

2.1.1.14 Site 14

Transect: A 50x100 meter area along the east side of the river just upstream of the scurve in Hatfield, about one mile upstream of the Hatfield boat launch. The survey area was within the broad, slightly impounded area upstream of the prominent ledges that constrict the channel and create the s-curve. The survey started approximately 40 meters offshore and then extended upstream along the shoreline.

Depth: 1 to 2.4 meters with an average of 2 meters. Submerged aquatic vegetation (primarily *Vallisneria*) was patchy.

Habitat: Mix of sand, silt, and gravel, with some light woody debris, and clay near the shoreline.

Flow rate: Light, though stronger toward the middle of the channel.

Mussel Findings: Eastern elliptio (thousands, many juveniles); no other species observed.

2.1.1.15 Site 15

Transect: Starting at the transmission line crossing, surveyors drift-dove a distance of 1.8 km downstream.

Depth: 1.0 to 2.7 meters, with an average of 2 meters.

Habitat: Primarily gravel and sand, with some cobble.

Flow rate: Light to moderate for most of this stretch, strong near the East bank. Submerged aquatic vegetation (primarily Vallisneria) was patchy and very abundant in some areas.

Mussel Findings: Eastern ellipto (high); no other species observed.

TABLE 2-1

Survey Site Locations (15) – Impoundment and Bypass Reach

Cite		Data	Dunation	Lawath	Ctout	Deliet	En al D	aint
Site		Date	Duration	Length	Start Point		End Point	
No.	Location	(2013)	(Hours)	(Meters)	Longitude	Latitude	Longitude	Latitude
1	Bypass Reach	Aug 1	4.00	250	-72.59088	42.21040	-72.59414	42.21134
2	Along Route 5 in Holyoke	Aug 6	1.00	50	-72.61309	42.25802	-72.61299	42.25808
3	Upstream and offshore from Mt. Holyoke College crew dock	Aug 6	4.00	125	-72.59842	42.26624	-72.59802	42.26730
4	Mt. Tom Power Plant (Across river)	Aug 6	4.25	275	-72.60608	42.28480	-72.60813	42.28530
5	Mitch's Island (Downstream)	Aug 6	5.25	130	-72.60801	42.29608	-72.60716	42.29714
6	Mitch's Island (East side)	Aug 5	4.00	210	-72.60455	42.30137	-72.60291	42.30278
7	Mitch's Marina	Sept 24-25	(2 days)	150	-72.59895	42.30605	-72.59818	42.30716
8	Mitch's Marina (Upstream, east side of river)	Aug 5	4.00	160	-72.59574	42.31119	-72.59638	42.30986
9	Upstream from Rainbow Beach	Aug5	4.00	100	-72.59237	42.32790	-72.59295	42.32801
10	West of Elwell Island (Upstream from bike path bridge)	Aug 1	2.00	175	-72.62125	42.33573	-72.62285	42.33671
11	Mill River (Hatfield)	Jul 31	3.00	150	-72.61641	42.35200	-72.61566	42.35179
12	Hadley Dike (Upstream) (west side of the river)	Jul 31	2.00	200	-72.58921	42.36065	-72.58918	42.36118
13	Mill River (Hadley) (Upstream)	Jul 31	2.00	100	-72.58945	42.38158	-72.58935	42.38219
14	Hatfield S-curve (Upstream)	Jul 31	2.00	150	-72.57686	42.39711	-72.57590	42.39767
15	Upper impoundment	Jul 31	4.00	1850	-72.58510	42.43520	-72.57956	42.41961

















2.1.2 Quantitative Survey (Impoundment)

Biologists repeated a quantitative survey within a 50x150 meter site near Mitch's Marina in Hadley (Figure 1). In a 2005 survey, this area contained a high concentration of yellow lampmussels, and therefore the site was selected for quantitative monitoring in 2009 and 2013. Within this site, 36 plots (size = 24 square meters [2.0 x 12.0 meters]) were placed in a systematic random array. Plots consisted of a pair of 12.0-meter long ropes connected on each end to 2.0-meter long PVC pipes that were anchored on each end. The long axis of the plot was parallel to the current. A centerline divided these plots into two long strips to facilitate careful searching. One SCUBA diver spent an average of 0.75 hours within each plot; two SCUBA divers completed the work over a period of two days.

