2010 Lake Shirley
Aquatic Vegetation Survey

October 1, 2010




Prepared For:

Lake Shirley Improvement Corporation

Submitted By:

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SECTION 1: INTRODUCTION

Geosyntec Consultants (Geosyntec) was contracted by the Lake Shirley Improvement Corporation (LSIC) to conduct a comprehensive macrophyte (vascular aquatic plant) survey of Lake Shirley in Lunenburg, MA, during the summer of 2010. The purpose of the survey was to:

1. Provide an update on the composition and distribution Lake Shirley's macrophyte community, allowing the LSIC and the Conservation Commissions of Lunenburg and Shirley to track changes in the Lake's plant community in response to drawdown and other lake management techniques; and

2. Continue to track changes in the distribution and dominance of nuisance non-native plant species within the lake.

Lake Shirley (Lunenburg, MA)

SECTION 2: AQUATIC VEGETATION SURVEY

2.1 METHODOLOGY

On August 26, 2010, Geosyntec conducted a macrophyte survey of Lake Shirley. Aquatic vegetation was sampled from a boat. Plant species were identified at 66 sampling locations (see Figure 3), based (with minor modifications) on the sampling stations established by Geosyntec's 2002-2009 vegetation surveys. Plants were identified by visual inspection and by using an aquatic vegetation grappling hook to sample submerged vegetation. At each station, the dominant plant(s) were recorded, as well as estimates of plant growth density and biomass. As categorized in Table 3, plant density is an estimate of aerial coverage when looking down to the lake bottom from the water surface. Biomass estimates the amount of plant matter within the water column. For example, a sampling station with dense growth of low-growing plants may have a high density estimate but a relatively low plant biomass estimate. A station with dense growth of a long, ropey plant like Eurasian milfoil, with stems reaching the water surface, would have both high plant density and high biomass estimates.

In addition to recording information from the 66 sampling stations, a running documentation of plant growth densities was estimated throughout the lakewide survey.

2.2 VEGETATION SURVEY RESULTS

2.2.1 Summary of 2002-2010 Vegetation Survey Results

To allow for comparison of changes in the Lake Shirley plant community over time, the following is a synopsis of the major findings of the vegetation surveys conducted by Geosyntec from 2002 through 2010, followed by a more detailed discussion of the 2010 survey results:

Year	Summary of Findings
2002	• Eurasian milfoil was the most well-distributed and dominant plant in the lake, present at 75% of sampling stations and dominant at 38% of all stations. • Variable milfoil was found at 60% of the stations and was dominant at 28% of stations. With the exception of the southwest portion of the lake, Variable milfoil was well distributed in all areas except the southwest portion of the lake. • Waterweed (*Elodea nuttallii*) was found at 52% of stations and was dominant at 28% of stations. • Fanwort was found at 50% of the stations and was dominant at 20% of stations. Fanwort was most abundant in the southern half of the Lake. • Only the deeper southern basin of the lake had a significant area with "sparse" (0-25% density) plant coverage. Plant densities elsewhere ranged from moderate (26-50%) to very dense (75-100%). • 27 macrophyte species observed, with a species richness index (average number of species per sampling station) of 4.27.
2003	• Eurasian milfoil was the most well-distributed and dominant plant in Lake Shirley, present at 75% of sampling stations and dominant at 21% of all stations. • Variable milfoil was found at 55% of the sampling stations and was dominant at 17% of stations, a slight decrease from 2002. • Although Fanwort was well distributed around the lake, this plant's dominance declined from 20% to 12% of all stations. • Invasive European Naiad is documented for the first time at two sampling stations. • A majority of the littoral zone had moderate plant growth, with 72% of the sampling stations this category. 11% of stations had sparse growth and 15% had either dense or very dense growth. • 21 macrophyte species observed, with a species richness index of 5.52.

