

**2012 Zebra Mussel (*Dreissena polymorpha*) Early Detection Project  
in the Housatonic River and Candlewood Lake:  
Falls Village, Bulls Bridge, and Rocky River Hydroelectric Projects**

HOUSATONIC RIVER PROJECT, FERC NO. 2576

*prepared for*

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Exposed ledge along the Candlewood Lake shoreline, where zebra mussel surveys were conducted in February 2013.

## INTRODUCTION

Zebra mussels (*Dreissena polymorpha*) were discovered in Lake Lillinonah and Lake Zoar in October 2010, and in Lake Housatonic in 2011, prompting concern about their potential presence elsewhere in the Housatonic River watershed (Biodrawversity 2011, 2012a, 2013). Zebra mussels are also established in several other waterbodies in the region, including the Hudson River in New York, East and West Twin Lakes in Connecticut, and Laurel Lake in Massachusetts.

The zebra mussel population in Laurel Lake, discovered in 2009, has been shown to export veligers to the Housatonic River (Biodrawversity 2009, 2013), but the distance that these veligers drift and their viability with distance from Laurel Lake are not known. The Housatonic River is 149 miles long, with approximately two-thirds of its length in Connecticut. With established populations at the northern and southern ends of the Housatonic River, and numerous possible dispersal vectors between infested and other susceptible waterbodies, it was prudent to establish an early detection program for zebra mussels in the Housatonic River and Candlewood Lake.

In 2011, FirstLight Power Resources (FLPR) began a monitoring program for zebra mussels in the Housatonic

River at the Falls Village, Bulls Bridge, and Rocky River hydroelectric facilities, and in Candlewood Lake (Biodrawversity 2012b). The monitoring plan was developed to gain a better understanding of (1) the presence/absence of zebra mussel adults or larvae, (2) adult population density, (3) colonization rate, and (4) habitat suitability. The plan included visual inspections and SCUBA surveys to search for adult zebra mussels, approximately biweekly collection of veliger samples at four locations from May to October, and deployment of artificial substrate samplers



Zebra mussel (*Dreissena polymorpha*).

at four locations. This plan is part of FLPR's Nuisance Species Monitoring Plan for its Housatonic River Project (FERC Project #2576). The monitoring program was repeated without modification in 2012.

## METHODS

**Study Sites:** Study sites were in the Housatonic River and Candlewood Lake, primarily near FLPR's hydroelectric facilities. Monitoring was conducted in four areas (Appendix 1, Maps 1–5), and the types of monitoring that were conducted are described in Table 1.

**Diving Surveys and Visual Inspections:** Underwater surveys included both SCUBA diving and snorkeling at Falls Village, Bulls Bridge, Rocky River stations, and Candlewood Lake, for a minimum of 3.0 person-hours per location (2 people x 1.5 hour), with more time (5 person-hours) spent SCUBA diving in Candlewood Lake. During periods of drawdown in the Falls Village Canal, Bulls Bridge Canal, and Candlewood Lake, biologists carefully searched dewatered areas, turning over cobbles and small boulders, and scrutinizing all cracks and crevices of exposed ledge. In the canals, the biologists also scanned and turned over rocks that were submerged but reachable by wading (generally less than two feet); this was not done in Candlewood Lake because the lake was frozen during the winter drawdown survey. For the drawdown surveys, levels of effort included one full day (x 2 people) in each of the canals, and two full days (x 3 people) in Candlewood Lake. Biologists noted the presence of any native or non-native bivalves, and recorded habitat conditions.

**Artificial Substrates:** Multiplate samplers were deployed at four locations in late April and early May, and collected in October. The samplers, purchased from Wildlife Supply Company, were constructed with four masonite plates that were 6, 8, 10, and 12 inches square, with the smallest plate on top, and these were separated by a 1-inch piece



Top: Searching for zebra mussels on exposed rocks in the dewatered Bulls Bridge Canal. Bottom: Concrete walls and bottom of the Falls Village Canal.

of PVC. They were secured with a steel cable and hung at a depth suitable for the specific conditions at each site. A brick counterweight was connected underneath to help stabilize the samplers in the water column.

