Zebra Mussel Phase I Assessment

Physical, Chemical, and Biological Evaluation of 20 Lakes and the Housatonic River in Berkshire County, Massachusetts

prepared by
Biodrawversity LLC

prepared for
Massachusetts Department of Conservation and Recreation, Lakes and Ponds Program

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Prepared for:

Massachusetts Department of Conservation and Recreation
Lakes and Ponds Program
251 Causeway Street, Suite 700
Boston, Massachusetts 02114-2104

Prepared by:

Biodrawversity LLC
441 West Street, Suite F
Amherst, Massachusetts 01002

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EXECUTIVE SUMMARY

Following the discovery of zebra mussels in Laurel Lake (Lee and Lenox, Massachusetts), Biodrawversity LLC was hired to conduct a Phase I Assessment of 17 Berkshire County lakes and the mainstem Housatonic River for the presence of zebra mussels (*Dreissena polymorpha*) and the potential of these waterbodies to support zebra mussels based on physical, chemical, and biological parameters. Fieldwork was conducted between September 8 and October 23, 2009. The Massachusetts Department of Conservation and Recreation (DCR) Lakes and Ponds Program performed similar studies at three additional lakes. Data were collected at two to six sites per lake (84 total sites) and 31 sites in the Housatonic River including a continuous 0.5-mile reach downstream of Laurel Brook. Data collection included some combination of the following at each site: secchi depth, water temperature, vertical profiles for dissolved oxygen and temperature, water chemistry (dissolved oxygen, pH, alkalinity, calcium, total nitrogen, total phosphorus, total suspended solids), adult zebra mussels, zebra mussel veligers, substrate, and the species composition and abundance of submerged aquatic plants, snails, and native freshwater mussels.

The pH of waterbodies ranged from 6.79 to 8.55, alkalinities ranged from 4.0 to 162.0 mg/L, and calcium concentrations ranged from 2.0 to 44.0 mg/L. Calcium and pH are widely considered the most critical parameters in assessing the susceptibility of a waterbody to zebra mussel survival and reproduction; low-risk waterbodies usually have pH below 7.4 and calcium below 12 mg/L, whereas high-risk waterbodies usually have pH above 8.0 and calcium above 20 mg/L. The 21 waterbodies surveyed for this report, were divided into three categories based on their susceptibility to successful colonization by zebra mussels:

- **Low Risk** (seven waterbodies): Benedict Pond, Big Pond, Center Pond, Goose Pond, Otis Reservoir, Thousand Acre Pond, and Windsor Pond
- **Medium Risk** (four waterbodies): Ashmere Lake, Shaw Pond, Lake Garfield, and Plunkett Reservoir
- **High Risk** (ten waterbodies): Cheshire Reservoir, Housatonic River (Great Barrington to Pittsfield), Lake Buel, Lake Mansfield, Laurel Lake, Onota Lake, Pontoosuc Lake, Prospect Lake, Richmond Pond, and Stockbridge Bowl

Zebra mussel adults and veligers were detected in Laurel Lake, Laurel Brook, and the Housatonic River. Adult zebra mussels were encountered in the Housatonic River along a nearly one-mile reach downstream of Laurel Brook, and a single mature adult was found in Stockbridge, 6.95 miles downstream of the Laurel Brook confluence. Veligers are reaching the Housatonic River from Laurel Brook and the broken water pipe that runs from Laurel Lake to the Eagle Mill Building (Laurel Lake Water Power, LLC) alongside the Housatonic River in Lee. The size distribution of adult zebra mussels in Laurel Lake and the Housatonic River indicate that these populations may have been established for one to three years. The establishment of a self-sustaining zebra mussel population in the Housatonic River, and the rate at which they spread downstream, may be limited by the physical and chemical conditions present in a small and dynamic river environment.

A total of 37 aquatic plant species, 15 snail species, and five native mussel species were encountered during the project. Species richness was calculated and compared across lakes to look for trends. Biological indicators with high correlation to "High Risk" lakes included presence of the submerged aquatic plant *Chara sp.*, high species richness of aquatic snails, and two of the more calcium-dependent snail species.

Zebra mussels were detected in Laurel Lake in the summer of 2009.

INTRODUCTION

The zebra mussel (*Dreissena polymorpha*) was accidentally introduced to North America in the late 1980s by commercial shipping vessels carrying freshwater ballast from the Black or Caspian Sea region of Eastern Europe (Hebert *et al*. 1989, Strayer 2009). Within ten years of its discovery in Lake Erie in 1987, the zebra mussel had spread throughout much of central and eastern North America. By 1998, it had spread as far eastward as the Hudson River in New York (1991), Lake Champlain in Vermont (1993), and East Twin Lake in northwestern Connecticut (1998). It has since spread to other smaller waterbodies in the Northeast, including Lake George (New York), Lake Bomoseen (Vermont), West Twin Lake (Connecticut), and some larger tributaries—and associated lakes—of the Hudson River and Lake Champlain. The United States Geological Survey's (USGS) Nonindigenous Aquatic Species (NAS) Program website provides time series maps, current sightings, and other information relevant to the spread of zebra mussels in all of North America.

Zebra mussels (*Dreissena polymorpha*) and the closely related quagga mussel (*Dreissena bugensis*) have caused ecological and economic damage throughout North America (MacIsaac 1996, Strayer 2009). Like blue or ribbed mussels in marine environments—and unlike any native freshwater mollusks in North America—adult dreissenid mussels attach to solid objects using strong byssal threads. Once established in a waterbody, they have the potential to alter basic ecosystem functions such as nutrient cycling and food web dynamics, they may eliminate native freshwater mussels via fouling and competition, and they can influence the fate and transport of contaminants (Nalepa 1993, Bruner *et al*. 1994a-b, MacIsaac 1996, Strayer 1999).

Until July of 2009, the zebra mussel had not been detected in waterbodies in Massachusetts. Adult zebra mussels were detected by a Town of Lee employee and

Adult zebra mussel from the Housatonic River in Lee.

Housatonic River in Great Barrington.

lake abutter in Laurel Lake in July of 2009 and confirmed by the DCR Lakes and Ponds Program. DCR biologists found adults and veligers in Laurel Lake and adults in Laurel Brook. The discovery of zebra mussels in Laurel Lake prompted a series of actions by state agencies that are summarized in the *Massachusetts Interim Zebra Mussel Action Plan* (DCR and DFG 2009). The *Interim Zebra Mussel Action Plan* also provides an overview of zebra mussel species taxonomy, ecology, origin and distribution.

Zebra mussels attached to the shell of a native freshwater mussel from Lake Champlain in Vermont.

The discovery of zebra mussels in Laurel Lake prompted concerns about whether other Massachusetts waterbodies may have zebra mussels and how susceptible other waterbodies are to colonization by zebra mussels. Susceptibility of southern New England waterbodies to zebra mussel invasion was first assessed in the early 1990s when zebra mussels were first approaching the region (Murray *et al.* 1993, Smith 1993, Whittier *et al.* 1995). Other assessments were completed for the United States or North America (Neary and Leach 1991, Strayer 1991, Drake and Bossenbroek 1994). These assessments were based primarily on calcium concentrations in surface waters, although alkalinity, pH, phosphorus, temperature, altitude, and several other factors were also used in models. In general, waterbodies with high calcium concentrations, high alkalinity, and high pH were considered most suitable for zebra mussel recruitment and survival.

In Massachusetts, only the Hoosic and Housatonic River watersheds were characterized as highly susceptible to zebra mussel invasion (Smith 1993). The Connecticut River watershed (with the exception of the Millers and Chicopee watersheds) and most of eastern Massachusetts were moderately to marginally susceptible. The Millers and Chicopee watersheds, the coastal plain of southeastern Massachusetts, and Cape Cod could not support zebra mussels (Smith 1993). There is considerable variation in the water chemistry of lakes and streams in the Hoosic

and Housatonic watersheds. Therefore, specific studies of numerous waterbodies were needed to predict where zebra mussels would be most likely to survive, if they were to be introduced more widely in the region.

In response to the discovery of zebra mussels in Laurel Lake, DCR sought a contractor to conduct a Phase I Assessment of 17 Berkshire County lakes and the mainstem Housatonic River for the presence of zebra mussels and the potential of these waterbodies to support zebra mussels based on physical, chemical, and biological parameters established in the scientific literature.

STUDY SITE SELECTION

Seventeen lakes and ponds in Berkshire County were chosen for this study, as well as five locations along the mainstem Housatonic River from Pittsfield to Lenox. DCR biologists surveyed three additional lakes and the results are included in this report (Figures 1-2, Table 1). DCR chose lakes based primarily on available water chemistry data (pH, alkalinity, and calcium), along with level of recreational use. Housatonic River sites were chosen based on habitat characteristics and access; five sites were surveyed specifically for the DCR-funded contract but the contractor surveyed 26 other locations in the mainstem Housatonic River from Pittsfield to Sheffield (shown on Figure 2) as part of a contract with the Division of Fisheries and Wildlife (Natural Heritage and Endangered Species Program) to survey native freshwater mussels in the watershed. Results from all the Housatonic River work, as they pertain to zebra mussels, are included in this report.

Within lakes, sampling sites were intended to include a minimum of three areas: (1) the lake outlet, (2) the public boat ramp, and (3) the deep basin. In some cases, the lake outlet and boat ramp were located near each other and these sites were combined. SCUBA surveys for adult mussels were generally not conducted in deepest areas of the deep lakes where anoxic conditions and gyttja (defined as a fine-grained, nutrient-rich mud found in depositional areas of lakes and ponds) precluded most macroinvertebrates; however, other parameters were recorded at these locations. Likely surfaces for zebra mussel colonization, such as rocky substrates, piers, anchors, mooring lines, concrete walls, bridge abutments and other surfaces were generally targeted for adult zebra mussel surveys. The number of sampling sites per lake ranged from two to six, for 84 lake sites and an average of 4.2 sites per lake.

Table 1. 21 waterbodies surveyed for this study.

Waterbody	Town	Watershed	Date Surveyed	Sites
Ashmere Lake	Hinsdale/Peru	Housatonic	9/9/2009	6
Benedict Pond	Great Barrington/Monterey	Housatonic	9/14/2009	4
Big Pond	Otis	Farmington	9/2/2009	5
Center Pond	Becket	Westfield	9/17/2009	4
Cheshire Reservoir	Cheshire/Lanesborough	Hoosic	10/1/2009	3
Goose Pond	Lee/Tyringham	Housatonic	9/16/2009	6
Lake Buel	Monterey/Great Barrington	Housatonic	9/16/2009	5
Lake Garfield	Monterey	Housatonic	9/15/2009	4
Lake Mansfield	Great Barrington	Housatonic	10/1/2009	3
Laurel Lake	Lee/Lenox	Housatonic	10/2/2009	5
Onota Lake	Pittsfield	Housatonic	9/30/2009	4
Otis Reservoir	Otis/Tolland	Farmington	9/9/2009	3
Plunkett Reservoir	Hinsdale	Housatonic	9/9/2009	2
Pontoosuc Lake	Pittsfield/Lanesborough	Housatonic	10/1/2009	3
Prospect Lake	Egremont	Housatonic	9/17/2009	4
Richmond Pond	Richmond/Pittsfield	Housatonic	9/10/2009	6
Shaw Pond	Otis/Becket	Farmington	9/8/2009	5
Stockbridge Bowl	Stockbridge	Housatonic	9/18/2009	5
Thousand Acre Pond	New Marlborough	Housatonic	9/14/2009	4
Windsor Pond	Windsor	Westfield	10/2/2009	3
Housatonic River	Pittsfield to Sheffield	Housatonic	9/15/2009 to 10/23/2009	31
			Total Sites	115
			Total Lake Sites	84
			Average Sites Per Lake	4.2

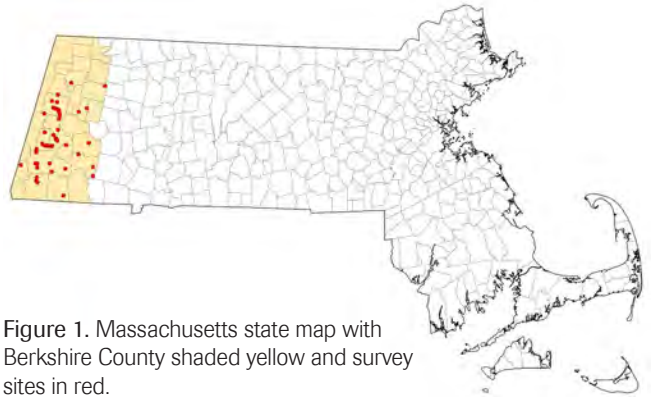

Figure 1. Massachusetts state map with Berkshire County shaded yellow and survey sites in red.

METHODS

Two or three surveyors spent approximately three to six hours at each lake, and could usually complete two lakes per day. Specific methods used at each survey site within each lake are noted in Appendix 1. The team split into two people in the boat and one person surveying shallow shoreline areas. As described under "Decontamination Procedure" (below), the field crew possessed two redundant sets of field gear, including boats, so that field equipment was not transferred to a new waterbody without undergoing proper decontamination procedures. For those days when two lakes were surveyed, a small and large lake were paired so that an appropriate level of effort could be expended on each. Laurel Lake was surveyed last so that there would be no risk of transporting veligers to a new waterbody. Landowners provided boats for use in Lake Buel, Prospect Lake, and Laurel Lake.

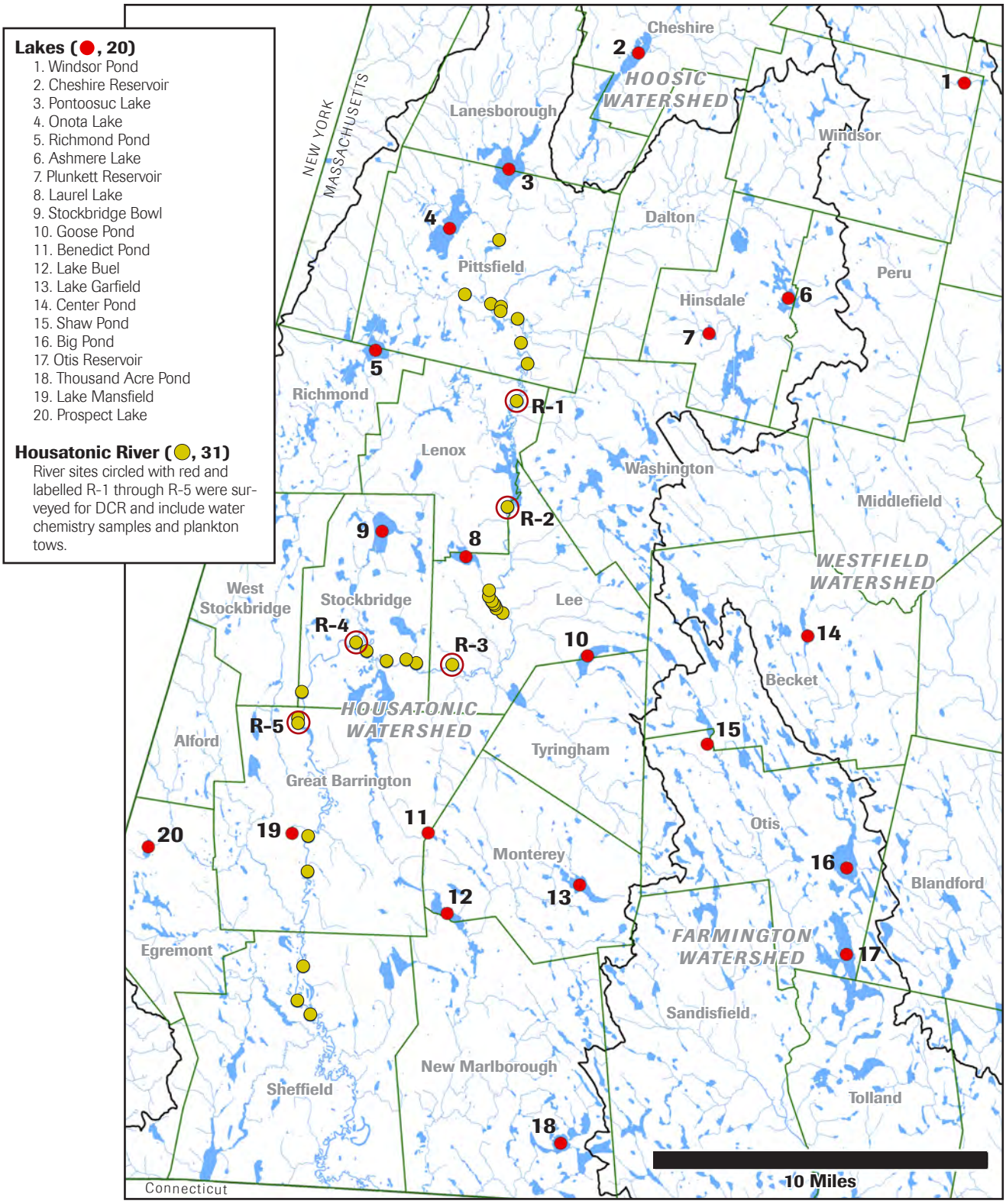

Figure 2. Waterbodies surveyed for zebra mussels and/or native freshwater mussels in Berkshire County in 2009. Red dots indicate lakes and ponds surveyed specifically for this study. Yellow dots are Housatonic River survey sites, which include five sites surveyed for the zebra mussel study and 26 additional sites that we surveyed in September and October for the Massachusetts Natural Heritage and Endangered Species Program. Green lines indicate town boundaries and the black line indicates major watershed boundaries. See Table 1 and Appendices 1 and 2 for additional details on these sites.