The following information was gathered for each plot: count, shell length, and shell condition of each yellow lampmussel, presence of co-occurring mussels or clams, water depth, and substrate. Please refer to Table 2 for additional information regarding habitat data and mussel counts for the 36 plots established at the quantitative monitoring site near Mitch's Marina in Hadley. Analyses also included population size estimates for each species, mean shell length, and shell condition index for yellow lampmussels (Table 3). Shell condition refers to the degree of shell erosion; each animal was given a subjective numeric rank of 0 (very light shell erosion), 0.25 (light to medium shell erosion), 0.5 (medium shell erosion), 0.75 (medium to heavy shell erosion), or 1.0 (heavy shell erosion). These data were then averaged for all individuals in a sample to produce an index of shell condition. Subsurface animals were surveyed by raking and sieving sediments across the entire plot. Data were recorded underwater, no yellow lampmussels were returned to their original locations. Length-frequency and shell condition statistics, and population size estimates, were computed for yellow lampmussels.

Chart 1 depicts the frequency distribution of size classes of yellow lampmussels observed in the Connecticut River in 2013. Chart 2 depicts the frequency distribution of size classes of eastern pondmussels observed in the Connecticut River in 2013.

2.1.3 Semi-Quantitative and Qualitative Surveys (Impoundment and Bypass Reach)

Biologists conducted semi-quantitative (catch-per-unit-effort; CPUE) and qualitative surveys in 14 sites (Table 1, Figure 1). Eight of the sites had been semi-quantitatively surveyed in 2009, and this was repeated in 2013. Biologists conducted qualitative searches (unrestricted meander surveys) at five locations in the upper impoundment, and one location approximately 900 meters downstream from Brunelle's Marina in South Hadley.

Best available mussel habitats were selected as survey locations; target conditions included sand and fine gravel substrates in depths of one to six meters, with slow to moderate flow rate. Two SCUBA divers worked together at all times. Surveyors recorded the following information: species found, relative abundance of mussel species, counts of all state-listed mussels, CPUE statistics, length of all state-listed mussels, GPS data for survey locations, and a habitat description.

2.2 Holyoke Canal Survey (First and Second Level)

During the September 2011 and 2013 canal drawdowns, two biologists searched for yellow lampmussels in areas of the First and Second Level Canals that were found to contain yellow lampmussels during prior surveys. Biologists repeated transect surveys at three monumented 50-meter transects in the First Level Canal and four monumented 50-meter transects in the Second Level Canal (seven total transects) that had been established in 2005. The start and end points of each transect were recorded with GPS. Biologists searched for yellow lampmussels within one meter of the transect lines using visual surveys and excavation. Biologists recorded the shell length, shell condition, habitat, photograph, and location of each yellow lampmussel. General locations and densities of mussel beds, which were comprised almost entirely of eastern elliptio, were noted and mapped during each survey.

Please refer to Table 3-4 regarding a comparison (2011 and 2013) of the location, habitat, demographics and condition data collected for the yellow lampmussels observed in the First and Second Level canals.

Section 3 Findings

3.1 Impoundment and Downstream of Bypass Reach

3.1.1 Quantitative Survey

A total of 158 yellow lampmussels were encountered during the quantitative survey (Table 2). Yellow lampmussel counts averaged 4.39 animals/plot (range = 0-10) and densities averaged 0.183/m2 (range = 0.000-0.417/m2). The population estimate for yellow lampmussels in the entire study area was 1,372 individuals, with a 95 percent confidence interval of 1,133-1,610 individuals.

Average shell length of yellow lampmussels was 88.5 mm (range = 12.0-111.5 mm). The shell condition index for the entire sample was 0.11. Habitat was very homogenous throughout the study area, ranging in depth from 2.0-2.3 meters and with a substrate comprised of nearly 100 percent sand. For the first time, Asian Clams (*Corbicula fluminea*) were detected in the plots. Live animals, including some relatively large adult clams, were detected in 25 percent of the plots but at low densities.