At the end of the colonization period, the samplers were collected, kept cool during transport, and refrigerated overnight. Samples were processed the next day. The

**Table 1.** Types of monitoring performed at each of the project areas between March 2012–February 2013.

Location	Adult Zebra Mussel Surveys	Plankton Tows (# Dates/# Samples)	Artificial Substrates
Falls Village	Lower impoundment (SCUBA): 1 site, 3/21/12 Entire length of canal during drawdown, 9/4/12	13/13	2*
Bulls Bridge	Lower impoundment (SCUBA): 1 site, 3/20/12 Entire length of canal during drawdown, 10/3/12	13/13	2
Rocky River Tailrace	Tailrace inlet and nearby river (SCUBA/snorkel): 10/4/12	13/13	2
Rocky River Intake	Shoreline near the intake structure during winter drawdown: 2/5/13	13/13	2
Candlewood Lake	Along the length of the dam (SCUBA): 1 long site, 3/20/12 Lake shoreline during winter drawdown: multiple locations, 2/5-2/6, 2013	-	-

\*1 lost during the colonization period



Plankton net in shallow water.

first step in processing the sample was to carefully dismantle the device and visually inspect all surfaces for large zebra mussels. To look for juvenile zebra mussels, all surfaces were then scraped clean, the scraped material collected and washed through a 600-micron sieve, and the retained material examined under a dissecting microscope.

**Veliger Sampling:** Plankton samples were taken approximately biweekly, starting on April 17 and ending on October 5. Samples were collected with a 33-E28 Veliger Net purchased from the Wildlife Supply Company. In flowing water (Rocky River tailrace, Bulls Bridge, and Falls Village), samples were taken by holding the net horizontally in the water column, typically 12 inches below the surface, for at least 60 seconds. The net was placed in light currents so that water could pass through the fine mesh without “backing up” and causing flow to divert around the net. At Rocky River Intake, 2–4 individual vertical plankton tows were collected between a depth of ~15 feet and the surface, and then combined into a single composite sample. Once collected, samples were placed in 500 mL Nalgene containers and preserved with 90 percent alcohol in the field and kept cool while transported. In the office, old alcohol was decanted and bottles were refilled with 70 percent alcohol.

Samples were analyzed under a dissecting microscope at 45X magnification, under cross-polarized light. An ocular micrometer was used to measure lengths of all bi-



Artificial substrate sampler being collected from the Rocky River Intake at the end of the colonization period.

refringent organisms (bivalves and ostracods) to help with identification. For each sample, the general approach was to put small amounts (5–10 mL) of the sample into a petri dish and record the time it took to scan that amount, and repeat that a minimum of five times per sample. The total volume of material and the total time expended on each sample were recorded. The volume of material analyzed ranged 25–75 mL per sample, and the total time expended ranged 30–90 minutes per sample.

## RESULTS

### I. Diving Surveys for Adult Zebra Mussels

**Falls Village Impoundment:** On March 21, 2012, two SCUBA divers surveyed the lower end of the Falls Village impoundment, starting near the canoe launch just upstream from the dam. Substrate was primarily silt and sand, but there were some large boulders a short distance upstream on the side opposite the canoe launch. No live or dead zebra mussels were detected. Eastern elliptio (*Elliptio complanata*) was observed at moderate densities; triangle floater (*Alasmidonta undulata*), eastern floater (*Pyganodon cataracta*), and eastern lampmussel (*Lampsilis radiata*) were observed at very low densities.

**Bulls Bridge Impoundment:** On March 20, 2012, two SCUBA divers surveyed the main channel at the down-

**Table 2.** Results of surveys for adult zebra mussels, including the native freshwater mussels encountered in each area.