2004	• Eurasian milfoil was the most well distributed plant in Lake Shirley, found at 77% of all stations. However, its relative dominance decreased to 14% of all stations. • Variable milfoil declined significantly in distribution and was not a dominant plant at any stations. • Fanwort continued to be well distributed and increased in dominance to 18% of stations. • Significant increase observed in the distribution (23%) and dominance (8%) of European Naiad. • A majority of the littoral zone had moderate plant growth, and 58% of sampling stations were in this category. 17% of stations had sparse growth and 26% had either dense or very dense growth. • 20 macrophyte species observed, with a species richness index of 5.18.
2005	• Eurasian milfoil was the most well-distributed and dominant plant in Lake Shirley. Eurasian milfoil was found at 92% of all stations and this plant increased in dominance (25% of all stations). • Fanwort declined significantly in overall abundance and dominance (9% of stations). • Modest increases in abundance and dominance for both Variable Milfoil and European Naiad. • A majority of the littoral zone had moderate plant growth (61% of the sampling stations). However, the sampling stations with sparse growth increased to 27%. A corresponding decrease in stations with either dense or very dense growth was also reported (13%). • 25 macrophyte species observed, with a species richness index of 6.36.
2006	• Macrophyte growth was diminished in many areas due to a severe algal bloom that affected Lake Shirley during summer 2006. It is also important to consider the cumulative effects on plant abundance related to the winter lake level drawdown conducted since 2003. • Eurasian milfoil continued to be the most well-distributed and dominant plant in the lake, although its overall abundance and growth density declined since 2005. 18 out of 20 stations (90%) where Eurasian milfoil was a dominant plant were determined to have either sparse or moderate growth densities. • Overall plant density decreased notably in 2006. Sparse plant growth was reported at 45% of stations, moderate growth at 42%, and dense or very dense growth at 11%. • 27 macrophyte species observed. Species richness declined dramatically to 3.36, approximately half of its 2005 level.
2007	• During the post-herbicide treatment survey, most areas exhibited either no growth or extremely limited vegetation. • The most well distributed native plant on this survey date was Wild Celery (*Vallisneria americana*), which was observed at 12 out of the 20 survey areas. • Eurasian milfoil observed in trace amounts at only one survey area. European Naiad observed at six survey areas in the southwest section of the lake. Fanwort observed at three survey areas.
2008	• Invasive European Naiad has rapidly emerged as the most dominant plant in the lake. European Naiad was found at 44% of all sampling stations and was the dominant plant at 20% of all stations. • Eurasian milfoil declined significantly. It was present in small quantities at only 18% of sampling stations and was not dominant at any of the stations. • Fanwort was found at only 4 stations (6%) and was a dominant plant at only one station. • Variable milfoil was found in small quantities at only one of the sampling stations. • 24 macrophyte species observed, with a species richness index of 2.92.
2009	• Invasive European Naiad continues to be the most dominant plant in the lake, found at 44% of all sampling stations and dominant at 15% of all stations. • Fanwort was found at 10 stations (15%) and was a dominant plant at only one station. • Eurasian milfoil continued to decline. It was present in small quantities at only two sampling stations. Variable milfoil was found in small quantities at only one of the sampling stations. • 22 macrophyte species observed, with a species richness of 2.83. Only 4 species were dominant at more than 1 sampling station.

2010	• Structured macroalgae (Musk Grass) has emerged as the dominant macrophyte in the lake, found at 56% of all sampling stations and dominant at 36% of all stations. Musk Grass was particularly dominant throughout much of the northern basin of the lake, where it formed a low-growing canopy along the lake bottom. • Native Wild Celery continues to be the most well distributed plant in Lake Shirley, found at 64% of the sampling stations. This plant was also dominant at 7 stations (11%), second only to Musk Grass. • Invasive European Naiad has declined since the 2009 survey. This plant was present at 29% of the sampling stations but was not a dominant plant at any station. In 2008 and 2009, European Naiad was the most dominant plant in the lake. • Invasive Fanwort, Eurasian milfoil and Variable milfoil were generally observed in low quantities, similar to what was observed in 2009. • Overall plant growth density and biomass was similar to 2009, following several years of steady decline in plant abundance. • 24 macrophyte species observed, with a species richness index of 2.88 (similar to 2009).