3.1.2 Semi-Quantitative and Qualitative Surveys

A total of 214 yellow lampmussel, 85 eastern pondmussels (*Ligumia nasuta*), and one tidewater mucket (*Leptodea ochracea*) were encountered during the semi-quantitative surveys (Table 3). Other non-listed species encountered included eastern elliptio (*Elliptio complanata*), alewife floater (*Anodonta implicata*), and triangle floater (*Alasmidonta undulata*). Yellow lampmussel counts and CPUE were highly variable across the 14 survey sites, ranging from zero (Sites 2 and 12-15) to a high of 77. Highest yellow lampmussel CPUE was 18.1 mussels/hour, at Site 4. All eastern pondmussels were found at Site 8; 85 animals were found and the CPUE was 21.2 mussels/hour. One tidewater mucket was found at Site 8, marking the first time that this species has been found in the impoundment.

Average shell length of the 214 yellow lampmussels encountered during the timed searches was 83.1 mm (range = 15.5-108.5 mm). Most yellow lampmussels exhibited light shell erosion. Average shell length of the 85 eastern pondmussels encountered during the timed searches was 69.1 mm (range = 32.5-90.5 mm). Most eastern pondmussels exhibited light shell erosion. The tidewater mucket was 68.5 mm in length.

Yellow lampmussels were only found in three types of substrate: silty-sand, sand, and a coarse sand/fine gravel mix. Yellow lampmussels did not appear to have a depth preference, although our surveys were usually confined to areas from 1- 4 meters deep. Flow velocities were generally less than 0.25 m/s in areas where yellow lampmussels were most abundant. Areas with sand substrate and high flow velocities had high bedload (i.e., sand that moves across the bed of the channel and that is not in suspension) and sharply defined dune-like bedforms; these conditions are challenging for all mussel species. Areas with slower flow velocities had only slight bedload, a flatter microtopography, and a somewhat cohesive algal matrix overlying the sand; yellow lampmussels were rarely found in areas of the river with very strong flows, a substrate with high proportions of clay or rock, or among submerged aquatic vegetation. Other mussel

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species, especially eastern Elliptio, were very abundant in these types of habitats (often exceeding 200/m2).

All eastern pondmussels and tidewater muckets were found at Site 8 in clay, silt, and silty-sand in shallow water along the far left side of the river. There was almost no perceptible flow in this area. This area was densely vegetated with *Elodea* sp. and *Vallisneria* sp., and mussels were found among the dense vegetation.

3.2 Holyoke Canal Survey (First and Second Level)

2011: Two biologists conducted the survey on September 20, 2011. The day was cloudy with light rain, but visibility was relatively good in most of the survey areas, except for the area immediately to the east and west of the Route 116 Bridge where the water was very turbid. In the First Level Canal, two live yellow lampmussels were found (Table 4 and Table 5). One was found in Transect 1-1 and the other was located during the meander survey. No yellow lampmussels were encountered in the other two transects in this canal, and no shells of this species were found. In the Second Level Canal, surveyors found seven live yellow lampmussels and three yellow lampmussel shells during the meander survey; none of these were dewatered during the drawdown. No yellow lampmussels encountered in the canals was 73.0 mm (range = 60.0-88.0). Most yellow lampmussels exhibited light shell erosion; the condition index for the all animals was 0.08. Most yellow lampmussels were found in sand and gravel, often near or among larger rock.

2013: Two biologists conducted the survey on September 24, 2013. The day was sunny and water was clear. In the First Level Canal, one live yellow lampmussel (length = 73.0 mm) and two shells were found (Table 4 and Table 5). No yellow lampmussels were found along the three transects. In the Second Level Canal, surveyors found one live yellow lampmussel (length = 95.0 mm) and no shells. No yellow lampmussels were found along the four transects in the Second Level Canal. Asian clams were notably abundant in the First Level Canal, after being detected in the canal for the first time in 2012.

3.3 Overall Habitat Assessment

In total, 372 live yellow lampmussels were encountered during this survey. Consistently high yellow lampmussel CPUE in the reach from Brunelle's Marina to near Rainbow Beach suggest that a large population exists in the lower impoundment. Biodrawversity estimated with 95 percent confidence that 1,133-1,610 occurred within a 50x150 meter plot (a total area of 7,500 m²), which represents only 0.3 percent of the 5-mile reach that appeared to support similar—and in some cases higher—mussel densities. The population estimate and confidence intervals (i.e., variability) in the quantitative plot was remarkably similar in 2009 and 2013 (estimate = 1,380 in 2009, and 1,372 in 2013). Both juveniles and very old adults were represented in samples, indicating both longevity and recruitment in the population (Figure 2).