Location	Survey Time		Species*						
	(hrs)	Method	DrPo	CoFl	ElCo	PyCa	StUn	AlUn	LaRa
Falls Village Lower Impoundment	3.0	SCUBA	-	-	X	X	-	X	X
Falls Village Canal	16.0	Walk/Wade							
Bulls Bridge Lower Impoundment	3.0	SCUBA, Snorkel	-	-	X	X	-	-	X
Bulls Bridge Canal	16.0	Walk/Wade	-	-	X	X	X	X	X
Rocky River Tailrace	3.0	SCUBA, Snorkel	-	-	X	-	-	-	-
Candlewood Lake	5.0	SCUBA	-	X	X	X	-	-	-
Candlewood Lake	45.0	Walk/Wade	-	X	X	X	-	-	-

\*Species Abbreviations: DrPo = *Dreissena polymorpha* (zebra mussel), CoFl = *Corbicula fluminea* (Asian clam), ElCo = *Elliptio complanata* (eastern elliptio), LaRa = *Lampsilis radiata* (eastern lampmussel), PyCa = *Pyganodon cataracta* (eastern floater), StUn = *Strophitus undulatus* (creeper), AlUn = *Alasmidonta undulata* (triangle floater)

stream end of the Bulls Bridge impoundment, to depths of eight feet. Substrate was primarily silt, sand, and scattered cobble. No live or dead zebra mussels were detected. Very few native mussels were observed; these included eastern elliptio, eastern floater, and eastern lampmussel.

**Rocky River Tailrace:** On October 4, 2012, one SCUBA diver and one snorkeler surveyed areas near the Rocky River Power House when the turbines were not running. Divers searched the concrete structures of the facility from the surface down to depths of at least 20 feet, as well as the cobble and boulder substrates along the bottom near the facility and in the river just upstream from the tailrace. No live or dead zebra mussels were detected. Surveyors found low densities of eastern elliptio. The Rocky River tailrace was not surveyed in March because water was being pumped up to Candlewood Lake, and therefore a supplemental SCUBA and snorkel survey was conducted in the pool below Boardman Bridge, one mile upstream. Neither live nor dead zebra mussels were found at Boardman Bridge.

**Candlewood Lake:** On March 20, 2012, two SCUBA divers searched for adult zebra mussels along the face of the dam, at depths of 2–22 feet. Substrate included a mix of silt (predominant in deeper water), sand, gravel, cobble, and few boulders. No live or dead zebra mussels were detected. Asian clams (*Corbicula fluminea*), eastern elliptio, and eastern floater were observed at low densities.

## II. Visual Inspections During Drawdowns

**Bulls Bridge Canal:** On October 3, 2012, two biologists surveyed approximately 0.9 miles of the Bulls Bridge Canal during the fall drawdown. The biologists walked the length of the canal, focusing survey efforts on substrates that zebra mussels prefer (e.g., hard surfaces), and where

water levels were sufficiently low to allow good access. The drawdown did not de-water the entire channel of the canal, and some portions remained too deep to survey safely. The canal contained large areas of suitable substrate for zebra mussels, including cement and iron structures, rip-rap, ledge, boulder, and cobble. The canal also had areas of seeping ledge that could possibly support zebra mussels even during extended drawdowns. No adult zebra mussels were observed. Five species of native freshwater mussel were observed: eastern elliptio, eastern floater, eastern lampmussel, triangle floater, and creeper.

**Falls Village Canal:** On September 4, 2012, two biologists surveyed the entire length of the Falls Village Canal during the fall drawdown. The biologists focused survey efforts on substrates that zebra mussels prefer (e.g., hard surfaces), and where water levels were sufficiently low to allow good access. The drawdown de-watered almost the entire canal, exposing large areas of suitable substrate for zebra mussels, including cement, ledge, boulder, and cobble. No adult zebra mussels or native mussels were observed.

**Candlewood Lake:** Three biologists spent two days (February 5–6, 2013) surveying for zebra mussels during the lowest point of Candlewood Lake's winter drawdown. Candlewood Lake was mostly frozen at the time of the survey, but snow cover was very light (<0.25 inches) and it was possible to thoroughly survey dewatered areas. Ice cover allowed surveyors to reach inaccessible shorelines by walking across the lake, particularly along the eastern edge of the long peninsula that divides the lake. Sites were chosen based on the presence of hard substrate, accessibility, and/or high boating traffic (e.g., state boat ramps). Substrates suitable for zebra mussels were plentiful, including cement (boat ramps, moorings, etc.), wood (docks and logs), ledge, boulder, and cobble. Zebra mussels were not



Exposed cobble and boulder field along the Candlewood Lake shoreline, where zebra mussel surveys were conducted in February 2013.

observed. Shells of Asian clams were found at several sites, and shells of two native mussels (eastern elliptio and eastern floater) were found at nearly all sites.