2.2.2 2010 Vegetation Survey Results

A listing of plant species present at each of the sixty-six sampling stations is provided in Table 3, including information on vegetation density, plant biomass, and dominant plants at each station. A summary of the major findings of the 2010 vegetation survey is as follows:

General Notes:

- Musk Grass (*Chara spp.*), a structured macroalgae that has the appearance of a vascular aquatic plant, has rapidly emerged as the dominant macrophyte in the lake.

- As shown in Figure 1, the overall abundance of aquatic plants in Lake Shirley declined during the period of 2002-2009. The 2010 survey indicates a change in this trend, with both the lake's plant density index and biomass index nearly equal to that of 2009.

- As shown in Table 1, most (77%) of the Lake Shirley sampling stations were characterized by sparse plant growth ranging from 0-25% density. 30% of all sampling stations were observed to either have no plants or trace (1-5% density) growth. Only 6% of the sampling stations were reported to have either dense or very dense plant growth. These plant growth density results are similar to the 2009 results.

- Only five species were observed at greater than 20% of the sampling stations, and only three species were determined to be a dominant plant at more than 2 of the 66 sampling stations.

- Overall, 24 species (see Table 3) of macrophytes were documented in Lake Shirley during the 2010 survey, similar to the 22 species observed in species in 2009 and 24 species in 2008.

Invasive/Non-native Species:

- In 2008 and 2009, invasive **European Naiad** (*Najas minor*) was the most dominant plant in Lake Shirley (present at 44% of stations in 2009, dominant at 15%). This plant exhibited a significant decline in 2010. Although European Naiad was observed at 32% of the sampling stations, making it the third most well distributed plant, it was not dominant at any stations.

European Naiad

- For the second year in a row, a slight increase in the distribution of invasive **Fanwort** (*Cabomba caroliniana*) was observed. Fanwort was found at 12 stations (18%) and was a dominant plant at only 2 stations. In 2009, Fanwort was found at 10 stations and was dominant at 1 station. Fanwort is still relatively scarce and well below its 2005 level, when it was present at 62% of all stations and was a dominant plant at 6 stations.

Fanwort

- Invasive **Eurasian milfoil** (*Myriophyllum spicatum*) continues to be present in the lake in trace amounts. This plant was present in small quantities at only 3 stations in 2010 and 2 stations in 2009. In 2005, Eurasian milfoil was found at 92% of the sampling stations and was the most dominant plant in Lake Shirley.

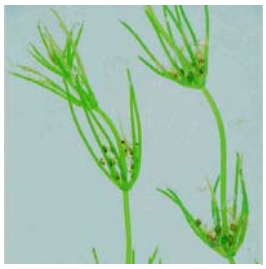
Eurasian milfoil

- As observed in 2008 and 2009, invasive **Variable milfoil** (*Myriophyllum heterophyllum*) was found in small quantities at only one of the sampling stations. This plant was found at 23% of the sampling stations in 2005 and was one of the most well distributed and dominant plants in Lake Shirley as recently as 2003.

Variable milfoil

Native Species:

- As stated above, **Musk Grass** (*Chara spp.*) has rapidly emerged as the dominant macrophyte in the lake. This macroalgae was found at 59% of all sampling stations and dominant at 36% of all stations. Musk Grass was particularly dominant throughout much of the northern basin of the lake, where it formed a low-growing canopy along the lake bottom. Musk grasses have a distinct musky odor and are brittle when crushed between two fingers. Similar-looking vascular plants such as Bushy pondweed (*Najas spp.*) and Coontail (*Ceratophyllum demersum*) do not produce an odor when crushed.

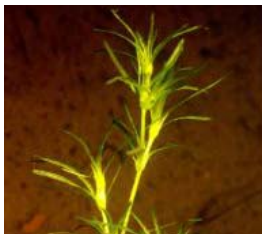


Musk Grass

- **Wild Celery** (*Vallisneria americana*) continues to be the most well distributed plant in the lake, and has increased in distribution and dominance since 2009. This beneficial native plant was present at 44 stations (67%) and dominant at 7 stations (11%), second only in dominance to Musk Grass.