Yellow lampmussels exist at low densities in the 5-mile reach between Rainbow Beach and the mouth of the Mill River, which is across from the downstream end of the Hadley Dike. There is a distinct shift in habitat near the Hadley Dike, from a broad low-gradient reach with a dune-like bedform and sand substrate downstream, to a higher gradient reach with strong flows and a rockier substrate upstream. No yellow lampmussels were

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encountered upstream from the Hadley Dike in 2005, 2009, or 2013, and habitat in this reach is generally unsuitable for the species (based on apparent habitat preference in the lower impoundment). The impoundment has been poorly surveyed from Brunelle's Marina downstream to the Holyoke Dam. The wide and deep pool near the dam and under the Route 202 Bridge may support yellow lampmussels. Downstream from the Holyoke Dam, most of the upper bypass reach contains strong flows and an armored substrate; only one yellow lampmussel was found in four person-hours.

Eastern pondmussels (a Species of Special Concern in Massachusetts) had been detected in the downstream-most areas of the impoundment and in the Oxbow prior to this survey (Biodrawversity 2008, 2013), but this was the first time that the species was found in the middle reaches of the impoundment. Some relatively small animals (in the 30.0-39.9 size class) were detected as well as larger animals (Figure 3), indicating both recruitment and longevity, and also indicating that prior surveys missed these animals. All were found at Site 8, in an area along the eastern shoreline that had not been surveyed prior to 2013. Habitat conditions in this area were quite distinct: this was a very shallow, densely vegetated, depositional environment with a clay, silt, and silt-sand substrate.

The tidewater mucket (a Species of Special Concern in Massachusetts) was detected in the impoundment for the first time, in the same area where all of the eastern pondmussels were found.

The non-native and invasive Asian Clam was detected during the quantitative survey near Mitch's Marina for the first time.

In 2011 and 2013 combined, only one live yellow lampmussel was found in the seven monumented 50-meter transects in the Holyoke Canals. None had been found in the same seven transects in 2009. In 2011 and 2013, meander surveys yielded a combined total of ten live yellow lampmussels and five yellow lampmussel shells. These totals were far lower than what had been found in 2009, when 22 animals were found during meander surveys.

TABLE 3-1	
Site 7 Habitat Data (Mitch's Marine, Hadley)	

				Species Counts or Presence					
	Plot	Depth	% Sand	L. cariosa	E. complanata	C. fluminea			
	1-1	2.0	100	1	Р				
	1-2	2.3	100	2	Р				
	1-3	2.1	100	3	Р				
	1-4	2.3	100	2	Р				
	1-5	2.2	100	3	Р				
	1-6	2.0	100	6	Р				
	2-1	2.0	100	5	Р	Р			
	2-2	2.2	100	3	Р	Р			
	2-3	2.0	100	4	Р	Р			
	2-4	2.0	100	6	Р				
	2-5	2.0	100	4	Р				
	2-6	2.0	100	4	Р				
	3-1	2.0	100	4	Р	Р			
	3-2	2.0	100	10	Р				
	3-3	2.0	100	4	Р				
	3-4	2.1	100	3	Р				
	3-5	2.0	100	6	Р				
	3-6	2.0	100	4	Р				
	4-1	2.0	100	0	Р				
	4-2	2.0	100	3	Р	Р			
	4-3	2.1	100	9	Р	Р			
	4-4	2.1	100	3	Р				
	4-5	2.1	100	4	Р				
	4-6	2.1	100	5	Р	Р			
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	5-2	2.1	100	8	Р				
	5-3	2.1	100	4	Р				
	5-4	2.1	100	4	Р				
	5-5	2.2	100	7	Р				
	5-6	2.2	100	2	Р				
	6-1	2.1	100	3	Р				
	6-2	2.1	100	3	Р				
	6-3	2.1	100	7	Р	Р			
	6-4	2.2	100	6	Р	Р			
	6-5	2.2	100	10	Р				
	6-6	2.2	100	3	Р				
	Yellow	Lampmussel Summary	Data						
		, ,	Total Count	158					
			Average Per Plot	4.39					
		Avera	age Density (#/m2)	0.183					
			Population Estimate	e 1,372					
		95%	Confidence Interva	l					
		for	Population Estimate	e 1,133 - 1,610					
		Mear	Shell Length (mm)	88.5					
		Shell I	_ength Range (mm)	12.0 - 111.5					
		S	hell Condition Index	0.11					