### III. Artificial Substrates

**Falls Village Canal:** On May 15, two samplers were hung from the boat barrier in the lower Falls Village impoundment, at a depth of three feet. One sampler was collected on October 4, 2012; the other was lost. Neither visual inspection nor examination of scraped materials under a microscope yielded any juvenile or adult zebra mussels.

**Bulls Bridge Impoundment:** On May 15, 2012, two samplers were hung from the boat barrier located just upstream of the Bulls Bridge Dam, on the eastern channel. The samplers were set at three feet below the surface. Both samplers were successfully collected on October 4, 2012. They were undamaged and unfouled (except for minor accumulation of senescent aquatic vegetation). Neither visual inspection nor examination of scraped materials under a microscope yielded juvenile or adult zebra mussels.

**Rocky River Tailrace:** On April 17, 2012, two samplers were hung at a depth of eight feet in the Rocky River tail-

**Table 3.** Locations, depths, deployment and retrieval dates, and presence of zebra mussels on the artificial substrate samplers.

Location	ID	Depth (ft)	Deployed	Collected	Zebra Mussels?
Falls Village Lower Impoundment	FV-1	3	5/15/12	Lost	-
Falls Village Lower Impoundment	FV-2	3	5/15/12	10/4/12	No
Bulls Bridge Lower Impoundment	BB-1	3	5/15/12	10/4/12	No
Bulls Bridge Lower Impoundment	BB-2	3	5/15/12	10/4/12	No
Rocky River Tailrace	RR-1	8	4/17/12	10/4/12	No
Rocky River Tailrace	RR-2	8	4/17/12	10/4/12	No
Rocky River Intake	RRI-1	4	4/17/12	10/4/12	No
Rocky River Intake	RRI-2	12	4/17/12	10/4/12	No

race; they were hung on separate cables from the guard-rails alongside the powerhouse, near where water exits from turbines but not within the strongest flows. Both samplers were collected on October 4, 2012. Neither visual inspection nor examination of scraped materials under a microscope yielded juvenile or adult zebra mussels.

**Rocky River Intake:** On April 17, 2012, two samplers were hung on a single cable from the rails of Rocky River's intake structure. These were positioned at depths of three and ten feet. Both of the samplers were successfully collected on October 4, 2012. Neither visual inspection nor examination of scraped materials under a dissecting microscope yielded any juvenile or adult zebra mussels.

#### IV. Veliger Monitoring

**Falls Village Canal:** There was no conclusive evidence of zebra mussel veligers in the samples from the Falls Village Canal. Like in 2011, small (80-150 micron) birefringent bivalves with straight hinges were observed in the late May and June samples, but shells of these organisms were taller than they were wide, and were more similar to the glochidia of native freshwater mussels (Biodrawversity 2012b). Ostracods were also observed in several samples.

**Bulls Bridge Impoundment:** There was no evidence of zebra mussel veligers in the samples from the Bulls Bridge impoundment. Low densities of ostracods were observed.

**Rocky River Tailrace:** Zebra mussel veligers were detected in the July 13 sample from the Rocky River tailrace. Three veligers were found in one hour of observation time. Native mussel glochidia, described above, were detected in the June samples, and low densities of ostracods were observed.

**Rocky River Intake:** There was no evidence of zebra mussel veligers in the samples from the Rocky River intake. Ostracods were observed in most of the samples.

#### CONCLUSION

Adult zebra mussels were not detected at any of the monitoring sites. Veligers were detected in the mid-July sample from the Rocky River tailrace. For both the 2011 and 2012 monitoring combined, adult zebra mussels still have not been found at any of the monitoring sites, and veligers have been documented in the Housatonic River in the Bulls Bridge impoundment and Rocky River tailrace.