Physical and Chemical Analysis

- **Water Chemistry:** Two water samples were collected per lake and a single water sample was collected for each of five Housatonic River sites. Lake samples were usually collected near the outlet and near the middle of the lake. Berkshire Envirolabs in Lee, Massachusetts, provided sample containers and completed the analyses. Samples were kept on ice and brought to the lab by 4:00 each afternoon (the lab requested this so that pH could be measured each afternoon). The lab measured the following six parameters: pH, alkalinity (mg/L), calcium (mg/L), total nitrate as N (mg/L), total phosphorus as P (mg/L), and total suspended solids (mg/L).
- **Dissolved Oxygen and Temperature:** These two parameters were measured at multiple locations in each lake in the field, using a YSI (Yellow Springs Instruments) Model 200 DO probe. At least one vertical profile was taken in each deep lake by recording dissolved oxygen and water temperature at 0.5-meter (1.5-ft) increments to a maximum depth of 10 meters (30 feet). For shallow unstratified lakes, or shallow locations within deeper lakes, dissolved oxygen and temperature were recorded at the surface and at the bottom.
- **Secchi Depth:** Secchi depth was recorded at one or more sites per lake, except for sites where the bottom was visible from the surface.
- **Physical Habitat:** Surveyors recorded the water depth, substrate (types and spatial extent), and shoreline condition at each survey site.

Biological Field Sampling

- **Adult Zebra Mussels:** Surveyors searched for adult zebra mussels by SCUBA diving, snorkeling in shallow water, and wading along shorelines to look for live animals or shells with an aquatic D-net or clear-bottom bucket. Surveys were qualitative and focused on visual searches for adult or juvenile mussels, looking on the undersides of hard objects, and tactile searches underneath overhanging boulders and undercut riverbanks. Available surfaces at each site were surveyed, but hard substrates were targeted. Surveyors spent 0.5 to 1.0 hours per site; survey duration depended on the spatial extent and suitability of habitat. All adult zebra mussels observed in the Housatonic River were collected for analysis of shell length.
- **Larval Zebra Mussels (Veligers):** Plankton tows were collected from three to six locations within each lake and combined into a single composite sample. Surveyors used the 33-E28 Veliger Net from the Wildlife Supply Company (length = 80 inches; opening width = 20 inches, mesh size = 63 microns, dolphin bucket = 1000 mL). Nets were connected to a 60-ft line marked in 3-ft (1-meter) increments, and a sliding line weight so that the net could quickly be lowered to the desired starting point. At shallow sites, horizontal plankton tows were collected from areas of relatively clear water (i.e., few macrophytes) from a depth that prevented the net from dragging on the bottom and scooping up mud. These tows were typically 50-150 feet in length. At deeper sites, plankton nets were lowered to within 3-6 feet of the bottom

Top: Motorboat used during the study. Bottom: Ethan taking a vertical temperature and dissolved oxygen profile using the YSI.

Top: Plankton tow in shallow water. Bottom: Plankton sample.

(or a maximum of 25 feet) while the boat was stationary, then the boat was driven at trolling speed for two or three minutes while the net collected plankton throughout the water column. At river sites, the plankton net was held in light to moderate current for two to three minutes, either by standing in the river or by lowering the net from a bridge. Contents were filtered and rinsed into a 500 mL container and preserved in 70 percent ethyl alcohol. The final composite sample was decanted several hours later, after contents had settled, and then topped off with fresh alcohol to ensure that alcohol concentrations were suitable for preservation. In the laboratory, samples were examined using a 45x dissecting microscope fitted with cross-polarized light following recommendations of Johnson (1995). Samples were transferred into 250 mL containers for permanent storage and 100 mL subsamples were sent to DCR.

- **Snails and Native Mussels:** Surveyors documented and/or collected snails and native mussels while searching for adult zebra mussels. Native mussels were identified in the field and released unharmed. In most cases, snails were identified in the field but some were also collected and preserved in 70 percent ethyl alcohol for identification in the laboratory using Jokinen (1983, 1992) and Smith (1995). The species and relative abundance of snails and mussels was recorded for each site within each lake. Snails with a more patchy distribution or whose habitat did not overlap with our target habitats (e.g., shallow littoral areas) were underrepresented in our samples.
- **Aquatic Plants:** Species composition and relative abundance of submerged aquatic plants were recorded at each survey site, and in some cases, other locations throughout the lake. Identification was done in the field except for some of the more challenging species (e.g., *Potamogeton* spp.) that were collected and identified at the University of Massachusetts Herbarium. Data are intended to provide a snapshot of community composition and abundance patterns. The limited number of survey sites per lake and the study's focus on zebra mussels precluded a more complete botanical inventory. Supplemental information on plant communities was gathered from other sources.
- Locations of survey sites were recorded with GPS and reference photographs were usually taken at each site. Reference photographs of other interesting or unique features of each waterbody were also taken.

Species composition and densities of native mussels, such as this *Pyganodon cataracta*, were recorded.

Mapping

- Bathymetric maps were available for all 17 lakes. In addition, 0.5-meter orthophotos for each lake were downloaded from the Massachusetts Office of GIS and used to display survey sites. Location data were imported into ArcGIS 9.2 to create the maps.
- Appendix 2 provides profiles for each lake that include observations, aerial imagery, and photographs.

Decontamination Procedure

- Decontamination procedures generally followed guidelines in the Massachusetts Interim Zebra Mussel Action Plan (DCR 2009), supplemented with more specific measures for field technicians and SCUBA divers who are specifically studying zebra mussels.
- The field crew possessed two completely redundant sets of field gear so that field equipment was not transferred to a new waterbody without undergoing proper decontamination. This included boats (a motorboat and a canoe were used), sample collecting equipment, SCUBA/snorkel gear, wetsuits, etc.
- After use and while still in the field, equipment was either bagged so that it could be washed later, left to soak in buckets of vinegar for two or more hours, sprayed with a 10 percent bleach solution and left to dry, or soaked and/or wiped down with 90 percent isopropyl alcohol. Plant fragments were removed from all gear. Boats were used in one location per day, and they were cleaned with a hot powerwash each evening. The motor was lowered into a bucket of salt water and run for approximately five minutes and the salt water remained in the motor until the next day.
- Each evening, plankton nets, wetsuits, and SCUBA gear were washed in hot soapy water, sprayed with a 10 percent bleach solution, rinsed, and dried.
- Laurel Lake was surveyed on the final day of the project to eliminate the risk of spreading veligers into a new waterbody. Multiple Housatonic River sites were surveyed each day but we worked from a downstream to upstream direction toward Laurel Brook so that we did not spread zebra mussels downstream.

RESULTS

I. Physical and Chemical Parameters

Table 2 summarizes much of the physical and chemical data. Lake profiles (Appendix 2) provide some additional habitat information for each lake. The pH of waterbodies ranged from 6.79 to 8.55, calcium concentrations ranged from 2.0-44.0 mg/L, and alkalinity ranged from 4.0-162.0 mg/L. Vertical profiles of dissolved oxygen and water temperature in stratified lakes (Appendix 2) demonstrate the thermocline depth and proportion of the water column that contained suitable oxygen levels at the time of the survey, but more frequent surveys would be needed to understand stratification and oxygen levels throughout the season. Nitrate, phosphorus, and total suspended solids were low and exhibited little variability among lakes.

II. Zebra Mussels

Zebra mussel veligers were collected in Laurel Lake (July 2009 and October 2009). Veligers were not detected in plankton samples from any other lakes. Adult zebra mussels were encountered in Laurel Lake (July 2009 and October 2009), Laurel Brook (July 2009), and in the Housatonic River (September and October 2009) (Figure 3). In Laurel Lake, zebra mussels occur in both shallow and deep water throughout most of the eastern half of the

Housatonic River in Stockbridge where an adult zebra mussel was found; this location is 6.95 miles from the Laurel Brook confluence.

Looking toward the confluence of Laurel Brook (black arrow) and the Housatonic River from under the Route 20 Bridge.

Table 2. Physical and chemical data for the 20 lakes and ponds and five of the Housatonic River survey sites (R-1 to R-5 of Figure 2).

						Water Chemistry						
Waterbody	Acres	Depth (Mean/Max)	Secchi Depth (ft)	Surface DO (mg/L)	Surface Temp (°C)	Sample	pH	Alkalinity (mg/L)	Calcium (mg/L)	Nitrate (mg/L)	Phosphorus (mg/L)	TSS (mg/L)
Ashmere Lake	217	8/23	14.5	8.7	21.7	1	7.62	28	10	<0.01	0.008	1
						2	7.64	35	10	<0.01	0.012	1
Benedict Pond	35	5/8	*	9.0	18.4	1	6.91	8	2	<0.01	0.009	<1
						2	7.03	8	2	<0.01	0.008	<1
Big Pond	310	15/26	5.8	94.0+	22.1	1**	6.87	-	-	-	-	-
						2**	6.99	-	10	-	-	-
Center Pond	125	6/13	*	8.5	18.4	1	7.37	22	6	0.01	0.015	<1
						2	7.46	22	6	0.01	0.011	3
Cheshire Reservoir	418	6/9	*	8.7	13.7	1	7.97	102	30	0.02	0.014	<1
						2	7.94	106	29	0.01	0.019	2
Goose Pond	225	18/46	19.5	8.9	18.9	1	7.30	12	6	<0.01	0.007	<1
						2	7.36	14	6	<0.01	0.009	<1
Lake Buel	196	20/42	17.0	9.6	19.9	1	8.36	131	32	<0.01	0.011	1
						2	8.36	133	32	<0.01	0.010	<1
Lake Garfield	272	14/31	12.3	9.5	19.7	1	7.90	46	14	0.01	0.020	4
						2	7.78	46	14	<0.01	0.019	3
Lake Mansfield	40	7/16	10.6	85.8+	16.6	1	8.55	-	19	-	-	-
Laurel Lake	170	26/53	15.3	9.2	16.1	1	8.08	162	44	<0.01	0.011	3
						2	8.11	162	44	<0.01	0.011	<1
Onota Lake	617	22/66	15.8	9.3	16.4	1	7.53	77	21	<0.01	0.012	<1
						2	7.81	73	19	<0.01	0.010	1
Otis Reservoir	1200	15/48	11.5	91.1+	21.7	1***	6.79	-	-	-	-	-
						2***	6.80	-	6	-	-	-
Plunkett Reservoir	73	10/22	14.5	9.3	21.4	1	7.86	32	13	<0.01	0.008	1
						2	7.80	32	11	<0.01	0.005	3
Pontoosuc Lake	480	14/35	8.2	9.4	15.4	1	7.79	106	38	0.01	0.021	2
						2	7.85	106	38	0.01	0.019	3
Prospect Lake	-	-	*	9.9	19.7	1	8.38	81	21	<0.01	0.007	2
						2	8.40	87	22	<0.01	0.012	<1
Richmond Pond	218	18/53	13.8	9.5	20.6	1	8.30	117	35	<0.01	0.009	<1
						2	8.27	123	40	0.01	0.010	<1
Shaw Pond	100	13/19	10.5	7.9	22.6	1	7.61	32	10	<0.01	0.021	<1
						2	7.59	30	11	<0.01	0.013	1
Stockbridge Bowl	372	27/48	11.0	9.7	19.6	1	8.35	122	32	0.26	0.017	4
						2	8.45	122	34	0.01	0.012	2
Thousand Acre Pond	155	4/8	7.5	9.4	18.8	1	7.33	20	3	<0.01	0.013	<1
						2	7.35	20	3	0.01	0.017	<1
Windsor Pond	48	21/53	10.0	8.8	14.2	1	6.90	4	8	<0.01	0.014	1
						2	6.88	6	6	<0.01	0.017	<1
Housatonic River												
Site 1 (R-1)	-	-	-	9.0	15.4	1	7.89	131	32	1.27	0.047	<1
Site 2 (R-2)	-	-	-	7.2	15.2	2	7.93	131	35	1.13	0.063	60
Site 3 (R-3)	-	-	-	11.1	15.8	3	8.02	135	35	0.97	0.169	4
Site 4 (R-4)	-	-	-	10.0	15.7	4	8.19	139	40	0.82	0.032	2
Site 5 (R-5)	-	-	-	10.5	16.4	5	8.34	141	43	0.67	0.099	32

* Lake bottom visible from the surface

** Sample 1 from 9/2 field measurement. Sample 2 from 2009 analysis by Berkshire Envirolabs.

*** Sample 1 from 9/9 field measurement. Sample 2 from 2009 analysis by Berkshire Envirolabs.

+ Expressed as percent saturation

lake, with highest densities on rocks at the lake's outlet. In the Housatonic River, adult zebra mussels were found at low densities along a 0.5-mile reach downstream of Laurel Brook, a location 0.9 miles downstream of Laurel Brook, and a location 6.95 miles downstream of Laurel Brook in the town of Stockbridge. Only one location was surveyed between the Willow Mill Dam (in South Lee) and the I-90 Bridge but it is likely that zebra mussels also occur in that reach. Adult zebra mussels were also detected below the broken water pipe running alongside the Eagle Mill Building in Lee, in the splash zone on the riverbank and in the river downstream. Data indicate that zebra mussels are entering the Housatonic River from two sources—Laurel Brook and the water pipe that runs from Laurel Lake to the Eagle Mill.

All adult zebra mussels encountered in the Housatonic River (51 animals) were collected and measured. Mean shell length was 19.07 millimeters (range = 12.52-28.52; standard deviation 3.07). Most adults were in the 15.0 to 20.0 millimeter size range (Figure 4) and both recruitment and longevity were evident in the population. Newly settled juveniles would not have been detected by snorkel surveys.

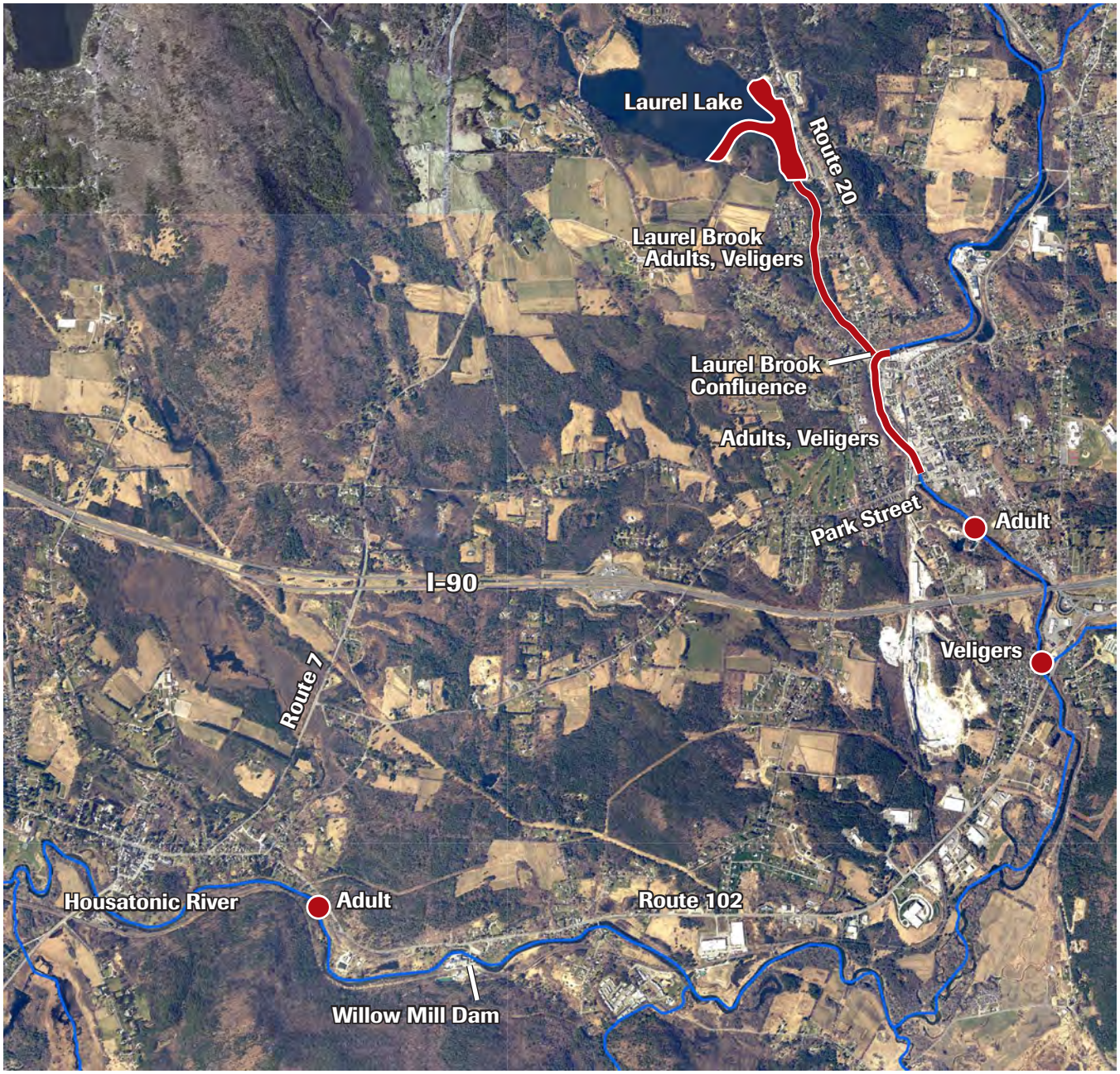

Figure 3. Locations where zebra mussel adults or veligers were detected in 2009 are shown in red, including major landmarks in that area of Lee and Stockbridge.