P = Present

Section 3 Findings

TABLE 3-2

Species counts and CPUE statistics for state-listed species for survey sites in the impoundment and bypass reach

				Mus	sel Co	CPUE	(Mussels	s/Hr)		
C 11 -	Duration							1-0-	1.0	L : N -
Site	(nrs)	Laca	Leuc	LINA	Alun	Anim	EICO	Laca	LeOc	LINA
1	4.00	1	0	0	0	0	100s	0.25	0.00	0.00
2	1.00	0	0	0	0	0	Abundant	0.00	0.00	0.00
3	4.00	46	0	0	0	0	Abundant	11.50	0.00	0.00
4	4.25	77	0	0	0	0	Abundant	18.12	0.00	0.00
5	4.00	6	0	0	0	0	Abundant	1.50	0.00	0.00
6	4.00	38	0	0	0	1	Abundant	9.50	0.00	0.00
7	(2 days)	158	0	0	0	0	100s	-	-	-
8	4.00	30	1	85	1	0	Abundant	7.50	0.25	21.25
9	4.00	10	0	0	0	1	100s	2.50	0.00	0.00
10	2.00	5	0	0	0	0	Abundant	2.50	0.00	0.00
11	3.00	1	0	0	0	0	100s	0.33	0.00	0.00
12	2.00	0	0	0	0	0	Abundant	0.00	0.00	0.00
13	2.00	0	0	0	0	0	Abundant	0.00	0.00	0.00
14	2.00	0	0	0	0	0	Abundant	0.00	0.00	0.00
15	4.00	0	0	0	0	0	Abundant	0.00	0.00	0.00
	Total	372	1	85	1	2	Average	3.84	0.02	1.52

Species Abbreviations:

LaCa = Lampsilis cariosa

LeOc = Leptodea ochracea

LiNa = *Ligumia nasuta*

AlUn = Alasmidonta undulata

AnIm = Anodonta implicata

ElCo = Elliptio complanata

TABLE 3-3				
2011 and 2013 Survey Data Summary	– Canals (7 monumented	50-meter	transects)

			Start		E	nd	Mussels				
Level	Transect		Latitude	Longitude	Latitude	Longitude	Depth (m)	LaCa	AnIm	EICo	Substrate*
First	1	2011	40 007610	72 602607	42 207000	70 602004	0.20	1	0	0	Si-S-G
First	1	2013	42.207613	-72.603607	42.207980	72.603284	0.15	0	0	100	Si-S-G
First	2	2011	42 200100	72 602001	42 200500	70 400500	0.20	0	0	~1000s	Si-S-G
First	2	2013	42.208109	-72.603001	42.208508	12.602528	0.25	0	0	~1000s	Si-S-G
First	3	2011	42.208560	72 602654	42.208229	72.603073	0.30	0	0	~100s	Si-S-G
First	3	2013		-72.602654			0.10	0	0	80	Si-S-G
Second	1	2011	12 200077	2.208877 -72.596996	42.208881	72.597735	0.50	0	0	~100s	Si-S-G
Second	1	2013	42.208877				0.40	0**	0	~100s	Si-S-G-C
Second	2	2011	42 200700	70 507010	42.208763	72.597574	0.50	0	0	~100s	Si-S-G-C
Second	2	2013	42.208798	-12.391213			0.45	0	0	~100s	Si-S-G-C
Second	3	2011	42 200722	70 507641	42 200725	70 507145	0.50	0	0	~100s	Si-S-G-C
Second	3	2013	42.208733	-72.397641	42.208/35	12.39/105	0.55	0	3	~100s	Si-S-G-C
Second	4	2011	40 000700		42 200414		0.50	0	0	~100s	Si-S-G-C
Second	4	2013	42.208702	-72.597158	42.208614	12.59//02	0.60	0	1	~100s	Si-S-G-C