To date, snorkel and SCUBA surveys in the Housatonic River from New Milford to the Massachusetts bor-

**Table 4.** Plankton sample results.

Location	Date	Sorted Volume (mL)	Sorting Time (mins)	Veligers
Falls Village	4/17/12	25	30	No
Falls Village	5/18/12	40	45	No
Falls Village	6/1/12	50	60	No
Falls Village	6/17/12	50	60	No
Falls Village	6/29/12	50	60	No
Falls Village	7/13/12	75	90	No
Falls Village	7/25/12	50	60	No
Falls Village	7/27/12	60	75	No
Falls Village	8/10/12	50	60	No
Falls Village	8/24/12	50	60	No
Falls Village	9/7/12	50	60	No
Falls Village	9/21/12	50	60	No
Falls Village	10/5/12	25	30	No
Bulls Bridge	4/17/12	25	30	No
Bulls Bridge	5/18/12	40	45	No
Bulls Bridge	6/1/12	50	60	No
Bulls Bridge	6/17/12	50	60	No
Bulls Bridge	6/29/12	50	60	No
Bulls Bridge	7/13/12	75	90	No
Bulls Bridge	7/25/12	50	60	No
Bulls Bridge	7/27/12	60	75	No
Bulls Bridge	8/10/12	50	60	No
Bulls Bridge	8/24/12	50	60	No
Bulls Bridge	9/7/12	50	60	No
Bulls Bridge	9/21/12	50	60	No
Bulls Bridge	10/5/12	25	30	No
Rocky River Tailrace	4/17/12	25	30	No
Rocky River Tailrace	5/18/12	40	45	No
Rocky River Tailrace	6/1/12	50	60	No
Rocky River Tailrace	6/17/12	50	60	No
Rocky River Tailrace	6/29/12	50	60	No
Rocky River Tailrace	7/13/12	75	90	YES
Rocky River Tailrace	7/25/12	50	60	No
Rocky River Tailrace	7/27/12	60	75	No
Rocky River Tailrace	8/10/12	50	60	No
Rocky River Tailrace	8/24/12	50	60	No
Rocky River Tailrace	9/7/12	50	60	No
Rocky River Tailrace	9/21/12	50	60	No
Rocky River Tailrace	10/5/12	25	30	No
Rocky River Intake	4/17/12	25	30	No
Rocky River Intake	5/18/12	40	45	No
Rocky River Intake	6/1/12	50	60	No
Rocky River Intake	6/17/12	50	60	No
Rocky River Intake	6/29/12	50	60	No
Rocky River Intake	7/13/12	75	90	No
Rocky River Intake	7/25/12	50	60	No
Rocky River Intake	7/27/12	60	75	No
Rocky River Intake	8/10/12	50	60	No
Rocky River Intake	8/24/12	50	60	No
Rocky River Intake	9/7/12	50	60	No
Rocky River Intake	9/21/12	50	60	No
Rocky River Intake	10/5/12	25	30	No

der, comprising nearly 50 sites and more than 100 person-hours of survey effort, have resulted in the discovery of only one adult zebra mussel (Biodrawversity 2013). This mussel was found in Cornwall, in a pool upstream from the Cornwall Covered Bridge. Despite the extreme rarity

of zebra mussels in this reach of the Housatonic River, other studies have provided strong evidence that zebra mussel populations are establishing and increasing in size both upstream in Massachusetts (Biodrawvversity 2012c, Ethan Nedeau unpublished data) and downstream in Lake Lillinonah and Lake Zoar (Biodrawvversity 2012a). Based on the spatial distribution, density, and shell lengths of zebra mussels collected in Lake Lillinonah in November 2012, we are nearly certain that a large up-river source is responsible for recent recruitment within the lake. The large zebra mussel population in Laurel Lake (MA), along with newly discovered large adult populations in the Housatonic River near a hydropower project in Stockbridge (MA), are the most likely sources.

FLPR's veliger monitoring has demonstrated that veligers are in the Housatonic River. This answered one of the key questions that the monitoring was designed to address. However, the study plan was not designed to fully characterize the density and temporal distribution of veligers. For example, the study was only able to detect D-shaped (or larger) larvae whose birefringence pattern had fully developed. It is quite possible that eggs, sperm, and early larval stages (i.e., trochophore and early straight-hinged larvae, generally less than 80–90 microns) are being transported and FLPR's monitoring would not have detected these life stages.