III. Snails and Native Mussels

Fifteen snail species were encountered during the survey (Table 3). Species richness ranged from zero to 11 per lake, with highest species richness in Stockbridge Bowl and Laurel Lake. Most species encountered are widespread in southern New England and not particularly indicative of calcareous conditions, although *Marstonia lustrica* and *Valvata tricarinata* prefer hardwater lakes (Jokinen 1983, 1992; Smith 1995). The native *Amnicola limosa* was present and usually abundant in 94.1 percent of the lakes, and the non-native *Viviparus georgianus* was present in 82.4 of the lakes.

Three native mussel species were found in lakes, including *Pyganodon cataracta* (17 of 17 lakes), *Elliptio complanata* (13 of 17 lakes), and *Lampsilis radiata* (1 of 17 lakes) (Table 4). The latter is also very rare elsewhere in the Massachusetts portion of the Housatonic River watershed; it was found in only one location in the Housatonic River in Great Barrington (Nedeau 2008). Two additional native mussel species—*Alasmidonta undulata* and *Strophitus undulatus*—were found in the Housatonic River (both are Species of Special Concern in Massachusetts). Neither species richness nor abundance of native mussels showed a correlation to pH, calcium, or alkalinity. Mussel distri-

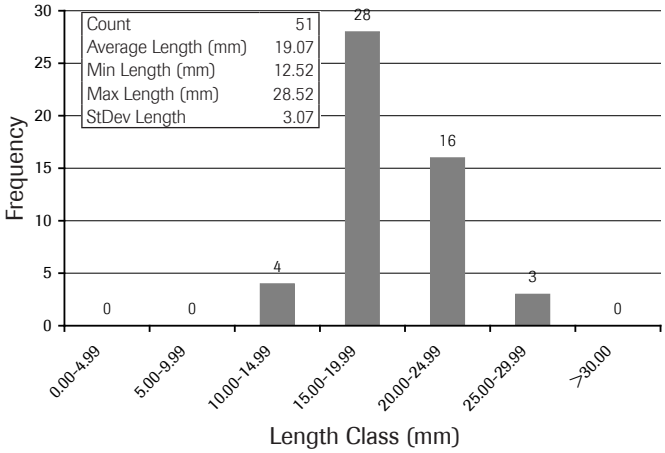

Figure 4. Length-frequency analysis for 51 zebra mussels collected in the Housatonic River (October 2009).

bution was more closely tied to habitat conditions; most common near shoreline areas of lakes in firm substrate, and generally sparse or absent in oxygen-poor gyttja in deeper areas of lakes.

IV. Aquatic Plants

A total of 37 aquatic plant species were observed, and an additional eight species were reported from past surveys of one or more of the 17 lakes (Table 5). Of these, 39 species are native and six species are introduced (non-native) in Massachusetts. Algae of the genus *Chara* were reported but not identified to species. In some cases, due to a lack of reproductive parts or seeds, specimens were only identified to genus and the most likely species were noted. This occurred within the genera *Sparganium* and *Potamogeton*. The number of plant species per pond ranged from seven

Table 4. Native freshwater mussel species encountered during the survey. The column "Abundance" contains numerical categories that range from 0.0 (very low abundance) to 1.0 (abundant). Mussels were not surveyed by DCR in Big Pond, Otis Reservoir, or Lake Mansfield.

	Mussels					#	
Waterbody	AlUn	ElCo	LaRa	PyCa	StUn	Species	Abundance
Ashmere Lake				X		1	0.25
Benedict Pond				X		1	0.00
Center Pond		X		X		2	0.25
Cheshire Reservoir				X		1	0.00
Goose Pond		X		X		2	0.50
Lake Buel		X		X		2	0.00
Lake Garfield		X		X		2	0.25
Laurel Lake*		X		X		2	-
Onota Lake		X	X	X		3	0.00
Plunkett Reservoir		X		X		2	0.00
Pontoosuc Lake		X		X		2	0.50
Prospect Lake		X		X		2	0.00
Richmond Pond		X		X		2	0.00
Shaw Pond		X		X		2	0.50
Stockbridge Bowl		X		X		2	0.00
Thousand Acre Pond		X		X		2	0.50
Windsor Pond				X		1	0.50
Housatonic River	X	X	X	X	X	4	0.00
Count	1	14	2	18	1	5	
Percent	5.5	72.2	11.1	100.0	5.5		

Species Codes - Mussels

Alasmidonta undulata	AlUn	*Lampsilis radiata*	LaRa
Elliptio complanata	ElCo	*Pyganodon cataracta*	PyCa
		Strophitus undulatus	StUn

Table 3. Aquatic snail species encountered during the survey (snail surveys were not conducted in the Housatonic River). The column "Abundance" contains numerical categories that range from 0.0 (very low abundance) to 1.0 (abundant). Snails were not surveyed by DCR in Big Pond, Otis Reservoir, or Lake Mansfield.

	Snail Species																Species	
Waterbody	AmLi	CaDe	Fe	FoPa	GyPa	Gy	HeAn	HeCa	HeTr	MaLu	PhAn	PhHe	PrEx**	PsCo	VaTr	ViGe	Richness	Abundance
Ashmere Lake	X	X					X		X							X	5	0.50
Benedict Pond	X													X		X	3	0.50
Center Pond	X					X	X				X					X	5	0.75
Cheshire Reservoir	X	X						X				X		X	X	X	7	1.00
Goose Pond	X						X	X								X	4	0.50
Lake Buel	X	X		X			X	X				X				X	7	0.00
Lake Garfield	X		X		X		X	X				X				X	7	0.75
Laurel Lake*	X									X					X	X	11	-
Onota Lake	X							X								X	3	0.00
Plunkett Reservoir	X														X	X	3	0.50
Pontoosuc Lake	X																1	0.00
Prospect Lake	X	X					X	X	X			X				X	7	0.75
Richmond Pond	X	X					X		X			X		X		X	7	0.25
Shaw Pond	X	X													X	X	4	0.75
Stockbridge Bowl	X	X		X	X		X	X		X		X	X		X	X	11	0.50
Thousand Acre Pond	X											X					2	1.00
Windsor Pond																		0.00
Housatonic River																		
Count	16	7	1	3	2	1	8	7	3	2	1	7	1	3	5	14		
Percent	94.1	41.2	5.9	17.6	11.8	5.9	47.1	41.2	17.6	11.8	5.9	41.2	5.9	17.6	29.4	82.4		

*No collections were made in Laurel Lake; species richness data and presence of select species provided by Natural Heritage and Endangered Species Program

**Found by McLain 2003, not during this survey.

Species Codes - Snails

Amnicola limosa	AmLi	*Gyraulus parvus*	GyPa	*Marstonia lustrica*	MaLu	*Valvata tricarinata*	VaTr
Campeloma decisum	CaDe	*Gyraulus sp.*	Gy	*Physa ancillaria*	PhAn	*Viviparus georgianus*	ViGe
Ferrissia sp.	Fe	*Helisoma anceps*	HeAn	*Physa heterostropha*	PhHe		
Fossaria parva	FoPa	*Helisoma campanulatum*	HeCa	*Promenetus exacuous*	PrEx		
		Helisoma trivolvis	HeTr	*Pseudosuccinia columella*	PsCo		

Table 5. Aquatic plant species observed at each of 17 lakes surveyed by Biodrawversity LLC (plant lists were not compiled for the three lakes in this report that were surveyed by DCR, including Big Pond, Otis Reservoir, and Lake Mansfield).

Latin Name	Common Name	Origin*	Ashmere	Benedict	Center	Cheshire	Goose	Buel	Garfield	Laurel	Onota	Plunkett	Pontoosuc	Prospect	Richmond	Shaw	Stockbridge	1000Acre	Windsor
Brasenia schreberi	Water-shield	N						X		X								X	X
Cabomba caroliniana	Fanwort	N				X			X										
Callitriche spp.	Waterstar Species	N														X			
Ceratophyllum demersum	Coontail	I				X		X	X	X	X			X	X	X	X	X	
Chara sp.	Chara, Muskgrass	N				X		X		X	X		X	X	X		X		
Eleocharis acicularis	Needle Spike-rush	N		X											X	X			X
Elodea canadensis	Northern Water-weed	N	X	X		X		X	X	X		X	X		X		X		
Elodea nuttallii	Nuttall's Water-weed	N		X	X											X			X
Eriocaulon aquaticum	Pipewort	N					X			X									X
Heteranthera dubia	Water Star-grass	N													X		X		
Isoetes echinospora	Spiny-spored Quillwort	N					X		X			X							
Megalodonta beckii	Water Beggars-ticks	N													X				
Myriophyllum heterophyllum	Variable Water-milfoil	I																X	
Myriophyllum spicatum	Spiked (Eurasian) Water-milfoil	I	X		X	X	X	X	X	X	X	X	X		X	X	X	X	
Myriophyllum verticillatum	Whorled Water-milfoil	N									X								
Najas flexilis	Common Naiad	N	X		X	X		X						X	X		X		
Najas minor	Lesser Naiad	I			X	X				X	X	X	X		X		X		
Najas guadalupensis	Guadalupe Naiad	I					X				X		X						
Nuphar variegata	Yellow Water-lily	N						X		X					X	X	X	X	X
Nymphoides cordata	Floating Heart	N																	X
Nymphaea odorata	White Water-lily	N		X				X		X						X	X	X	
Polygonum amphibium	Water Smartweed	N							X										
Polygonum punctatum	Water Smartweed	N								X									
Potamogeton sp.	Pondweed Species	N													X				
Potamogeton amplifolius	Big-leaved Pondweed	N	X	X	X			X	X	X	X	X			X	X	X	X	
Potamogeton crispus	Curly Pondweed	I						X		X	X			X	X		X		
Potamogeton epihydrus	Ribbon-leaf	N	X		X		X			X		X			X				X
Potamogeton foliosus	Leafy Pondweed	N								X									
Potamogeton gramineus	Grass-leaf Pondweed	N	X				X		X	X									
Potamogeton hillii	Hill's Pondweed	N				?							?				X		
Potamogeton illinoensis	Illinois Pondweed	N						X		X				?			?		
Potamogeton ogdenii	Ogden's Pondweed	N									X								
Potamogeton pectinatus	Sago Pondweed	N						?		X							?		
Potamogeton perfoliatus	Perfoliate Pondweed	N	X									X							
Potamogeton praelongus	Whitestem Pondweed	N						X							X				
Potamogeton pusillus	Tiny Pondweed	N			?		?			X		X	?	?			?		
Potamogeton richardsonii	Richardson's Pondweed	N								X	?								
Potamogeton robbinsii	Robbin's Pondweed	N	X	X	X	X	X	X	X	X	X		X	X	X				
Potamogeton spirillus	Northern Snailseed-pondweed	N			X		X									X			
Potamogeton vaseyi	Vasey's Pondweed	N							X										
Potamogeton zosteriformis	Flatstem-pondweed	N							X					X	X				
Ranunculus flabellaris	Yellow Water Crowfoot	N								X									
Ranunculus longirostris	Water Buttercup	N						X											
Sparganium spp.	Burreed Species	N		X			X	X				X				X			X
Utricularia macrorhiza	Common Bladderwort	N					X	X							X	X			
Utricularia purpurea	Purple Bladderwort	N						X								X			
Utricularia radiata	Small Floating Bladderwort	N					X					X			X	X			X
Vallisneria americana	Tape-grass	N		X	X	X	X	X	X	X	X		X	X	X		X		
	Species Richness		8	8	9	9	12	18	12	22	11	10	7	7	20	13	13	7	9

X = reported
? = could not be positively ID due to lack of flowers or fruits
* Origin, I = Introduced, N = Native

to 22, with an average species richness of 11.4. The most commonly encountered plant species were *Myriophyllum spicatum*, occurring in 14 of the 17 lakes, followed by *Potamogeton amplifolius* (12), *P. robbinsii* (12), *Vallisneria americana* (12), *Elodea canadensis* (10) and *Ceratophyllum demersum* (10). The most species-rich genus was *Potamogeton*, with a total of 17 possible species.

DISCUSSION

Laurel Lake

The results of this Phase 1 Assessment show that zebra mussels are now firmly established in Laurel Lake, where water chemistry and physical habitat are optimal for the population to flourish. At this time, zebra mussels seem to be more prevalent on rocky substrates toward the eastern third of the lake, with highest densities near the boat ramp and dam. Veligers have been found throughout the lake.

The broken pipe that runs from Laurel Lake to the Eagle Mill is one of two sources of zebra mussels to the Housatonic River.

Although it would be difficult to develop an exact chronology of invasion based on shell lengths, it seems that zebra mussels have probably been in Laurel Lake for at least two years and probably not more than three years.

Zebra mussel shell growth rates are highly variable, depending on water temperature, water chemistry, and resource competition. In the southern end of Lake Champlain, newly settled juveniles grew to 14-15 millimeters by October (Pete Stangel, Vermont Agency of Natural Resources, personal communication) and could conceivably approach 30 millimeters by the end of their second growing season. When zebra mussels first appeared in the Hudson River, before the population became large enough to deplete phytoplankton, animals that were one year from settlement were approximately 28 millimeters long (Strayer and Malcom 2006). Once zebra mussel populations increased enough to exhaust their food supply, one-year old animals were only half that long and adults would not have reached 28 millimeters until their third or fourth year (David Strayer, Cary Institute of Ecosystem Studies, personal communication). Zebra mussels in Laurel Lake and the Housatonic River may grow faster than average rates currently established in the scientific literature because densities are still low and food resources are abundant. Based on shell growth rates from European populations (shown in McMahon 1991), seasonal growth rates provided by Horvath and Lamberti (1999), and data from the Hudson River and Lake Champlain, the largest animals encountered in Laurel Lake or the Housatonic River could have been one to three years old.

It may be impractical to eliminate the Laurel Lake population by various means (ENSR 2005), since zebra mussels are established over a large area, the natural resource value of Laurel Lake is high, and because a state-endangered snail (*Marstonia lustrica*) occurs in the lake. Water chemistry in Laurel Lake is ideal for zebra mussels, but the long-term success of the species in Laurel Lake is uncertain. Food, space, or environmental conditions will contribute to the dynamics of the zebra mussel population in Laurel Lake, and it is hard to predict what the long-term outcome will be. Strayer and Malcom (2006) noted that space-limited populations might be more likely to occur in small lakes (such as Laurel Lake) where food is abundant but where hard substrates are limited. Space-limited populations may be more stable than food-limited populations. Most of the benthic habitat in the lakes we surveyed (including Laurel Lake) is gyttja, which is not an ideal substrate for zebra mussels, and rocks were largely confined to shoreline areas.

Housatonic River

Adult zebra mussels now inhabit the Housatonic River

along a distance of at least seven miles, though at very low densities. It took two surveyors 65 minutes to find the adult zebra mussel in Stockbridge, and densities were comparable in the reach through Lee (Lee Town Park to Route 20 Bridge) except that high densities were found at the mouth of Laurel Brook and below the broken pipe along the Eagle Mill. The 20.2-millimeter animal collected in Stockbridge is probably in its second summer and the largest zebra mussel found in the Housatonic River (28.52 millimeters) may also be in its second year.

The high concentration of adult zebra mussels near the outlet of Laurel Lake results in high concentrations of veligers exported to the Housatonic River during the reproductive season. The distance that veligers will drift in the Housatonic River will be a function of current speed and maturation time. Stoeckel *et al*. (1997) found that younger larvae that are not yet competent to settle could remain in the water column for several days or weeks, during which time they could be transported great distances before settling (e.g., 190 miles in the lower Illinois River).

The overall threat of zebra mussels to the Massachusetts portion of the Housatonic River is uncertain. The few studies of zebra mussels in small rivers suggest that populations may never reach levels that we might expect to find in lakes (Hunter *et al*. 1997). Zebra mussels are rarely abundant in streams less than 30 meters wide (Strayer 1991), which is approximately the width of non-impounded sections of the Housatonic River downstream of Laurel Brook. Connected ponds and impoundments will provide suitable habitats along otherwise challenging river environments and can act as sources for downstream colonization (Horvath *et al*. 1996, Stoeckel *et al*. 1997, Horvath and Lamberti 1999, Martel *et al*. 2001). In the lower Hudson River, Strayer *et al*. (1996) documented a precipitous decline in reproductive success following initial rapid population growth as adults outcompeted larvae for food and the ratio of food supply to available substrate decreased. Long-term studies of the Hudson River population showed 11-fold fluctuations over a 13-year period, with 2-4 year cycles driven by high variation in recruitment success that is correlated to the size of the adult population and resource competition (food limitation) (Strayer and Malcom 2006). The lower Hudson River is a very different physical environment than the Housatonic River, and it will be interesting to monitor zebra mussels in the Housatonic River to document their dispersal rate and population dynamics in a relatively small, high-gradient riverine environment.

Risk to Other Waterbodies

Although some variation is noted in the literature, calcium below 12 mg/L or pH below 7.4 is thought to preclude zebra mussel colonization in most lakes (Whitter *et al*. 1995). Colonization is possible in waterbodies with calcium between 12-20 mg/L and a pH at or above 7.4 (Murray *et al*. 1993). According to the review on the USGS-NAS website, optimal ranges for calcium are from 40-55 mg/L; at least 10 mg/L are needed to initiate shell growth and 20-25 mg/L are needed to maintain shell growth. Optimal larval survival occurs at a pH of 8.4, and optimal adult growth occurs at pH 7.4-8.0, whereas larval development and adult growth is inhibited below pH 7.4. Hincks and Mackie (1997) predicted that zebra mussels could occur in lakes with calcium levels higher than 8.5 mg/L if other parameters (such as pH) were within the preferred range, but this study was based on laboratory trials and zebra mussels have never become established in waterbodies with such low calcium.