*Substrate abbreviations: Si = Silt, S = Sand, G = Gravel, C = Cobble

**One shell

Species Abbreviations:

LaCa = Lampsilis cariosa LeOc = Leptodea ochracea

LiNa = *Ligumia nasuta*

AlUn = Alasmidonta undulata

AnIm = Anodonta implicata EICo = Elliptio complanata

		Loc	ation					
				Length			Shell	
Year	Canal	Latitude	Longitude	(mm)	Gender	Age Estimate		Substrate*
2011	First	42.207758	-72.603510	71.0	Female	6 to 9	0.00	S-G
2011	First	42.209451	-72.601451	77.0	Male	7 to 10	0.25	S-G
2011	Second	42.205999	-72.593966	60.0	Female	4 to 6	0.00	S-G-C
2011	Second	42.206776	-72.594135	69.0	Female	6 to 9	0.00	S-G-C
2011	Second	42.207076	-72.594131	68.0	Female	6 to 9	0.00	S-G-C
2011	Second	42.207482	-72.593927	76.0	Male	7 to 10	0.00	S-G-C
2011	Second	42.207612	-72.594170	73.0	Female	7 to 10	0.25	S-G-C
2011	Second	42.208696	-72.596728	88.0	Female	>10	0.25	S-G-C
2011	Second	42.208733	-72.596781	75.0	Male	7 to 10	0.00	S-G-C
2013	First	42.207969	-72.603263	73.0	Male	6 to 9	0.00	S
2013	Second	42.208602	-72.597806	95.0	Female	>10	0.25	S-G

TABLE 3-42011 and 2013 Survey Data Summary - Yellow Lampmussels, Canals

*Substrate abbreviations: S = Sand, G = Gravel, C = Cobble

¹ "Condition" refers to the degree of shell erosion. O=no or very light shell erosion; 1=extremely heavy shell erosion

Section 3 Findings

Chart 1. 2013 Frequency Distribution Per Size Class – Yellow Lampmussels in the Connecticut River (n = 373).



Section 3 Findings





Section 4 Discussion

Section 4 Discussion

The 2013 impoundment and dam bypass reach survey utilizing the revised protocol yielded 158 yellow lampmussels during the two-day quantitative survey. A total of 214 yellow lampmussels, 85 eastern pondmussels and one tidewater mucket were encountered during the semi-quantitative and qualitative surveys.

Eastern pondmussels (a Species of Special Concern in Massachusetts) had been detected in the downstream-most areas of the impoundment and in the Oxbow prior to this survey (Biodrawversity 2008, 2013), but this was the first time that the species was found in the middle reaches of the impoundment. Some relatively small animals (in the 30.0-39.9 size class) were detected as well as larger animals (Figure 3), indicating both recruitment and longevity, and also indicating that prior surveys missed these animals. All were found at Site 8, in an area along the eastern shoreline that had not been surveyed prior to 2013.

The tidewater mucket (a Species of Special Concern in Massachusetts) was detected in the impoundment for the first time, in the same area where all of the eastern pondmussels were found.

The non-native and invasive Asian Clam was detected during the quantitative survey near Mitch's Marina for the first time and appears poised to become extremely abundant in this area of the river, similar to the dominance it has achieved in the lower Connecticut River in Connecticut. Asian clams had also been found downstream from the Holyoke Dam, in the Holyoke Canals, in the Oxbow, and in some nearby lakes prior to the 2013 impoundment survey.

In 2011 and 2013 combined, only one live yellow lampmussel was found in the seven monumented 50-meter transects in the Holyoke Canals. None had been found in the same seven transects in 2009. In 2011 and 2013, meander surveys yielded a combined total of ten live yellow lampmussels and five yellow lampmussel shells. These totals were far lower than what had been found in 2009, when 22 animals were found during meander surveys. We attribute this to a much lower drawdown in 2009 that exposed a larger area (especially in the Second Level Canal) than was exposed in 2011 or 2013, and the greater emphasis on meander surveys in 2009 (this was a special request from NHESP due to the deeper drawdown). Because the drawdown depth and water clarity at the time of a survey exert such a strong influence on survey methods and results in the canal, it is difficult to draw any conclusions about yellow lampmussel population trends in the canal. Asian clams seem to have become established and abundant in the canals, especially in the First Level Canal, in the last 2-3 years.