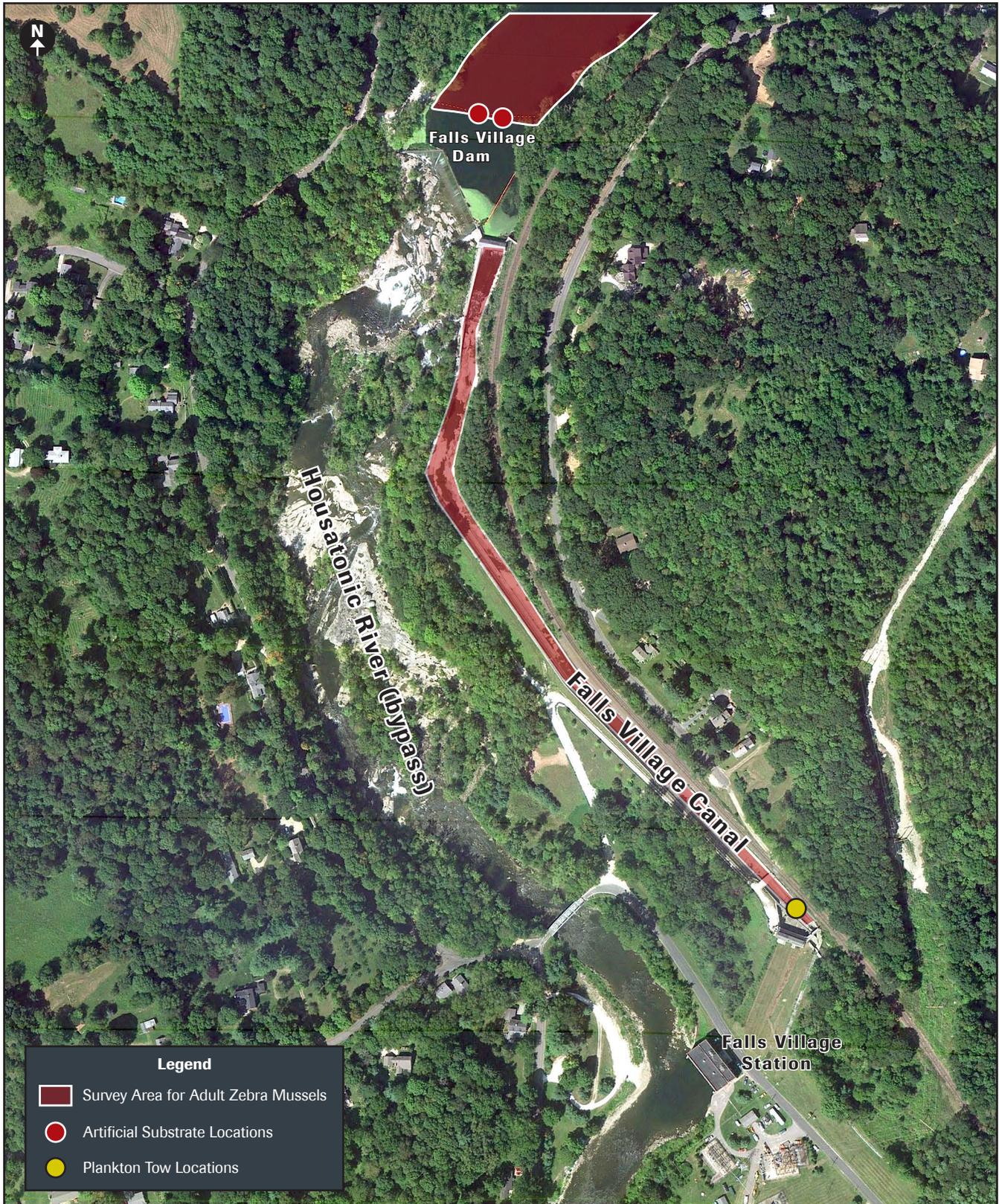
FLPR plans to submit this report to FERC after consultation with stakeholders at the annual NSMP Technical Committee meeting. Any modifications to the 2013 monitoring will be discussed as part of FLPR's annual FERC filing.