Studies that review water chemistry parameters in waterbodies where zebra mussels are *actually established* are more informative than studies that attempt to predict where zebra mussels might occur based on thresholds. Cohen and Weinstein (2001) reviewed calcium thresholds based on field data collected throughout North America and found that zebra mussels were established in numerous waterbodies with calcium levels in the upper teens and low twenties. Zebra mussels are established in several northeastern lakes and rivers where calcium concentrations may seem marginal based on early predictions, such as Lake Bomoseen in Vermont (18 mg/L calcium), West Twin Lake in Connecticut (21 mg/L calcium), and portions of the lower Hudson River and middle and northern Lake Champlain (Cohen and Weinstein 2001, Pete Stangel, Vermont Agency of Natural Resources, personal communication). Cohen and Weinstein (2001) stated, "*The available studies and data do not allow an unambiguous determination of the calcium threshold needed for the establishment of zebra mussel populations. In part this is due to inherent complexities in the dynamics of establishment and the mussel's physiological response to its chemical environment, and to the variation in calcium concentrations within water bodies with depth, location, season and year*."

Weight-of-evidence suggests that zebra mussels may exist within a range of chemical conditions but will probably only become firmly established in waterbodies with high pH (>7.4) and high calcium (>20 mg/L). In this study, lakes were categorized according to their potential to support reproduction and growth of zebra mussels based primarily on water chemistry (calcium, pH, and alkalinity). Conservative thresholds used to define Low, Medium, and High Risk are shown on Figure 5.

Of the 20 lakes surveyed in this report, seven are categorized as Low Risk, four are categorized as Medium Risk, and nine are categorized as High Risk (Table 6, Figure 5).

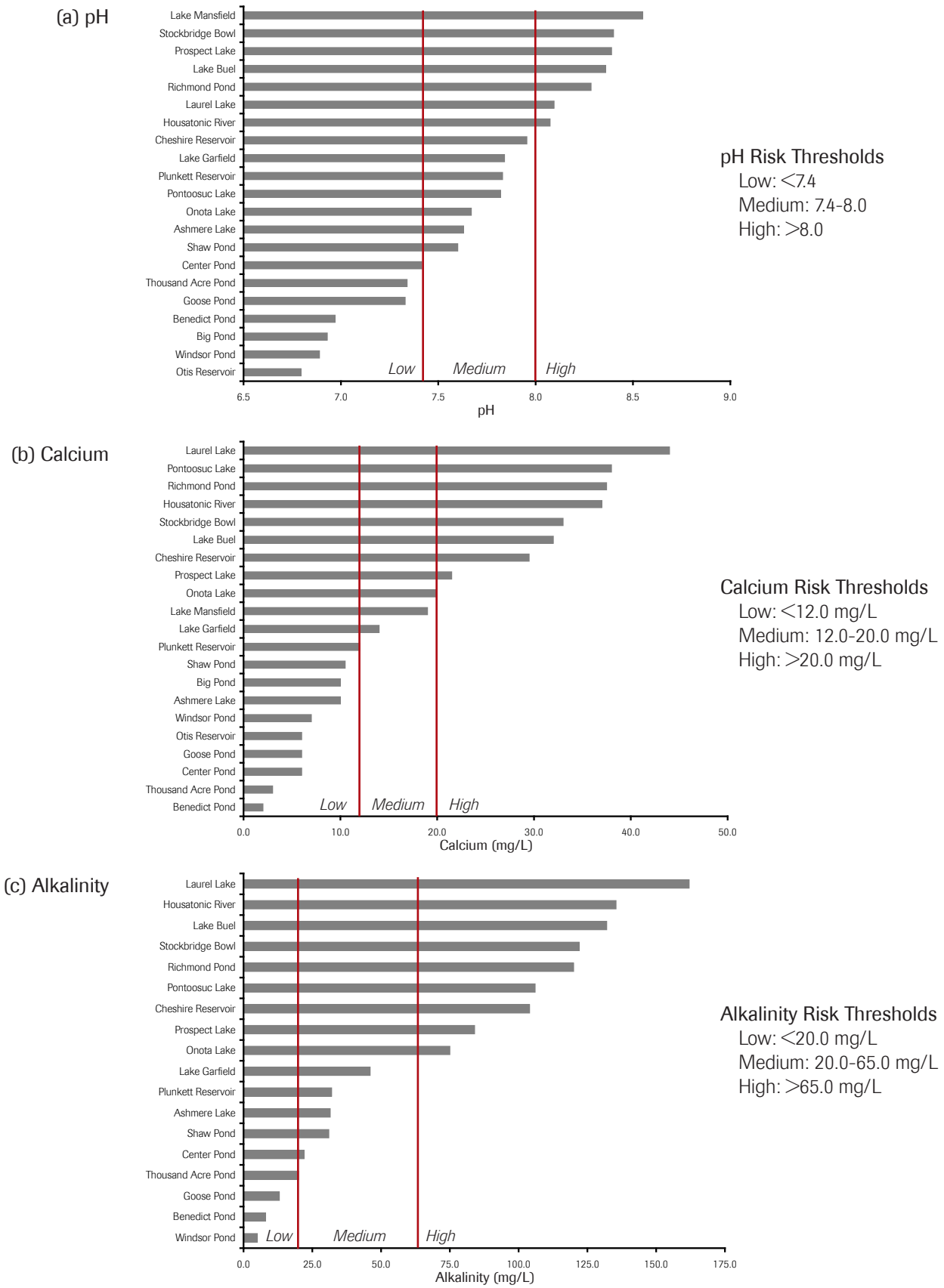

Figure 5. Graphs showing pH, calcium, and alkalinity of the 21 waterbodies surveyed for this report (see also Table 2) and assignment of the risk of zebra mussel colonization based on published tolerance/preference levels. Threats based on these three parameters are combined into a single risk assessment (Table 6). Alkalinity is not reported for Big Pond, Otis Reservoir, or Lake Mansfield.

Table 6. Risk of zebra mussel colonization for the 21 waterbodies surveyed for this project, based on pH, calcium, and alkalinity.

	Risk Based On…			
Waterbody	pH	Calcium	Alkalinity	Overall
Laurel Lake	High	High	High	High
Stockbridge Bowl	High	High	High	High
Prospect Lake	High	High	High	High
Lake Buel	High	High	High	High
Housatonic River	High	High	High	High
Richmond Pond	High	High	High	High
Pontoosuc Lake	Medium	High	High	High
Cheshire Reservoir	Medium	High	High	High
Onota Lake	Medium	High	High	High
Lake Mansfield	High	Medium	-	High
Plunkett Reservoir	Medium	Medium	Medium	Medium
Lake Garfield	Medium	Medium	Medium	Medium
Ashmere Lake	Medium	Low	Medium	Medium
Shaw Pond	Medium	Low	Medium	Medium
Center Pond	Medium	Low	Medium	Low
Benedict Pond	Low	Low	Low	Low
Thousand Acre Pond	Low	Low	Low	Low
Goose Pond	Low	Low	Low	Low
Otis Reservoir	Low	Low	-	Low
Windsor Pond	Low	Low	Low	Low
Big Pond	Low	Low	-	Low

Table 7. Species richness of snails, native mussels, and plants observed in waterbodies characterized as Low, Medium, or High Risk of zebra mussel invasion based on water chemistry.

	Risk	Species Richness		
Lake	Group	Snails	Mussels	Plants
Benedict Pond	Low	3	1	8
Center Pond	Low	5	2	10
Goose Pond	Low	4	2	13
Thousand Acre Pond	Low	2	2	7
Windsor Pond	Low	1	1	9
	Average Richness	3.0	1.6	9.4
Lake Garfield	Medium	7	2	12
Ashmere Lake	Medium	5	1	8
Shaw Pond	Medium	4	2	13
Plunkett Reservoir	Medium	3	2	10
	Average Richness	4.8	1.8	10.8
Cheshire Reservoir	High	7	1	10
Lake Buel	High	7	2	19
Laurel Lake	High	11	2	22
Onota Lake	High	3*	3	12
Pontoosuc Lake	High	1*	2	9
Prospect Lake	High	7	2	9
Richmond Pond	High	7	2	20
Stockbridge Bowl	High	11	2	13
	Average Richness	6.8	2.0	14.3

*Anomalously low based on size and chemistry of waterbody.

The Housatonic River is also considered High Risk based on water chemistry. Within the High Risk category, the potential timeline for successful colonization is expected to be influenced by the level of recreational use since greater use provides a higher probability of introduction and the scientific literature show that multiple introductions are needed to establish a population (Johnson and Carlton 1996, Padilla *et al*. 1996, Schneider *et al*. 1998, Kraft and Johnson 2000, Bossenbroek *et al*. 2001).

Despite the broad ecological tolerance of most snail species we encountered, there was a strong relationship between snail species richness, pH, and calcium. In the lakes categorized as "High Risk" for zebra mussels, average snail species richness was 6.8 (8.3 when two obvious outliers—Onota Lake and Pontoosuc Lake—were removed) (Table 7). In contrast, average snail species richness was only 3.0 in lakes categorized as "Low Risk" for zebra mussels. *Valvata tricarinata* and *Marstonia lustrica* were only found in High Risk or Medium Risk lakes and are known to prefer calcareous waters (Jokinen 1983). There appeared to be a correlation between plant species richness, pH, and calcium. In the lakes categorized as "High Risk" for zebra mussels, average plant species richness was 14.4 (Table 7). In contrast, average plant species richness was only 9.4 in "Low Risk" lakes and 10.8 in "Medium Risk" lakes. *Chara*, an algae and biological indicator of calcareous lakes was found in all "High Risk" lakes, but in no other targeted lakes.

Overall, biological indicators for "High Risk" lakes include presence and abundance of *Chara* sp., high species richness of aquatic snails, and some of the more calcium-dependent snail species such as *Valvata tricarinata* and *Marstonia lustrica*. *M. lustrica* is listed as Endangered in Massachusetts and is currently only known from Stockbridge Bowl and Laurel Lake, whereas *V. tricarinata* is more widespread and probably a better indicator of calcareous lakes throughout the Berkshire and Taconic region of western Massachusetts and western Connecticut. Presence of marl on submerged substrates is a clue that calcium concentrations are in the range that can support zebra mussels. The chemical and biological indicators outlined in this report can provide a tool to screen a larger number of waterbodies for their potential to support reproduction and growth of zebra mussels.

In summary, this study confirms zebra mussels in Laurel Lake and documents adult zebra mussels in the Housatonic River for the first time. It also identifies High Risk lakes throughout Berkshire County where landowners, anglers, and boaters should carefully follow established decontamination procedures (DCR 2009) and assist with early detection of new populations.

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ACKNOWLEDGMENTS

Thanks to the Massachusetts Department of Conservation and Recreation, Lakes and Ponds Program, for their support of this work. Support staff included Tom Flannery, Jim Straub, Steve Asen, Anne Carroll, and Dave Worden. Native mussel studies in the Housatonic River watershed were completed under a two-year contract (2008-2009) with the Massachusetts Natural Heritage and Endangered Species Program, and this work helped to supplement the zebra mussel studies in 2009. Thanks to October Mountain State Forest for use of the yurt during the study period. Fred Vorck and Dave Logan provided a motorboat for the Lake Buel survey, Ray Grogan and the Laurel Lake Preservation Association offered a motorboat for the Laurel Lake survey, and Janice Delaney provided a motorboat for the Prospect Lake survey. Water chemistry analysis was completed by Berkshire Envirolabs in Lee.

Fieldwork was led by Ethan Nedeau with assistance from Steve Johnson and Mason Colby. Lori Johnson helped process veliger samples.

Appendix 1. Methods employed at each survey site within each lake and the Housatonic River.

			Methods							Plankton Tow Details		
Waterbody/Site	Longitude	Latitude	SCUBA	Snorkel*	D-Net*	Plankton	Chemistry	Secchi**	DO Profile***	Depth	Distance	Water Sample Name
Ashmere Lake												
Ashmere-1	-73.08136	42.43676	X			X		X		4-8'	75'	
Ashmere-2	-73.08395	42.43745	X			X	X	X	X	18'	75'	Ashmere-Water-1
Ashmere-3	-73.08247	42.44422	X					X				
Ashmere-4	-73.08368	42.44646	X			X	X	X		8'	75'	Ashmere-Water-2
Ashmere-5	-73.08347	42.44495		X	X							
Ashmere-6	-73.08056	42.44566		X	X							
		Count	4	2	2	3	2	4	1			
Benedict Pond												
Benedict-1	-73.28645	42.20391	X			X	X			3'	100'	Benedict-Water-1
Benedict-2	-73.28872	42.20554				X				3'	100'	
Benedict-3	-73.29007	42.20448	X	X		X	X	X		6'	100'	Benedict-Water-2
Benedict-4	-73.28883	42.20333	X	X	X							
		Count	3	2	1	3	2	1				
Big Pond												
Big-1	-73.04910	42.19417				X				5-10'	100'	
Big-2	-73.04179	42.19177				X	X	X	X	20'	50'	BigPd Comp
Big-3	-73.03636	42.18941		X		X				5-10'	100'	
Big-4	-73.03638	42.18592				X				4-6'	50'	
Big-5	-73.03894	42.17957		X		X				<5'	50'	
		Count	0	2	0	5	1	1	1			
Center Pond												
Center-1	-73.06967	42.29842				X	X	X	X	8'	100'	CenterP-Water-1
Center-2	-73.06818	42.29191				X	X	X	X	9'	100'	CenterP-Water-2
Center-3	-73.06216	42.29436	X	X	X	X				9'	100'	
Center-4	-73.06908	42.30465	X	X		X				6'	100'	
		Count	2	2	1	4	2	2	2			
Cheshire Reservoir												
Cheshire-1	-73.16669	42.55563	X	X		X				3-4'	100'	
Cheshire-2	-73.18227	42.53867	X	X	X	X	X	X	X	5'	100'	Cheshire-Water-1
Cheshire-3	-73.18374	42.53819	X	X	X	X	X	X	X	4'	100'	Cheshire-Water-2
		Count	3	3	2	3	2	2	2			
Goose Pond												
Goose-1	-73.18082	42.28742	X			X		X	X	18'	50'	
Goose-2	-73.18631	42.28721				X				20'	100'	
Goose-3	-73.19788	42.28229				X		X	X	20'	100'	
Goose-4	-73.20151	42.27311	X	X	X	X	X	X		8'	100'	Goose-Water-2
Goose-5	-73.18745	42.28831	X				X					Goose-Water-1
Goose-6	-73.19203	42.28237	X									
		Count	4	1	1	4	2	3	2			
Lake Buel												
LakeBuel-1	-73.27502	42.16775		X	X							
LakeBuel-2	-73.26733	42.16594	X			X	X	X	X	18'	100'	LakeBuel-Water-2
LakeBuel-3	-73.26795	42.16378	X			X				3-8'	100'	
LakeBuel-4	-73.28302	42.16985	X			X		X		20'	125'	
LakeBuel-5	-73.28091	42.17425	X	X	X	X	X			15'	100'	LakeBuel-Water-1
		Count	4	2	2	4	2	2	1			
Lake Garfield												
Garfield-1	-73.20877	42.18989	X	X	X	X	X			3'	100'	LGarfield-Water-1
Garfield-2	-73.20464	42.18435				X				3'	100'	
Garfield-3	-73.19537	42.18164	X	X	X	X	X	X	X	18'	100'	LGarfield-Water-2

Appendix 1 (continued). Methods employed at each survey site within each lake and the Housatonic River.

			Methods							Plankton Tow Details		
Waterbody/Site	Longitude	Latitude	SCUBA	Snorkel*	D-Net*	Plankton	Chemistry	Secchi**	DO Profile***	Depth	Distance	Water Sample Name
Lake Garfield (continued)												
Garfield-4	-73.18959	42.17671	X	X	X	X		X		16'	100'	
		Count	3	3	3	4	2	2	1			
Lake Mansfield												
Mansfield-1	-73.36749	42.20180	X			X				9'	50'	
Mainsfield-2	-73.36826	42.20341	X			X	X	X	X	12'	50'	LkMansfield Comp
Mansfield-3	-73.36788	42.20484	X			X				7'	75'	
		Count	3	0	0	3	1	1	1			
Laurel Lake												
Laurel-1	-73.26195	42.32194				X	X	X		3'	100'	Laurel-Water-1
Laurel-2	-73.26231	42.32418				X				17'	100'	
Laurel-3	-73.26655	42.32412				X				15'	100'	
Laurel-4	-73.26694	42.32471				X	X	X	X	20'	20'	Laurel-Water-2
Laurel-5	-73.26802	42.32647				X				30'	125'	
		Count	0	0	0	5	2	2	1			
Onota Lake												
Onota-1	-73.26950	42.47596	X			X	X	X		3'	100'	Onota-Water-1
Onota-2	-73.27847	42.47765	X			X		X	X	18'	100'	
Onota-3	-73.29118	42.46508	X			X	X	X	X	24'	100'	Onota-Water-2
Onota-4	-73.27982	42.46574	X			X				20'	100	
		Count	4	0	0	4	2	3	2			
Otis Reservoir												
Otis-1	-73.04320	42.14471		X		X				8'	50'	
Otis-2	-73.05457	42.15383				X	X	X	X	30'	50'	Otis Comp
Otis-3	-73.05797	42.15926	X			X				15'	100'	
		Count	1	1	0	3	1	1	1			
Plunkett Reservoir												
Plunkett-1	-73.13113	42.42593	X	X	X	X	X	X		8'	150'	Plunkett-Water-1
Plunkett-2	-73.12544	42.42521	X			X	X	X	X	10'	100'	Plunkett-Water-2
		Count	2	1	1	2	2	2	1			
Pontoosuc Lake												
Pontoosuc-1	-73.24718	42.48505	X			X	X	X		7'	125'	Pontoosuc-Water-1
Pontoosuc-2	-73.24978	42.49963	X			X		X	X	20'	100'	
Pontoosuc-3	-73.24002	42.49423	X			X	X	X		6'	75'	Pontoosuc-Water-2
		Count	3			3	2	3	1			
Prospect Lake												
Prospect-1	-73.45207	42.19549	X			X	X	X		2-4'	100'	Prospect-Water-1
Prospect-2	-73.45140	42.19265	X	X	X	X	X	X		6'	125'	Prospect-Water-2
Prospect-3	-73.45303	42.19114		X	X							
Prospect-4	-73.44899	42.19674		X		X				3-6'	125'	
		Count	2	3	2	3	2	2				
Richmond Pond												
Richmond-1	-73.33154	42.41582		X	X							
Richmond-2	-73.31710	42.41315		X	X							
Richmond-3	-73.32027	42.41361	X			X	X	X		20'	100'	Richmond-Water-1
Richmond-4	-73.32288	42.41180	X	X	X	X				10'	75'	
Richmond-5	-73.32216	42.41396				X		X	X	18'	100'	
Richmond-6	-73.32939	42.41182		X	X		X					Richmond-Water-2
		Count	2	4	4	3	2	2	1			
Shaw Pond												
Shaw-1	-73.12419	42.25180	X			X	X	X		9'	75'	ShawP-Water-1
Shaw-2	-73.12305	42.25443	X			X	X	X	X	16'	75'	ShawP-Water-2

Appendix 1 (continued). Methods employed at each survey site within each lake and the Housatonic River.