The biennial canal surveys from 2003 to 2013 underwent significant changes in survey protocols, particularly with the increase from three to five transects from 2003 to 2005, the focus on meander surveys (and no transects at all) in 2007, and the establishment of seven new transects and inclusion of meander surveys in 2009. Methods and analyses were consistent from 2009 to 2013. Throughout all of these years, one consistent theme was that the transects were ineffective at characterizing the density and demographics of the yellow lampmussel population in the canals, due either to the number, size, or placement of transects. Yellow lampmussels were not detected in transects in 2003, 2005, 2009, or 2013; one was detected in a transect in the First Level Canal in 2011.

Section 4 Discussion

These data provide little insight on the yellow lampmussel population in the canals, except that the "population", if present, is too small to be detected with the study design. The same conclusion can be drawn for the alewife floater population in the canals. Varying densities of eastern elliptio, from less than 1.0 mussels/m² to nearly 100 mussels/m² were documented each year. The variable and typically low densities of eastern elliptio in the canals are also difficult to characterize with the transect surveys. The dense eastern elliptio beds along the eastern side of the First Level Canal from the cement cofferdam upstream to the Cabot Street Bridge was mostly unchanged during the period from 2005 to 2013, though greater evidence of mortality within these beds was noted in 2013. The cause of the mortality was not apparent, but it did not appear to be from exposure.

Qualitative (meander) surveys were more effective at detecting yellow lampmussels (and alewife floaters) in the canals. This allowed some information to be gathered on the size, gender, shell condition, and habitat of yellow lampmussel. Yellow lampmussels were detected in the canals in 2005 (2 live), 2007 (10 live), 2009 (22 live), 2011 (8 live), and 2013 (2 live), for a total of 44. Of these, seven were found in the First Level Canal and 37 were found in the Second Level Canal. Several shells were also found from 2005 to 2013. Biodrawversity attributes the higher number of yellow lampmussels found in 2009 to a much lower drawdown that exposed a larger area (especially in the Second Level Canal) than was exposed in other years, and the greater emphasis on meander surveys in 2009 (this was a special request from NHESP due to the deeper drawdown). Because the drawdown depth and water clarity at the time of a survey exert such a strong influence on survey results in the canal, it is difficult to draw any conclusions about yellow lampmussel population trends in the canal. Asian clams seem to have become established and abundant in the canals, especially in the First Level Canal, in the last 2 to 3 years.











6,000 Feet 1,500 3,000

FIGURE 1, PAGE 2 OF 2 MUSSEL SURVEY TRANSECTS



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Canal Mussel Survey Holyoke, Massachusetts

Tighe&Bond

January 2014

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PHOTOGRAPHS

RARE MUSSEL SPECIES SURVEY REPORT 2013



Photo 1. Two lines of buoys at the quantitative monitoring plots near Mitch's Marina (Site 7). These buoys indicate the position of the 2.0 x 12.0 meter plots.



Photo 2. Connecticut River Site 1. View from public boat ramp upstream toward the Holyoke Dam bypass reach and Route 116 Bridge. Surveyors swam diagonally across the river to the sandbar of the island situated between the tailrace and bypass reach.

Photographs

RARE MUSSEL SPECIES SURVEY REPORT 2013

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Photo 3. Mitch's Marina (Hadley). View from the sandbar at the upstream end of Mitch's Island. Approximate area of Site 7 is depicted (2009).



Photo 4. SCUBA diver setting up a 2.0 x 12.0 meter plot for the quantitative survey (2009).

Photographs

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Photo 5. Representative view of Second Level Canal during 2011 survey.



Photo 6. Surveyor looking for yellow lampmussels along a transect line (2011).

Photographs

RARE MUSSEL SPECIES SURVEY REPORT 2013



Photo 7. Tidewater mucket (Leptodea ochracea) found at Site 8 (2013).



Photo 8. Eastern Pondmussel (Ligumia nasuta) found at Site 8 (2013).

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