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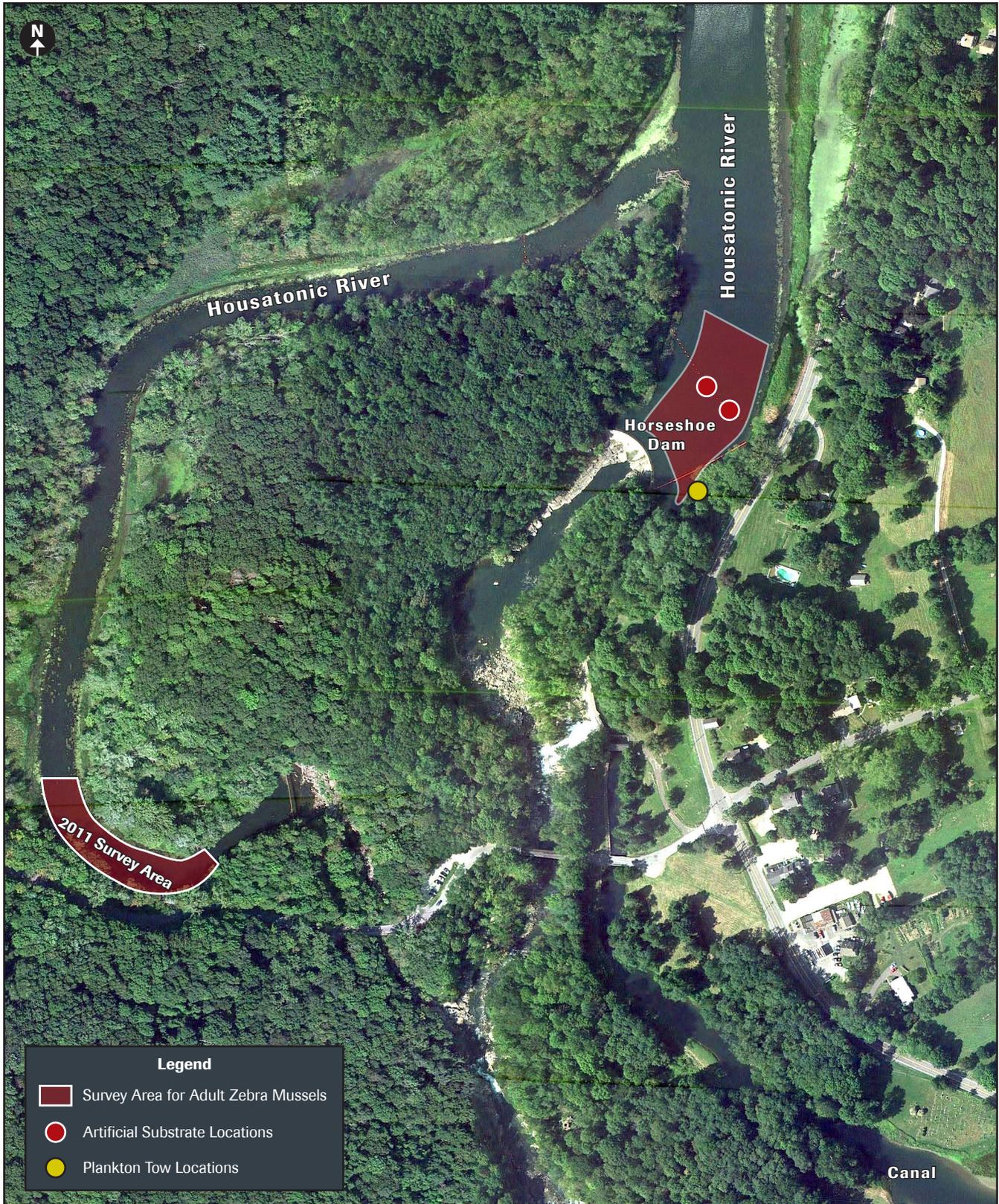
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# APPENDIX 1 - MAP 1