			Methods							Plankton Tow Details		
Waterbody/Site	Longitude	Latitude	SCUBA	Snorkel*	D-Net*	Plankton	Chemistry	Secchi**	DO Profile***	Depth	Distance	Water Sample Name
Shaw Pond (continued)												
Shaw-3	-73.12817	42.25602	X					X	X			
Shaw-4	-73.12341	42.25048	X			X		X		8'	75'	
Shaw-5	-73.12493	42.25182		X	X							
		Count	4	1	1	3	2	4	2			
Stockbridge Bowl												
Stockbridge-1	-73.32401	42.34159	X	X	X	X		X	X	18'	100'	
Stockbridge-2	-73.31565	42.33390	X	X		X	X			18'	100'	Stockbridge-Water-1
Stockbridge-3	-73.32160	42.33010	X	X		X	X			18'	100'	Stockbridge-Water-2
Stockbridge-4	-73.32326	42.32842		X								
Stockbridge-5	-73.32086	42.33657				X				18'	100'	
		Count	3	4	1	4	2	1	1			
Thousand Acre Pond												
1000Acre-1	-73.20741	42.06929	X			X	X			2-4'	100'	1000Acre-Water-1
1000Acre-2	-73.20129	42.06659	X	X	X	X	X	X		6'	100'	1000Acre-Water-2
1000Acre-3	-73.20757	42.06690	X			X				2-4'	100'	
1000Acre-4	-73.21078	42.07029		X	X							
		Count	3	2	2	3	2	1	0			
Windsor Pond												
Windsor-1	-72.98439	42.53679		X	X	X				6'	100'	
Windsor-2	-72.98101	42.53705				X		X	X	25'	150'	
Windsor-3	-72.97579	42.53734	X	X	X		X					Windsor-Water-1,2
		Count	1	2	2	2	1	1	1			
Housatonic River												
Site 1 (R-1)	-73.24054	42.39391		X		X	X			Surface; stationary in current		Housatonic-Water-1
Site 2 (R-2)	-73.24471	42.34750			X	X	X			Surface; stationary in current		Housatonic-Water-2
Site 3 (R-3)				X		X	X			Surface; stationary in current		Housatonic-Water-3
Site 4 (R-4)	-73.33239	42.28696		X		X	X			Surface; stationary in current		Housatonic-Water-4
Site 5 (R-5)	-73.36541	42.25129		X		X	X			Surface; stationary in current		Housatonic-Water-5
		Count	0	4	1	5	5					

*Snorkel refers to visual surveys while snorkeling in shallow water, whereas D-net refers to surveys done while wading in shallow water and using an aquatic D-net to collect organisms.
**Secchi depth not recorded for shallow lakes where the bottom was always visible from the surface.
***Vertical profiles were usually only conducted for deeper stratified lakes.

Zebra Mussel Phase I Assessment

Physical, Chemical, and Biological Evaluation of 20 Lakes and the Housatonic River in Berkshire County, Massachusetts

APPENDIX 2
Lake Profiles

Profiles include a photograph of the lake, an orthophoto showing locations of survey sites (see Appendix 1 for coordinates and methods employed at each), and summaries of habitat, water chemistry, and biological sampling. Full profiles are provided for the 17 lakes surveyed by Biodrawversity and brief profiles are provided for the three lakes surveyed by DCRs Lakes and Ponds Program. Lakes are ordered alphabetically.

Ashmere Lake

Hinsdale/Peru

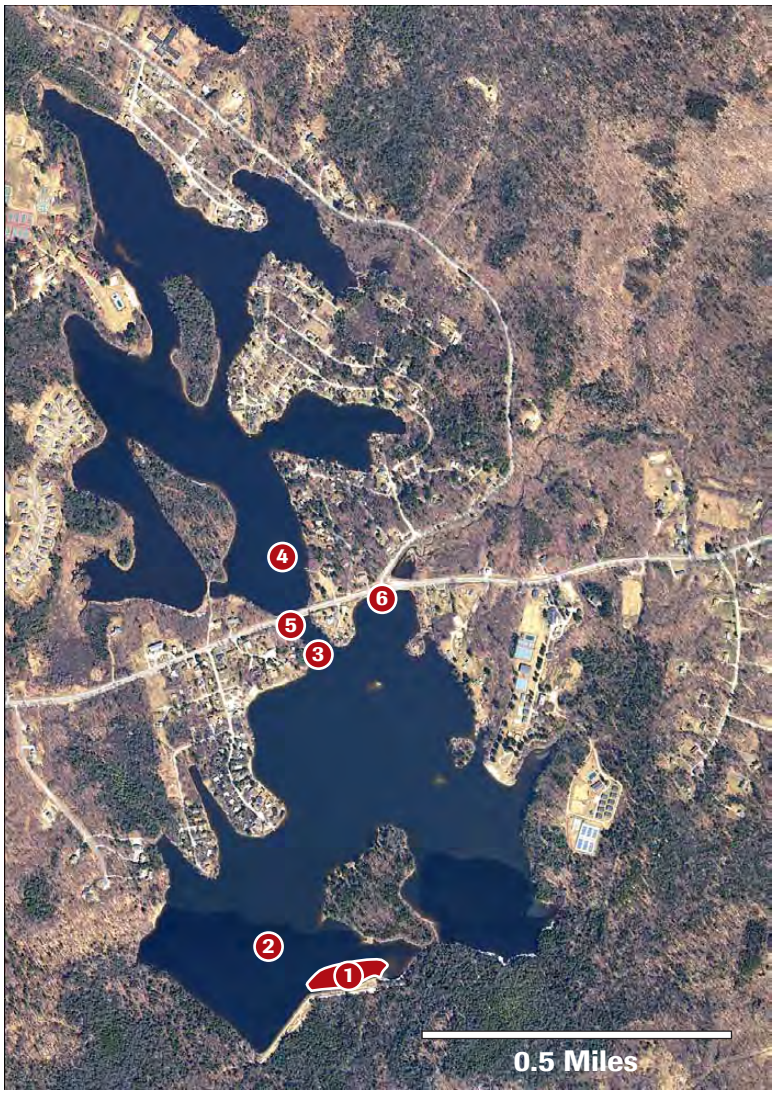
Surveyed: September 9, 2009. Morning.
Weather: Mostly cloudy, 65 degrees, moderate north-northwest wind.

Survey Sites: Six general locations were surveyed, four by boat and two by land. Methods included SCUBA (4 locations), snorkeling and wading surveys (2 locations), 3 plankton tows, 2 water chemistry samples, and one vertical dissolved oxygen profile at the deep point of the lake (Appendix 1).

Summary: Ashmere Lake is a 217-acre warmwater lake located in the towns of Hinsdale and Peru that is divided into two distinct basins by Route 143. Aquatic plants are abundant in intermediate depths and low along the immediate shoreline and in deeper waters below the photic zone. Substrate is primarily gyttja in deeper areas with higher amounts of sand and rock along shorelines and in portions of the southern basin. Secchi depth was 15.5 feet at the deepest point of the lake. The vertical profile showed fairly uniform temperature throughout the water column (19.5 bottom to 21.2 surface) but a considerable decline in dissolved oxygen in deep water. Most of the lake, especially the northern basin, is too shallow for thermal stratification. Shoreline development and recreational use is high but boat access is limited.

Vertical profile. Site 2
Depth 21.2 ft (6.5 m)

Depth (m)	DO (mg/L)	Temp (C)
0.0	8.65	21.2
0.5	8.57	21.2
1.0	8.58	21.2
1.5	8.51	21.2
2.0	8.50	21.2
2.5	8.48	21.2
3.0	8.43	21.2
3.5	8.35	21.1
4.0	8.31	21.1
4.5	8.20	21.1
5.0	6.49	20.8
5.5	6.12	20.7
6.0	4.08	20.5
6.5	0.06	19.5



Potential for Zebra Mussels: Ashmere Lake is considered Medium Risk because of marginally suitable pH (7.63), calcium (10 mg/L), and alkalinity (28-35 mg/L). Ashmere Lake is at the lower end of what this report considers Medium Risk and it could be reassigned to Low Risk with increased confidence about variation in water chemistry and thresholds for zebra mussels.

Benedict Pond

Great Barrington/Monterey

Surveyed: September 14, 2009. Morning.
Weather: Sunny, 65 degrees, light wind.

Survey Sites: Four locations were surveyed, two by boat and two by land. The surveys by land included the boat launch area, public swimming area, and along the concrete wall/dam along the west side of the pond. Methods included SCUBA (3 locations), snorkeling (2 locations), and wading surveys (1 location); 3 plankton tows, and 2 water chemistry samples (Appendix 1).

Summary: Benedict Pond is a 35-acre shallow pond entirely contained within Beartown State Forest in Great Barrington and Monterey. With a maximum depth of only eight feet, the entire lake bottom is within the photic zone and aquatic plants are abundant throughout the lake. Dominant species included *Potamogeton robbinsii* and *Vallisneria americana*. The non-native snail *Viviparus georgianus* was common in shallow areas, and the native mussel *Pyganodon cataracta* was present but at low abundance throughout the lake. Substrate is primarily muck and detritus with underlying clay and ledge, although rocks and ledge are prevalent along much of the shoreline. Old stumps are evident throughout the lake, indicating that this was once a forested wetland before the dam was built. Water clarity was high, with the bottom always visible from the surface. The lake is unstratified and there was little difference in dissolved oxygen between the surface (9.07) and bottom (8.90). Shoreline development is limited to a primitive campground, public beach (with bathrooms), and boat launch for non-motorized boats.

Potential for Zebra Mussels: Benedict Pond is considered Low Risk because of unsuitable pH (6.91-7.03), calcium (2 mg/L), and alkalinity (8 mg/L). Benedict Pond is among the least suitable lakes surveyed for this project.

Big Pond
Otis

Surveyed: September 2, 2009. Late morning.
Weather: Sunny, 71 degrees, calm to slightly breezy.

Survey Sites: Five general locations were surveyed, four by boat and one by land. Methods included snorkeling (2 locations), wading surveys (2 locations), 5 plankton tows, 2 water chemistry samples, and one vertical dissolved oxygen profile at the deep point of the lake (Appendix 1).

Summary: Big Pond is a 310-acre lake (raised Great Pond) located entirely in Otis. Maximum depth is 26 feet with a mean depth of 15 feet. One large island is present with an additional 6 smaller islands. Substrate is primarily rock and sand, with some organic sediments in the deeper areas as well as in the shallow outlet area. Water was dark tea colored with a Secchi depth of 5.8 feet. The vertical profile at the time of the survey showed thermal stratification with a surface temperature of 22.1 degrees C and dissolved oxygen of 94.0% saturation. Temperature at 7 meters deep was 13 degrees C and 3.4% saturation. Aquatic plants are in low abundance in the main lake, but high density and widespread in the lake's shallow southern outlet stream, dominated by *Utricularia* sp., *Nymphaea odorata*, and *Nuphar variegata*. Non-indigenous plant species were not observed during this evaluation except for an isolated *Phragmites* stand along the shoreline, and a complete list of species can be obtained from the Big Pond Association. Indigenous mussels were common at the sample locations, but aquatic snails were not observed during this evaluation. Shoreline development and recreational use is high, with public boat access available at an MA OFBA access site in the southern end of the lake.

Vertical profile. Site 2
Depth 25 ft (7.6 m)

Depth (m)	DO (% Sat)	Temp (C)
0.0	94.0	22.1
1.0	88.7	20.5
2.0	85.4	20.2
3.0	81.8	20.1
4.0	66.8	19.7
5.0	8.2	18.3
6.0	2.6	15.9
7.0	3.4	13.0

Potential for Zebra Mussels: Big Pond is considered Low Risk because of low pH (6.87-6.99) and low calcium (10 mg/l).

Center Pond
Becket

Surveyed: September 17, 2009. Morning.
Weather: Cloudy, 60 degrees, light wind.

Survey Sites: Four locations were surveyed but only two of these included snorkeling and SCUBA diving. Locations included the public and private launches and beach area at the south end of the pond, the outlet at the north end of the pond, and two other locations where water samples and plankton tows were collected. Methods included SCUBA (2 locations), snorkeling (2 locations), and wading surveys (1 location), 4 plankton tows, and 2 water chemistry samples (Appendix 1).

Summary: Center Pond is a 125-acre pond located in Becket. Its maximum depth is reported as 11 feet but we measured 13 feet at Site 2 and a fisherman said there was a deeper hole. Even though weather was cloudy, we could see the secchi disc on the bottom at a depth of 13 feet. Substrate was a mix of sand, silt/detritus, and rock ("rubble"). The lake is unstratified and there was little difference in dissolved oxygen between the surface (8.38 and 8.52) and bottom (8.11 and 8.27). The dominant aquatic plant was *Potamogeton robbinsii* but non-native Najas minor and Myriophyllum spicatum were also present. The non-native *Viviparus georgianus* was the most common snail species, and the native mussels *Pyganodon cataracta* and *Elliptio complanata* were both present (though not abundant). This was the only lake where we observed freshwater jellyfish *Craspedacusta sowerbyi* in the medusa (free-swimming) stage. Shoreline development is patchy, with a large summer camp along the eastern shore, higher development along the northern and southern ends of the lake, and less development along the high-gradient western shore.

Potential for Zebra Mussels: Center Pond is considered Low Risk because of marginally suitable pH (7.37-7.46), unsuitable calcium (6 mg/L), and low alkalinity (22 mg/L).

Cheshire Reservoir

Cheshire/Lanesborough

Surveyed: October 1, 2009. Morning.
Weather: Cloudy, 45 degrees, moderate to strong southwest wind.

Survey Sites: Three locations were surveyed including the boat launch at the northern end of the north basin, the south side of the north basin along the park and causeway, and the north side of the middle basin near the boat launch. Methods included SCUBA (3 locations), snorkeling (2 locations), and wading surveys (2 locations); 3 plankton tows, and 2 water chemistry samples (Appendix 1).

Summary: Cheshire Reservoir is a 418-acre waterbody in Cheshire and Lanesborough with three distinct basins divided by roads. The long narrow reservoir was formed by damming the Hoosic River and its maximum depth is only nine feet. Water clarity was high and we could see the bottom from the surface at all locations, despite cloudy weather. Substrate was mainly silt and detritus, with some rock along shoreline areas. The lake is unstratified and there was very little variation in dissolved oxygen or temperature in deep versus shallow water. Aquatic plants were abundant at nearly all depths, with a mix of native (*Vallisneria americana, Potamogeton robbinsii, Ceratophyllum demersum*) and non-native (*Najas minor, Myriophyllum spicatum*) species dominant. Species richness of snails was high (7 species); *Valvata tricarinata* (an indicator species for calcium-rich lakes) was present. The native mussel *Pyganodon cataracta* was present at low numbers. Shoreline development and recreational use is highest in the northern basin, whereas the southern two basins have more intact shorelines and are more difficult to access.

Potential for Zebra Mussels: Cheshire Reservoir is considered High Risk because of suitable pH (7.94-7.97), suitable calcium (29-30 mg/L), and high alkalinity (102-106 mg/L). All three parameters are within the preferred range for zebra mussels. In addition, the reservoir is accessible from multiple locations and recreational use is high (especially anglers). The high species richness of snails and presence of *Valvata tricarinata* provide biological support for the vulnerability of Cheshire Reservoir to zebra mussels. The shallow water, limited amounts of hard substrates, and abundant macrophytes (which likely contribute to depressed oxygen levels in the winter) might help to limit zebra mussel populations should they ever reach this waterbody.

Goose Pond

Lee/Tyringham

Surveyed: September 16, 2009. Morning.
Weather: Cloudy, 60 degrees, moderate to strong wind.

Survey Sites: Six locations were surveyed but SCUBA/snorkel surveys were completed at only four sites, whereas two sites (#2 and #3) only included plankton tows and physical/chemical parameters. Overall, methods included SCUBA (4 locations), snorkeling and wading surveys (1 location), 4 plankton tows, 2 water chemistry samples, and two vertical DO/oxygen profiles (Appendix 1).