## Monitoring Sites at the Falls Village Hydroelectric Facility

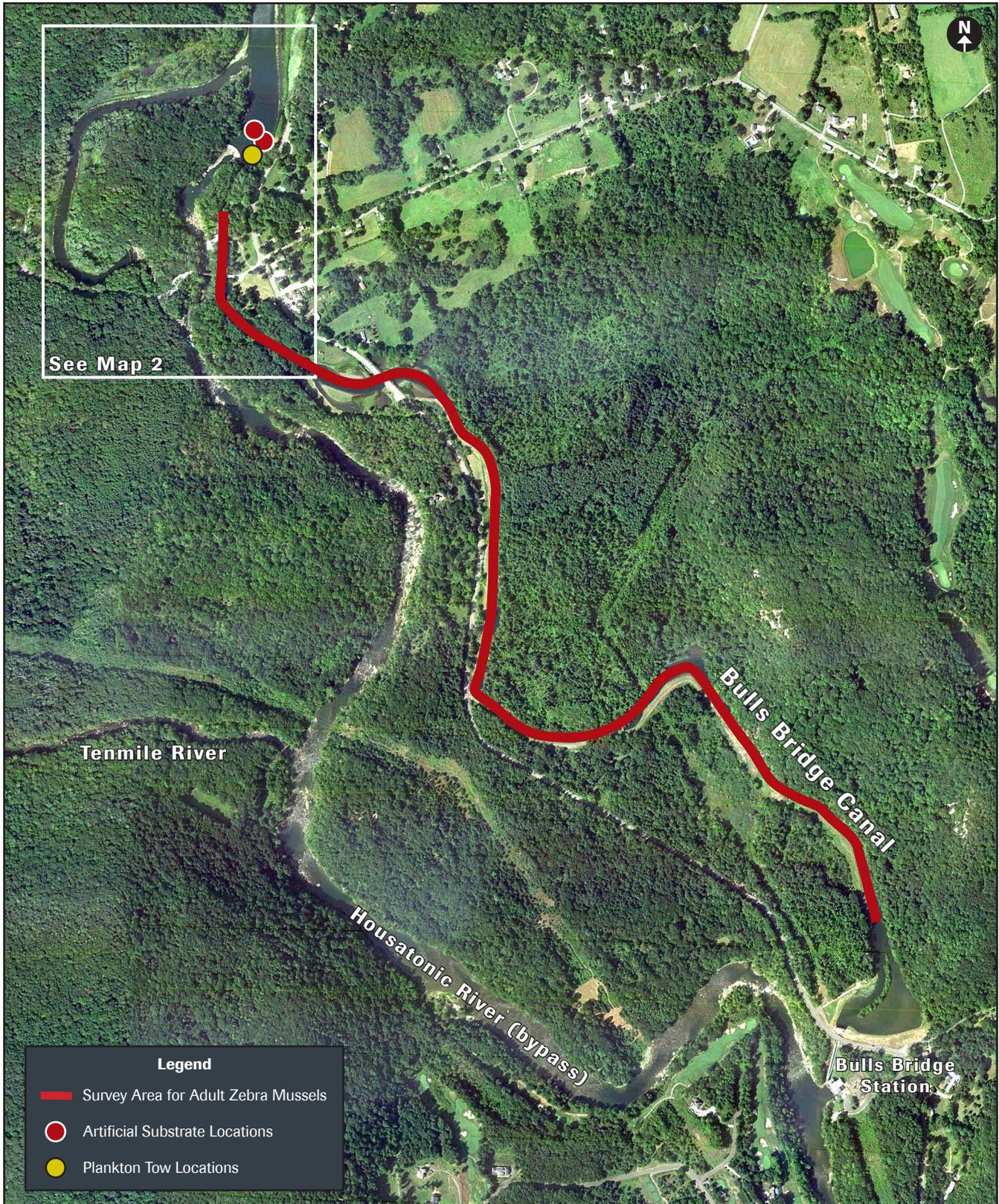


## APPENDIX 1 - MAP 2 Monitoring Sites at the Bulls Bridge Impoundment



# APPENDIX 1 - MAP 3

## Survey Area in the Bulls Bridge Canal



APPENDIX 1 - MAP 4

# Monitoring Sites at the Rocky River Hydroelectric Facility



# APPENDIX 1 - MAP 5 Monitoring Sites in Candlewood Lake