Summary: Goose Pond is a 225-acre lake with a small upper basin separated from the larger main basin by a shallow channel. Average depth is 18 feet and the maximum depth is 46 feet. Under cloudy and windy conditions, we measured secchi depth of 19 feet in upper Goose Pond and 20 feet in lower Goose Pond. Substrate was variable, including sand, gravel, cobble, and boulder along shorelines, rubble in deeper areas near high-gradient shorelines, and gyttja in most of the deeper areas that we surveyed. The thermocline started at around 7.0 meters and water below 8.0 meters was very cold and low in oxygen. Although plant diversity was fairly high (12 species), abundance was low at most survey sites. *Potamogeton robbinsii*, *Najas* sp., and *Vallisneria americana* were widely distributed. We observed one patch of *Myriophyllum spicatum* near the eastern end of the lower basin. Low to moderate densities of snails (4 species) and native mussels (2 species) were observed throughout the lake. Shoreline development is high in the southwestern third of the lower basin, whereas the upper basin is nearly pristine.

Vertical profile. Site 3
Depth 33 ft (10 m)

Depth (m)	DO (mg/L)	Temp (C)
0.0	9.16	19.1
0.5	9.09	19.1
1.0	9.07	19.1
1.5	9.02	19.1
2.0	8.98	19.1
2.5	8.96	19.1
3.0	8.92	19.1
3.5	8.92	19.1
4.0	8.93	19.1
4.5	8.93	19.1
5.0	8.94	19.1
5.5	8.90	19.1
6.0	8.88	19.1
6.5	8.86	19.1
7.0	8.20	18.6
7.5	4.11	13.9
8.0	2.23	11.7
8.5	0.28	11.0

Vertical profile. Site 1
Depth 19 ft (5.8 m)

Depth (m)	DO (mg/L)	Temp (C)
0.0	8.75	18.7
1.0	8.67	18.7
2.0	8.56	18.7
3.0	8.54	18.7
4.0	8.55	18.7
5.0	8.16	18.7
6.0	0.14*	14.2*

* presumably in the muck.

Potential for Zebra Mussels: Goose Pond is considered Low Risk because of marginally suitable pH (7.30-7.66), unsuitable calcium (6 mg/L), and low alkalinity (12-14 mg/L).

Lake Buel

Monterey/New Marlborough

Surveyed: September 16, 2009. Afternoon.
Weather: Cloudy, 65 degrees, light wind.

Survey Sites: Five locations were surveyed within Lake Buel. Overall, methods included SCUBA (4 locations), snorkeling and wading surveys (2 locations), 4 plankton tows, 2 water chemistry samples, and one vertical DO/ oxygen profile (Appendix 1).

Summary: Lake Buel is a 196-acre lake that has two relatively deep basins on both ends and a shallow middle. It feeds into the Konkapot River. Average depth is 20 feet and the maximum depth is 42 feet. The two secchi readings were 17 feet (under cloudy skies), indicating high water clarity. Substrate was mostly gyttja in deeper water, with gravel and cobble along some shorelines and rubble along some of the higher gradient shorelines (such as near Site 4). Dissolved oxygen began to decline at a depth of 5.5 meters (18 feet) and there was very little oxygen near or below 7.0 meters (23 feet). Plant diversity was high (18 species) but the most commonly encountered species were *Vallisneria americana, Potamogeton amplifolius, Elodea canadensis, Myriophyllum spicatum,* and *Chara* sp. Seven species of snails and two species of native mussels were encountered but usually at low densities. Lake Buel has a highly developed shoreline, a large public boat ramp, and recreational use is high.

Vertical profile. Site 2
Depth 31 ft (9.5 m)

Depth (m)	DO (mg/L)	Temp (C)
0.0	9.38	20.1
0.5	9.32	20.1
1.0	9.26	20.1
1.5	9.19	20.1
2.0	9.13	20.1
2.5	9.15	20.1
3.0	9.09	20.0
3.5	9.03	20.0
4.0	8.78	20.0
4.5	8.74	19.9
5.0	8.61	19.7
5.5	7.85	19.5
6.0	6.56	18.7
6.5	4.34	18.0
7.0	0.61	15.9
7.5	0.33	15.0
8.0	0.05	13.9
8.5	0.04	12.9
9.0	0.00	11.7

Potential for Zebra Mussels: Lake Buel is considered High Risk because all three chemical parameters are within the optimal range for zebra mussels, including pH (8.36), calcium (32 mg/L), and alkalinity (131-133 mg/L). Presence of marl and the submerged aquatic plant *Chara* sp. provide further evidence of the suitability of Lake Buel for zebra mussels.

Lake Garfield

Monterey

Surveyed: September 15, 2009. Midday.
Weather: Partly cloudy, 65 degrees, light wind.

Survey Sites: Sites included the boat ramp at the western end, the channel connecting the western basin to the main part of the lake, the erratic and nearby deep hole toward the middle of the lake, and the southeastern shoreline. Methods included SCUBA (3 locations), snorkeling and wading surveys (3 locations), 4 plankton tows, 2 water chemistry samples, and one vertical DO/oxygen profile (Appendix 1).

Summary: Lake Garfield is a 272-acre lake that forms the headwaters of the Konkapot River. Average depth is 14 feet and the maximum depth is 31 feet. Two secchi depth readings at sites 3 and 4 were 12.5 and 12.0 feet, respectively, indicating only moderate water clarity. Substrate was variable, with some sand in shallow low-gradient shoreline areas, gyttja in deep water and coves, and rock (gravel, cobble, boulder) along shorelines and some deeper areas. Rubble extended to depths of at least 20 feet near Site 3. Dissolved oxygen began to decline sharply at a depth of 5.0 meters (16.5 feet) and there was very little oxygen near or below 6.0 meters (~20 feet). Aquatic plants were typically abundant in the photic zone, with *Potamogeton robbinsii*, *P. amplifolius*, *Ceratophyllum demersum, Elodea canadensis, Vallsineria americana*, and *Myriophyllum spicatum* the most common species. Seven species of snails and two species of native mussels were encountered; snails were abundant but mussels were not common. Some of the shoreline areas are highly developed and recreational use is high, although public access for large trailered boats is limited.

Vertical profile. Site 3
Depth 30 ft (9.15 m)

Depth (m)	DO (mg/L)	Temp (C)
0.0	9.32	20.0
0.5	9.27	19.9
1.0	9.24	19.9
1.5	9.18	19.8
2.0	9.15	19.8
2.5	9.09	19.7
3.0	9.02	19.7
3.5	8.99	19.7
4.0	9.01	19.6
4.5	8.44	19.5
5.0	7.74	19.2
5.5	5.10	18.5
6.0	1.45	17.0
6.5	0.95	15.5
7.0	0.06	13.3
7.5	0.04	11.7
8.0	0.02	11.4
8.5	0.01	11.4

Potential for Zebra Mussels: Lake Garfield is considered Medium Risk. Calcium may be too low (14 mg/L) to support a large zebra mussel population. Alkalinity (46 mg/L) and pH (7.78-7.90) are also both in the "Medium Risk" range that this report uses to classify risk.

Lake Mansfield

Great Barrington

Surveyed: October 1, 2009. Late morning.
Weather: Overcast and raining at times, 49 degrees, very calm to slightly breezy.

Survey Sites: Three general locations were surveyed, two by boat and one from shore. Methods included extensive SCUBA (all 3 locations-the majority of the lake was covered), 3 plankton tows, 2 water chemistry samples, and one vertical dissolved oxygen profile at the deep point of the lake (Appendix 1).

Summary: Lake Mansfield is a 40-acre lake located entirely in Great Barrington. Maximum depth is 16 feet with a mean depth of 7 feet. The depths and clarity of the water create a littoral zone throughout the entire surface area of the lake. Aquatic plants were observed to be high density (>70% vegetative cover) throughout the majority of the lake, excluding a small region in the center of the lake. Species included several indigenous pondweeds (*Potamogeton* sp.), *Elodea canadensis*, *Ceratophyllum demersum* and the non-indigenous Eurasian Water-milfoil (*Myriophyllum spicatum*). The majority of the lake was considered flat bottom, with deep silt, probably the result of a large volume of annually decaying plants. No hard substrates were observed throughout the main lake, but some large rocks were observed adjacent to the shorelines, especially along the western shoreline. Water clarity was excellent with the bottom visible from most points on the lake and a Secchi depth of 10.6 feet. The vertical profile at the time of the survey showed a surface temperature of 16.6 degrees C and dissolved oxygen of 85.8% saturation. Temperature at 3 meters deep was 16.34 degrees C and 80.2% saturation. Thermal stratification is unlikely to occur in this relatively shallow water body. Marl was present covering the dense aquatic vegetation and water sampling confirmed that this was indeed a hard-water lake. There is no shoreline development except for a small Town Park and associated swim beach in the northeastern region of the lake. Public access is available at a gravel MA OFBA access ramp for non-motorized watercraft.

Potential for Zebra Mussels: Lake Mansfield is considered High Risk because of high pH (8.55) and medium calcium (19 mg/l).

Laurel Lake

Lee/Lenox

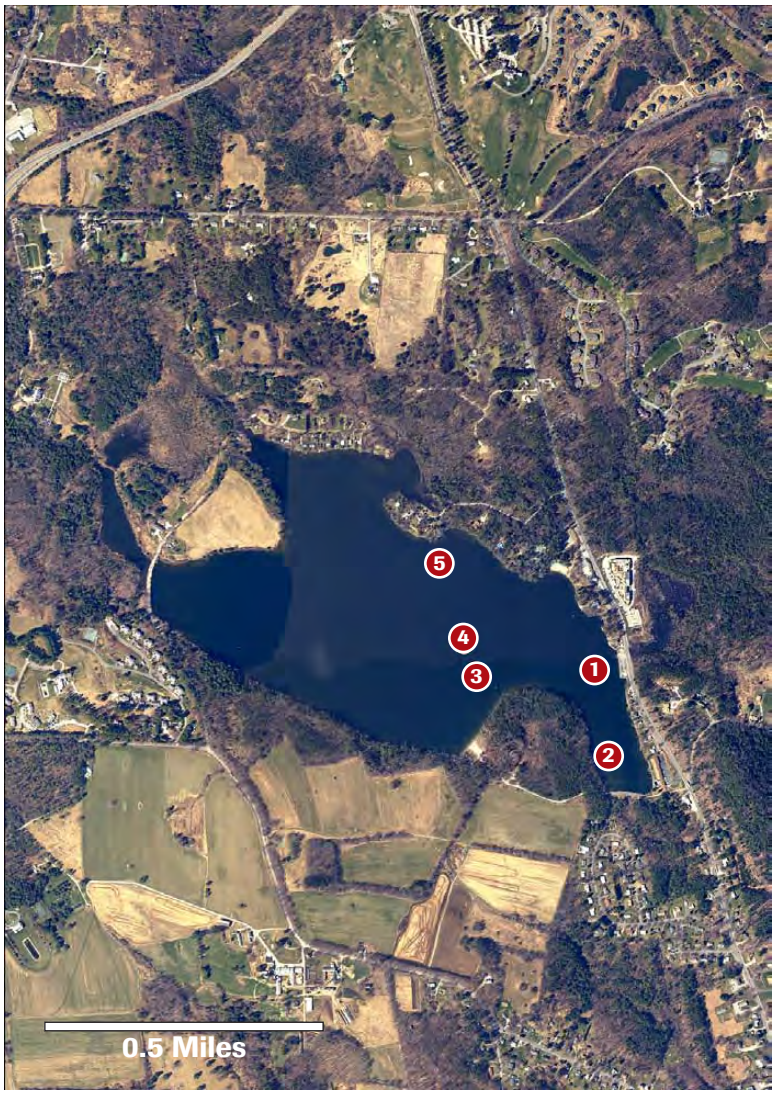
Surveyed: October 2, 2009. Morning.
Weather: Sunny, 55 degrees, light wind.

Survey Sites: Five locations were surveyed in Laurel Lake but we did not complete any SCUBA or snorkel surveys. Methods included five plankton tows, two water samples, and one vertical DO/oxygen profile (Appendix 1). DCR surveyed multiple sites (using SCUBA) in July 2009.

Summary: Laurel Lake is a 170-acre lake with an average depth of 26 feet and a maximum depth of 53 feet. A dam at its outlet maintains water levels and flooded what had originally been rich fens in the western third of the lake. Two secchi depth readings were 15.5 feet (Site 2) and 15.0 feet (Site 4). Where we could see the bottom, substrate was a mix of cobble, rubble, and ledge (especially at the eastern half of the lake), and presumably gyttja is predominant in deeper areas. All rocks were covered with marl. Dissolved oxygen began to decline sharply at a depth of 6.0 meters (~20 feet) and there was very little oxygen near or below 7.0 meters (23 feet). We observed variable densities of *Myriophyllum spicatum*, *Vallisneria americana*, *Potamogeton amplifolius*, *P. crispus*, *Ceratophyllum demersum*, and *Chara* sp. Combined with data from other sources, 22 aquatic species may occur in Laurel Lake. Eleven species of snails may occur in the lake, which is tied for highest snail diversity in the lakes that we surveyed. Shoreline development is light except along the eastern and northern shoreline. A large public boat ramp and fishing area along Route 20 and two public beaches make this lake very accessible to recreational users.

Vertical profile. Site 4
Depth 45 ft (13.7 m)

Depth (m)	DO (mg/L)	Temp (C)
0.0	9.16	16.3
0.5	9.09	16.3
1.0	9.12	16.2
1.5	9.09	16.2
2.0	9.03	16.2
2.5	8.99	16.2
3.0	8.99	16.1
3.5	9.03	16.1
4.0	9.01	16.1
4.5	9.02	16.1
5.0	9.01	16.1
5.5	9.01	16.1
6.0	5.02	14.8
6.5	1.62	12.6
7.0	0.48	10.8
7.5	0.22	9.7
8.0	0.18	8.7
8.5	0.12	8.0
9.0	0.08	7.4



Potential for Zebra Mussels: Zebra mussels are established in Laurel Lake. Laurel Lake provide optimal conditions for zebra mussels, including high calcium (44 mg/L), high alkalinity (162 mg/L), and high pH (8.08-8.11). The aquatic plant *Chara* sp., the snail species *Valvata tricarinata* and *Marstonia lustrica*, and the presence of marl on submerged surfaces indicate the alkaline nature of this waterbody.

Onota Lake
Pittsfield

Surveyed: September 30, 2009. Morning.
Weather: Cloudy, 50 degrees, strong west wind.

Survey Sites: Four locations were surveyed: two in the northern basin and two in the southern basin. Methods included SCUBA (4 locations), 4 plankton tows, 2 water samples, and 2 DO/oxygen profiles (Appendix 1).

Summary: Onota Lake is a 617-acre lake with a shallow northern basin and a deep southern basin. The northern basin is more weedy and eutrophic than the southern basin. Secchi depth was 11.5 feet at Site 2 versus 20 feet at Site 3. Substrate was a mix of sand and gyttja in the northern basin, but there was a higher proportion of rock (gravel, cobble, boulder, and ledge) in the southern basin, especially near shorelines. The northern basin was not stratified. The thermocline in the southern basin began at 7.0 meters (~20 feet) and there was very little oxygen near or below 8.5 meters (28 feet). Plant densities were high in shallow areas of the northern basin, but low in the two sites we surveyed in the southern basin. Common species included *Chara* sp., *Potamogeton robbinsii, Najas* spp., *Vallisneria americana*, and *Myriophyllum spicatum*. Three snail species were observed and they were at extremely low densities. Three native mussel species were observed, including *Lampsilis radiata* that was not found in the other 19 lakes.

Vertical profile. Site 2
Depth 24 ft (7.3 m)

Depth (m)	DO (mg/L)	Temp (C)
0.0	9.11	16.4
0.5	9.09	16.5
1.0	9.08	16.5
1.5	9.09	16.5
2.0	9.07	16.5
2.5	9.05	16.5
3.0	9.05	16.4
3.5	9.05	16.4
4.0	9.05	16.4
4.5	9.06	16.4
5.0	9.07	16.4
5.5	9.11	16.3
6.0	9.10	16.2
6.5	-	16.1
7.0	0.05	16.0

Vertical profile. Site 3
Depth 38 ft (11.6 m)

Depth (m)	DO (mg/L)	Temp (C)
0.0	9.39	17.2
0.5	9.42	17.2
1.0	9.43	17.2
1.5	9.37	17.2
2.0	9.32	17.3
2.5	9.32	17.3
3.0	9.30	17.3
3.5	9.27	17.3
4.0	9.28	17.3
4.5	9.27	17.3
5.0	9.28	17.3
5.5	9.31	17.3
6.0	9.25	17.2
6.5	9.13	17.1
7.0	6.95	15.9
7.5	5.48	14.8
8.0	3.17	12.9
8.5	0.55	10.6

Potential for Zebra Mussels: Onota Lake is considered High Risk, although the chemical parameters are toward the low end of the high-risk thresholds, including calcium (19-21 mg/L), pH (7.53-7.81 mg/L), and alkalinity (73-77 mg/L). The deeper oligotrophic southern basin may be at greater risk than the northern basin. Heavy recreational use with multiple points of entry increases the vulnerability of Onota Lake.

Otis Reservoir

Otis/Tolland

Surveyed: September 9, 2009. Late morning.
Weather: Overcast, 70 degrees, with moderate to high winds at times on the open reservoir. Coves were calm to moderately windy.

Survey Sites: Three general locations were surveyed, all by boat. Methods included extensive SCUBA (1 large area at the outlet dam), snorkeling (1 location), 3 plankton tows, 2 water chemistry samples, and one vertical dissolved oxygen profile at the deep point of the lake.

Summary: Otis Reservoir is a large 1,200-acre lake located Otis and Tolland with approximately 1/3 of the shoreline within Tolland State Forest. Maximum depth is 48 feet with a mean depth of 15 feet. Three large islands are present as well as numerous smaller islands. Substrate is primarily rock and sand, with some silty deposits observed in deeper regions. Water color was clear to light tea colored with excellent clarity and a Secchi depth of 11.5 feet. The vertical profile at the time of the survey showed a surface temperature of 21.7 degrees C and dissolved oxygen of 91.1% saturation. Temperature at 7 meters deep was 19.2 degrees C and 16.1% saturation. Although the top and bottom temperatures were similar at the time of the survey, the reservoir is known to thermally stratify during the summer. Aquatic plants are in low abundance, and non-indigenous plant species have not been documented except for *Phragmites* along some shoreline regions. Some trace densities of *Utricularia* sp. were noted at the dive site. Aquatic snails and indigenous mussels were common at the sampling locations. Shoreline development is high along the approximate 2/3 of shoreline not controlled by Tolland State Forest. Recreational use is very high, with various private access sites and a large MA OFBA boat access and parking area within the State Park.

Vertical profile. Site 2
Depth 25 ft (7.6 m)

Depth (m)	DO (% Sat)	Temp (C)
0.0	91.1	21.7
1.0	90.8	21.7
2.0	90.3	21.5
3.0	88.7	21.3
4.0	84.8	21.2
5.0	79.1	21.0
6.0	72.2	20.3
7.0	16.1	19.2

Potential for Zebra Mussels: Otis Reservoir is considered Low Risk because of low pH (6.8) and low calcium (6 mg/l).

Plunkett Reservoir

HInsdale

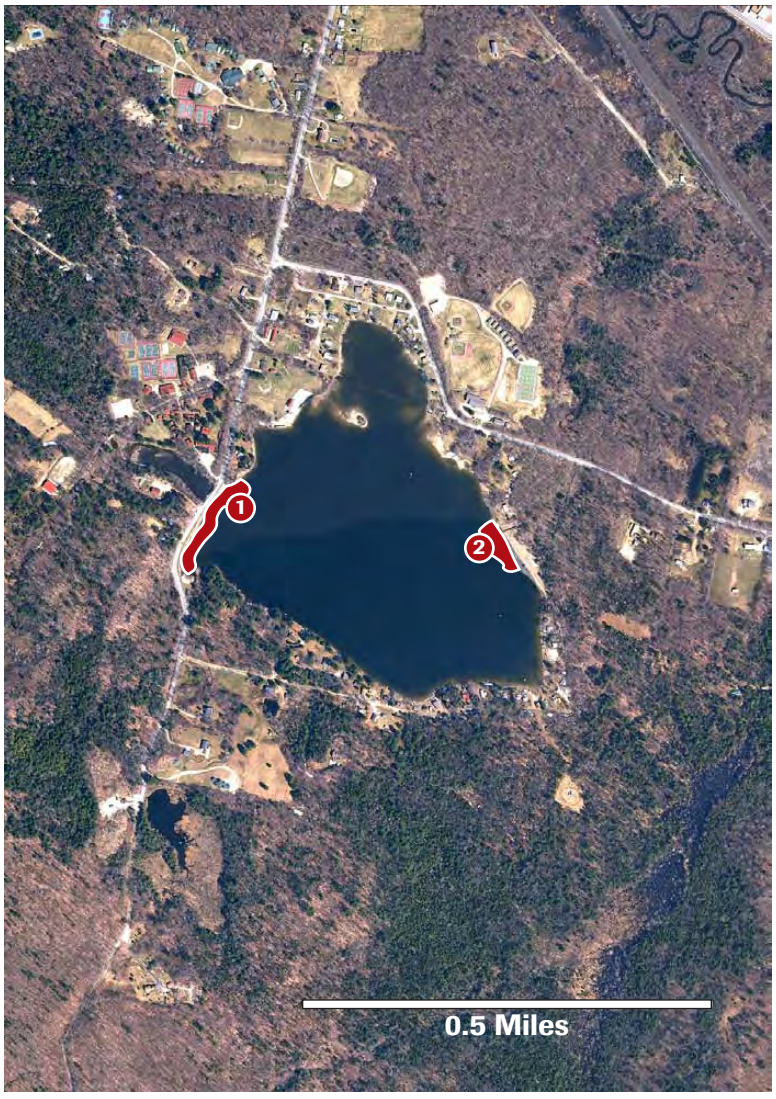
Surveyed: September 9, 2009. Afternoon.
Weather: Partly sunny, 75 degrees, light wind.

Survey Sites: Two sites were surveyed in Plunkett Reservoir, including the boat ramp and causeway area on the west wide of the lake and near the outlet along the face of the dam. Methods included SCUBA (2 sites), snorkel/wading surveys (1 site), 2 plankton tows, 2 water samples, and one DO/temperature profile (Appendix 1).

Summary: Plunkett Reservoir is a 73-acre warmwater pond with an average depth of 10 feet and a maximum depth of 22 feet. Secchi depth was 14.5 feet at Site 2 (where depth was 16 feet). Substrate was a mix of sand, gravel, and cobble in shallow water, with higher proportions of gyttja in deep water. The long dam along the eastern shore provided large amounts of rock and concrete. The DO/temperature profile was done at a depth of 16 feet where the water column was not thermally stratified but there was a sharp decline in dissolved oxygen below 4 meters (13 feet). Aquatic plants were sparse in shallow water but abundant in deeper areas (especially in depths of 7-10 feet at Site 1). Common plant species included *Potamogeton spp., Najas minor, Myriophyllum spicatum, Elodea canadensis, and Utricularis radiata*. Snail densities were medium to high in shallow water, especially *Amnicola limosa* and *Viviparus georgianus*. A single individual of *Valvata tricarinata* was found. Two native mussel species were observed (*Elliptio complanata* and *Pyganodon cataracta*) but there were at low densities, The lake is accessible for shore fishing and small boats, and the shoreline is heavily developed.

Vertical profile. Site 2
Depth 16 ft (4.88 m)

Depth (m)	DO (mg/L)	Temp (C)
0.0	9.28	21.4
0.5	9.27	21.4
1.0	9.15	21.3
1.5	9.12	21.3
2.0	8.98	21.1
2.5	8.97	21.0
3.0	8.99	20.9
3.5	8.84	20.7
4.0	6.55	20.2
4.5	2.38	19.2
4.75	1.85	19.3



Potential for Zebra Mussels: Plunkett Reservoir is considered Medium Risk due to marginally suitable calcium (11-13 mg/L), pH (7.80-7.86), and alkalinity (32 mg/L). The calcium levels are at the low end of the range that this report considers Medium Risk and Plunkett Reservoir could be reassigned to Low Risk with increased confidence about variation in water chemistry and thresholds for zebra mussels . Aquatic mollusk densities are moderate to high and *Valvata tricarinata*, an indicator of calcareous lakes, is present.

Pontoosuc Lake

Pittsfield/Lanesborough

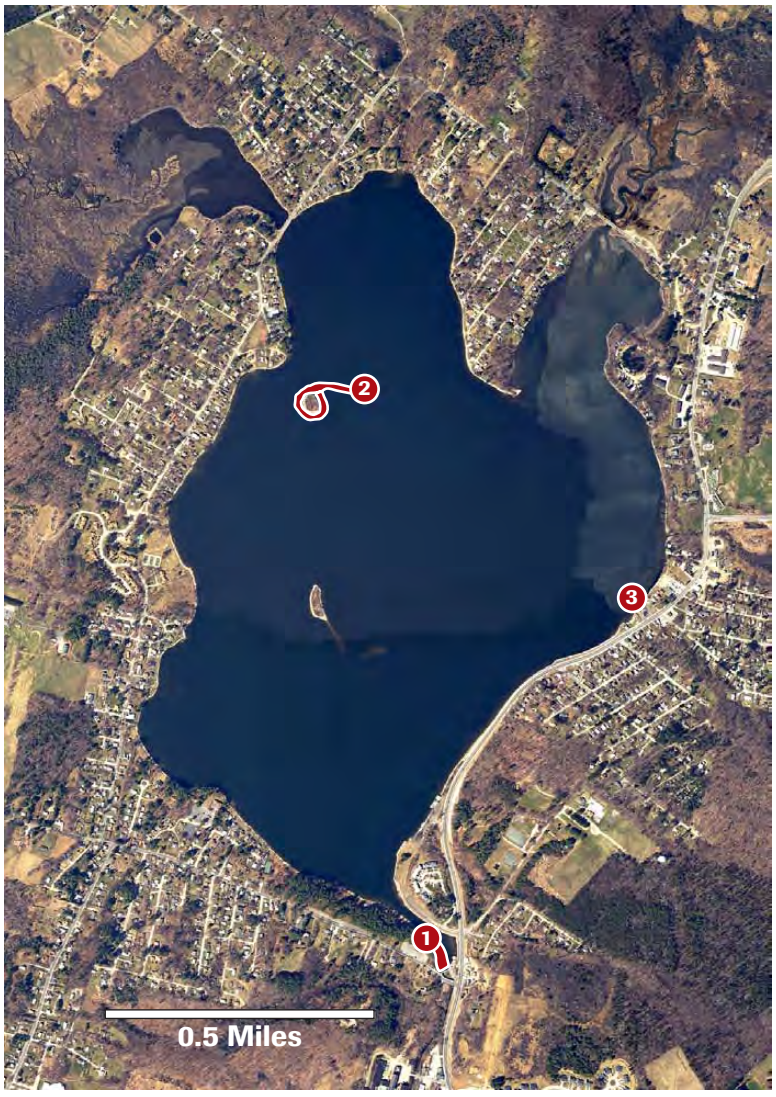
Surveyed: October 1, 2009. Afternoon.
Weather: Cloudy, 49 degrees, moderate west wind.

Survey Sites: Three sites were surveyed in Pontoosuc Lake, including the perimeter of the island in the northwest side of the lake, the eastern shoreline along Route 7, and the area from the boat launch to the dam. Methods included SCUBA (3 sites), 3 plankton tows, 2 water samples, and one DO/temperature profile (Appendix 1).

Summary: Pontoosuc Lake is a 480-acre lake with an average depth of 14 feet and a maximum depth of 35 feet. Secchi depth was approximately 8 feet (three readings), indicating poor water clarity. Substrate was a mix of sand and rock (gravel and cobble) near shore to muck in deeper water. Substrate near the boat launch and dam was rockier than other areas of the lake, and among the natural rocks were large amounts of old concrete, pipes, and other debris. The DO/temperature profile was done at a depth of 33 feet and the water column was not stratified, and DO did not drop until 9.0 meters. A cool early autumn and strong winds in days prior to the survey may have mixed the water column. Aquatic plants were sparse in shallow water (likely due to annual drawdowns) but abundant in deeper areas where *Najas minor, Chara* sp., *Vallisneria americana, Myriophyllum spicatum*, and *Potamogeton* spp. were the most common taxa. Only one snail species (*Amnicola limosa*) was found and snail densities were extremely low. Old and heavily eroded mussel shells were found near Site 2 but only the outlet area (Site 1) supported moderate densities of live native mussels (mostly *Pyganodon cataracta*). Pontoosuc Lake is heavily developed along all shorelines and recreational use is very high.

Vertical profile. Site 2
Depth 33 ft (10.0 m)

Depth (m)	DO (mg/L)	Temp (C)
0.0	8.83	15.9
0.5	8.76	15.9
1.0	8.76	15.9
1.5	8.74	15.9
2.0	8.71	15.9
2.5	8.67	15.9
3.0	8.67	15.9
3.5	8.67	15.9
4.0	8.69	15.9
4.5	8.72	15.8
5.0	8.73	15.8
5.5	8.78	15.8
6.0	8.79	15.6
6.5	8.49	15.4
7.0	7.95	15.3
7.5	7.75	15.2
8.0	7.54	15.1
8.5	7.24	15.1
9.0	0.24	12.6



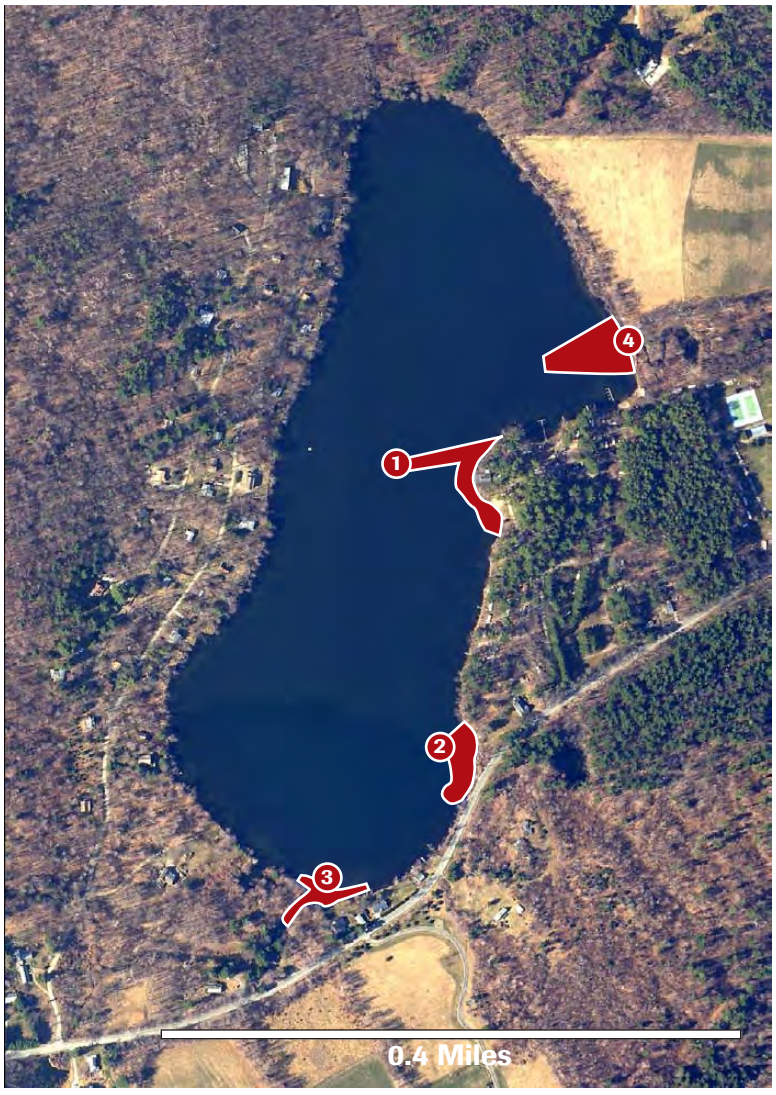
Potential for Zebra Mussels: Pontoosuc Lake is considered High Risk due to suitable calcium (38 mg/L), pH (7.79-7.85), and alkalinity (106 mg/L). In addition to suitable water chemistry, the lake is accessible to the public from multiple points and the large boat ramp allows for heavy recreational use by outside boats.

Prospect Lake
Egremont

Surveyed: September 17, 2009. Afternoon.
Weather: Cloudy, 60 degrees, light wind.

Survey Sites: Four sites were surveyed in Prospect Lake, including near the fishermen access points along Prospect Lake Road, in the deep inlet where there is a public canoe launch, in the cove near the outlet dam, and in the middle portion of the pond. Methods included SCUBA (2 sites), snorkel/wading surveys (3 sites), 3 plankton tows, and 2 water samples (Appendix 1).

Summary: Prospect Lake is a small shallow pond located in Egremont. The highest depth we recorded was only 9 feet, and the bottom was visible from the surface at all survey sites. Substrate was mostly muck and detritus throughout the middle and southern ends of the lake, with some gravelly muck and ledge in the areas near the outlet, and usually some rock (gravel, cobble, boulder) near immediate shorelines. There was little variation in temperature (19.7-19.5 from surface to bottom) or dissolved oxygen (9.89-9.68 from surface to bottom) in the water column at Site 2, and this shallow lake presumably stays well-mixed during the year. Aquatic plants were abundant at all depths throughout the lake; common species included *Chara* sp., *Potamogeton robbinsii*, *P. crispus*, *Ceratophyllum demersum*, and *Vallisneria americana*. Seven snail species were found and they were usually at moderate to high densities. Two species of native mussels were found; these were common near the outlet in the gravelly muck but uncommon at the three other survey sites. Most of the western, southern, and eastern shorelines are developed, and there is public access at the southern end for car-top boats.



Potential for Zebra Mussels: Prospect Lake is considered High Risk due to suitable calcium (21-22 mg/L), pH (8.38-8.40), and alkalinity (81-87 mg/L). Prospect Lake had a higher pH than any other lake surveyed except for Lake Mansfield, although its calcium levels are toward the lower end of the range that we consider optimum for zebra mussels. Presence of marl and the aquatic algae *Chara* sp. provide further evidence of the suitability of this waterbody for zebra mussels. However, its small size, shallow depths, high primary productivity, and limited amounts of hard substrates might collectively limit the success of zebra mussels in this lake.

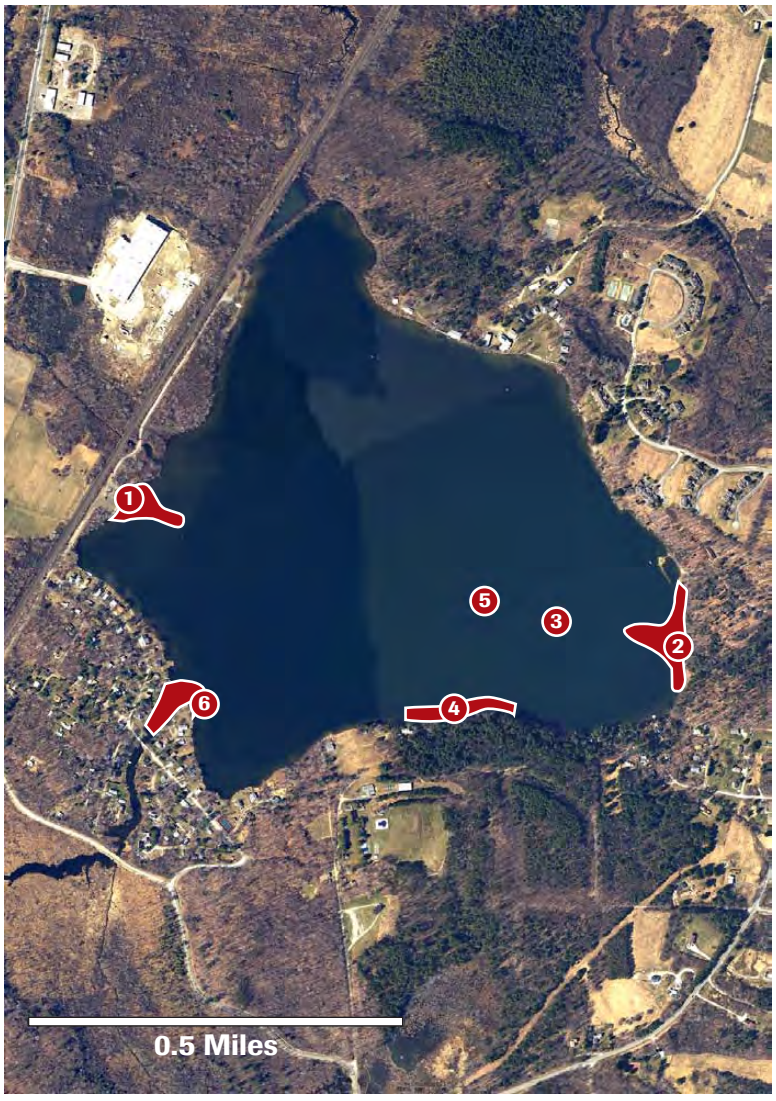
Richmond Pond

Richmond/Pittsfield

Surveyed: September 10, 2009. Morning.
Weather: Sunny, 65 degrees, moderate to strong wind.

Survey Sites: Six sites were surveyed in Richmond Pond, including the public boat ramp, four locations in the deep eastern third of the lake, and the lake outlet. Methods included SCUBA (2 sites), snorkel/wading surveys (4 sites), 3 plankton tows, 2 water samples (Appendix 1). DCR biologists also dove multiple locations in Richmond Pond on August 6, 2009.

Summary: Richmond Pond is a 218-acre raised great pond. It has an average depth of 18 feet and maximum depth of 53 feet, although most of the western and northern parts of the lake are very shallow and there is one deep basin in the southeastern part of the lake. The two Secchi depths were 13.5 and 14 feet. Substrate was mostly muck and detritus throughout the shallow areas, gyttja in deep water, and a mix of sand and rock (gravel, cobble, boulder) near high-gradient shorelines out to a depth of >25 feet. Most of the rocky substrates were found closer to shore at sites 2 and 4. Aquatic plants were abundant in the photic zone; common species (among the 20 found) included *Chara* sp., *Potamogeton robbinsii*, *Ceratophyllum demersum*, *Vallisneria americana, Najas spp., and Myriophyllum spicatum*. Seven snail species were found and they were usually at moderate to high densities. Two species of native mussels were found and these were always at low densities. Our attempt to get a vertical DO/temperature profile at the deep point of the lake was thwarted by strong winds and an anchor that would not hold in the soft gyttja at that location. Except for the high-density development along the southwest shoreline, most of the lakeshore homes are widely spaced and set back from the water and portions of the shoreline is undeveloped. Public access is primarily through the large public boat ramp on the western shoreline.



Potential for Zebra Mussels: Richmond Pond is considered High Risk due to suitable calcium (35-40 mg/L), pH (8.27-8.30), and alkalinity (117-123 mg/L). It is among the six most vulnerable ponds we surveyed based on its water chemistry and physical attributes, with the deeper and rockier southeastern third of the lake most likely to support zebra mussels.

Shaw Pond

Becket/Otis

Surveyed: September 8, 2009. Afternoon.
Weather: Sunny, 75 degrees, light wind.

Survey Sites: Five sites were surveyed in Shaw Pond, including the shoreline near the public boat ramp and four locations accessed by boat. Methods included SCUBA (4 sites), snorkel/wading surveys (1 site), 3 plankton tows, 2 water samples, and 1 vertical DO/temperature profile (Appendix 1).

Summary: Shaw Pond is a 100-acre pond located in Becket and Otis, and it is within the Farmington River watershed. Average depth is 13 feet and maximum depth is 19 feet. Secchi depths ranged from 9.5 to 12.5 feet (average = 10.5 feet). Substrate was mostly muck in deeper areas and a mix of clay, sand and rock (gravel, cobble, boulder) in shallow nearshore areas and along the high-gradient eastern shoreline. The vertical DO/temperature profile did not detect thermal stratification but dissolved oxygen was low in depths below 4.0 meters (12 feet). Aquatic plant densities were variable, with low densities of *Utricularia* spp., *Myriophyllum spicatum*, *Potamogeton amplifolius*, and *Ceratophyllum demersum* most prevalent in deeper areas and a greater variety of plants (including floating-leaved *Nuphar* and *Nymphaea*) in shallow shoreline areas. Moderate densities of aquatic snails were found in shallow water, with the non-native *Viviparus georgianus* comprising the majority of the snail biomass. Two species of native mussels were found and these were usually at low densities, although *Elliptio complanata* was very common in shallow water near Site 2. Shoreline development is mainly limited to the western side of the lake along Route 8, which is also where the small public boat ramp is located.

Vertical profile. Site 2
Depth 19 ft (5.8 m)

Depth (m)	DO (mg/L)	Temp (C)
0.0	7.75	22.4
0.5	7.71	22.2
1.0	7.70	21.1
1.5	7.68	20.7
2.0	7.65	20.6
2.5	7.66	20.5
3.0	7.68	20.4
3.5	7.46	20.3
4.0	3.92	19.6
4.5	1.50	18.9
5.0	0.10	18.5
5.5	0.05	18.2

Potential for Zebra Mussels: Shaw Pond is considered Medium Risk due to low calcium (10-11 mg/L) and marginally suitable pH (7.59-7.61) and alkalinity (30-32 mg/L). Shaw Pond is at the lower end of what this report considers Medium Risk and it could be reassigned to Low Risk with increased confidence about variation in water chemistry and thresholds for zebra mussels.

Stockbridge Bowl

Stockbridge

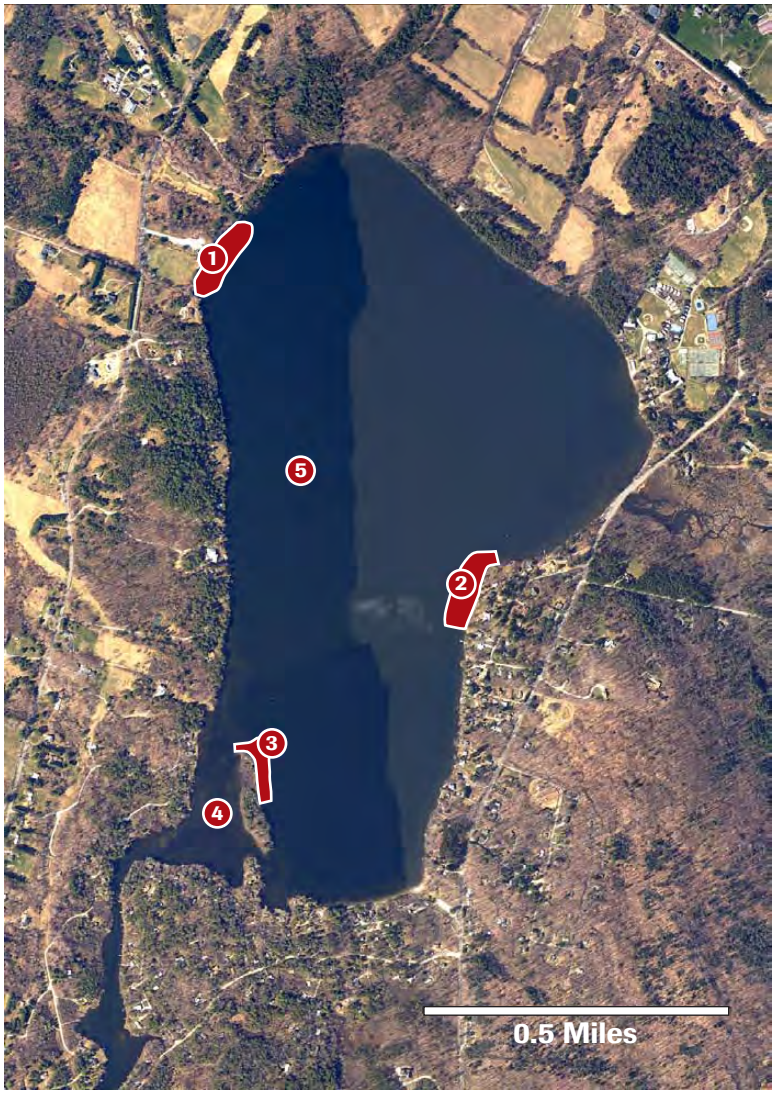
Surveyed: September 18, 2009. 10:30-4:00.
Weather: Sunny, 70 degrees, light to moderate breeze.

Survey Sites: Five sites were surveyed in Stockbridge Bowl, including the boat ramp (and nearby deep water), the peninsula along the eastern shore, the island in the southwest corner of the pond, shallow water near the outlet, and deep water along the western shore. Methods included SCUBA (3 sites), snorkel/wading surveys (4 sites), 4 plankton tows, 2 water samples, and 1 DO/temperature profile (Appendix 1).

Summary: Stockbridge Bowl is a 372-acre lake with an average depth of 27 feet and maximum depth of 48 feet. Water clarity was relatively poor (secchi depth 11 feet) due to high algae counts that are typical in this lake during mid to late summer. Substrate was a mix of clay, sand, and rock (gravel, cobble, boulder) along most shoreline areas to higher amounts of gyttja in deeper water. The outlet cover was mucky with scattered boulders and very weedy. The vertical DO/temperature profile taken at a depth of 10 meters (33 feet) revealed a thermocline starting near 6.0 meters and a sharp decline in dissolved oxygen at 6.5 meters. Aquatic plant densities were variable, with low densities of plants very close to shore or in water deeper than 3.0-3.5 meters, but high plant densities in intermediate depths. Dominant plant species included *Chara* sp., *Vallisneria americana*, *Najas* spp., *Potamogeton amplifolius*, *Myriophyllum spicatum*, and *Ceratophyllum demersum*. The outlet cove supported very high abundance of aquatic plants, including nearly 80 percent coverage by *Nuphar* and *Nymphaea*. Eleven species of aquatic snails were found, and although shells were abundant, live snails were harder to find. Among the snails were the two species that prefer hardwater lakes—*Valvata tricarinata* and *Marstonia lustrica*. Two mussel species—*Pyganodon cataracta* and *Elliptio complanata*—were present at low densities at all survey sites.

Vertical profile. Site 1
Depth 33 ft (10.0 m)

Depth (m)	DO (mg/L)	Temp (C)
0.0	9.71	19.6
0.5	9.67	19.5
1.0	9.69	19.1
1.5	9.67	19.1
2.0	9.68	19.1
2.5	9.66	19.0
3.0	9.65	19.0
3.5	9.62	19.0
4.0	9.57	19.0
4.5	9.57	19.0
5.0	9.53	18.9
5.5	9.56	18.9
6.0	7.19	17.8
6.5	3.28	15.4
7.0	1.85	13.9
7.5	0.18	12.3
8.0	0.07	11.2
8.5	0.03	9.9



Potential for Zebra Mussels: Stockbridge Bowl is considered High Risk due to optimal chemical conditions for zebra mussels, including high calcium (32-34 mg/L) high pH (8.35-8.45) and high alkalinity (122 mg/L). Other indicators include the prevalence of marl on all submerged surfaces, abundance of *Chara* sp., high species richness of snails, and presence of two snail species that prefer hardwater lakes. Stockbridge Bowl is one of the most heavily used lakes in Massachusetts by boaters and anglers and it is accessible via several locations. It is also geographically close to Laurel Lake.

Thousand Acre Pond

New Marlborough

Surveyed: September 14, 2009. Afternoon.
Weather: Sunny, 70 degrees, light breeze.

Survey Sites: Four sites were surveyed in Thousand Acre Pond, including the public boat launch, the outlet, the middle of the pond, and the southeastern shoreline. Methods included SCUBA (3 sites), snorkel/wading surveys (2 sites), 3 plankton tows, 2 water samples, and 1 DO/temperature profile (Appendix 1).

Summary: Thousand Acre Pond is a 155-acre pond in New Marlborough created by damming the headwaters of the Whiting River (a tributary of Connecticut's Blackberry River, which flows into the Housatonic River). Average depth is 4 feet and maximum depth is 8-9 feet. Water clarity was relatively poor (secchi depth 7.5 feet) and the water appeared slightly tannic. Substrate was a mix of clay and muck, with some large boulders along shoreline areas and in a shoal toward the middle of the pond (Site 2). Large tree stumps were common throughout the pond. The vertical DO/temperature profile taken at a depth of 8.5 feet at Site 3 (the outlet) revealed an unstratified water column that was oxygenated to the bottom. Aquatic plant densities were generally high, especially in shallow areas where there was dense coverage of floating-leaved plants (*Nuphar, Nymphaea*, and *Brasenia*) and submerged aquatic plants (*Utricularia* spp., *Myriophyllum heterophyllum, Myriophyllum spicatum, Potamogeton amplifolius*, and *Ceratophyllum demersum*). Only two species of aquatic snails were found, including *Amnicola limosa* (abundant) and *Physa heterostropha*. Two mussel species—*Pyganodon cataracta* and *Elliptio complanata*—were present at all survey sites but were only abundant in the rocky shoal in the middle of the lake (Site 2). The lake is almost entirely within the boundaries of Campbells Falls State Park and there is no shoreline development. The boat launch is only suitable for canoes and non-motorized boats.

Vertical profile. Site 3
Depth 8.5 ft (2.6 m)

Depth (m)	DO (mg/L)	Temp (C)
0.0	9.49	18.4
1.0	9.30	18.2
2.0	8.95	17.9
2.5	8.91	17.8

Potential for Zebra Mussels: Thousand Acre Pond is considered Low Risk due to low calcium (3 mg/L) low pH (7.33-7.35) and low alkalinity (20 mg/L). In addition to unsuitable water chemistry, the shallow and weedy pond does not provide suitable physical habitat for zebra mussels.

Windsor Pond

Windsor

Surveyed: October 2, 2009. Afternoon.
Weather: Cloudy, 55 degrees, calm.

Survey Sites: Three sites were surveyed in Windsor Pond, including the boat launch, outlet, and deep part of the pond. Methods included SCUBA (1 site), snorkel/wading surveys (2 sites), 2 plankton tows, 2 water samples, and 1 DO/temperature profile (Appendix 1).

Summary: Windsor Pond is a small 48-acre pond in the headwater region of the Westfield River in Windsor. Average depth is 21 feet and maximum depth is 53 feet. Secchi depth was only 10 feet and the water was slightly tannic. Substrate was reported to be muck overlying gravel and rubble; we did not dive in deep water to confirm substrate conditions but we did observe mucky sand, gravel, and cobble near the boat launch and outlet. The vertical DO/temperature profile taken at Site 2 revealed much colder water than any other lakes we surveyed and a thermocline starting near 6.5 meters, where temperature and dissolved oxygen dropped sharply. Overall, Windsor Pond had a unique plant assemblage compared to other lakes surveyed for this report, including species often found in neutral or slightly acidic oligotrophic ponds such as *Eriocaulon aquaticum*, *Eleocharis acicularis*, and *Nymphoides cordata*. Aquatic plant densities were low. The shoreline vegetation also included several acidophilic plants such as *Chamaedaphne calyculata*, *Myrica gale*, and *Vaccinium* sp. No snails were encountered in the limited surveys but it is likely that some occur in shallow littoral areas of the pond. *Pyganodon cataracta* was the only native mussel species encountered and it was at moderate abundance at Site 1 and Site 3. Lakeshore development is high along the southern and northeastern sides of the lake and there is also a public beach adjacent to the boat ramp.

Vertical profile. Site 2
Depth 44 ft (13.4 m)

Depth (m)	DO (mg/L)	Temp (C)
0.0	8.75	14.2
0.5	8.66	14.2
1.0	8.63	14.2
1.5	8.57	14.2
2.0	8.51	14.1
2.5	8.45	14.1
3.0	8.48	14.0
3.5	8.46	14.0
4.0	8.44	14.0
4.5	8.34	14.0
5.0	8.31	13.9
5.5	8.26	13.9
6.0	7.86	13.8
6.5	1.81	11.9
7.0	0.33	9.4
7.5	0.19	8.6
8.0	0.14	8.1
8.5	0.10	7.7
9.0	0.08	7.5

Potential for Zebra Mussels: Windsor Pond is considered Low Risk due to low calcium (6-8 mg/L) low pH (6.88-6.90) and low alkalinity (4-6 mg/L).