Wild Celery

- **Bushy Pondweed** (*Najas flexilis*) has increased slightly in abundance since 2009, when it experienced a significant decline. This plant was found at 16 stations (24%) and was dominant at 3 stations. Bushy Pondweed was the fourth most well distributed plant in the lake. Bushy Pondweed can be distinguished from other Najas species by the pointed tips of its oppositely arranged leaves.



Bushy Pondweed

- **Thin-leaf Pondweed** (*Potamogeton pusillis)* has increased in distribution and dominance since 2009, when it was observed in small amounts at only 4 stations. In 2010, this plant was observed at 14 stations (21%) and dominant at 2 stations.

Data summary tables, a vegetation density map, and a species tally sheet from the 2010 vegetation survey are provided on the following pages.

Thin-leaf Pondweed

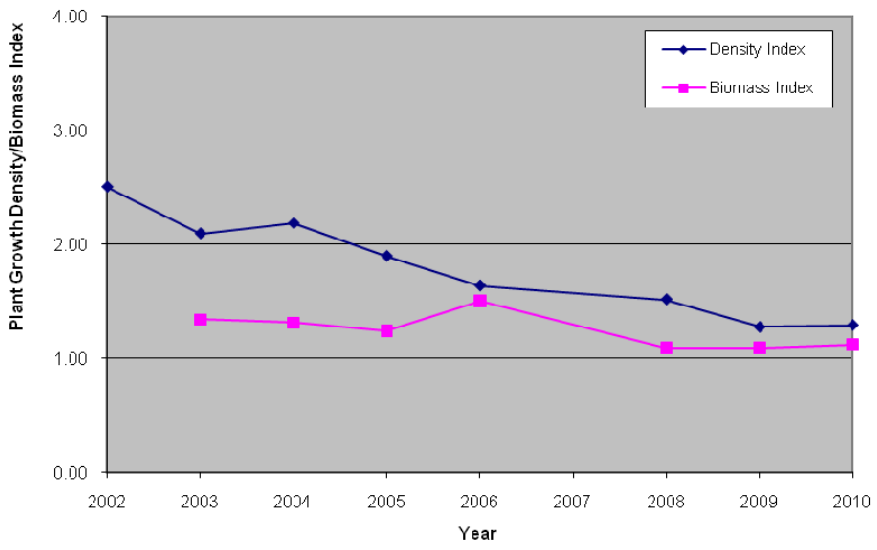
Table 1: Plant Growth Density Estimates, 2002-2009

Density Rating	# of stations (% of stations)							
	2002 (64 stations)	**2003** (65 stations)	**2004** (66 stations)	**2005** (66 stations)	**2006** (66 stations)	**2008** (66 stations)	**2009** (66 stations)	**2010** (66 stations)
1: Sparse 0-25%	**9** (14%)	**7** (11%)	**11** (17%)	**18** (27%)	**30** (45%)	**39** (59%)	**52** (79%)	**51** (77%)
2: Moderate 26-50%	**23** (36%)	**47** (72%)	**38** (58%)	**40** (61%)	**28** (42%)	**22** (33%)	**11** (17%)	**11** (17%)
3: Dense 51-75%	**23** (36%)	**9** (15%)	**11** (17%)	**5** (8%)	**6** (9%)	**3** (5%)	**2** (3%)	**4** (6%)
4: Very Dense 76-100%	**9** (14%)	**2** (3%)	**6** (9%)	**3** (5%)	**1** (2%)	**2** (3%)	**1** (2%)	**0** (0%)
Density Index*	**2.50**	**2.09**	**2.18**	**1.89**	**1.64**	**1.52**	**1.27**	**1.29**

Table 2: Plant Biomass Estimates, 2003-2009

Biomass Rating		# of stations (% of stations)					
	2003 (65 stations)	**2004** (66 stations)	**2005** (66 stations)	**2006** (66 stations)	**2008** (66 stations)	**2009** (66 stations)	**2010** (66 stations)
1: Scattered plant growth; or primarily at lake bottom	**45** (69%)	**53** (80%)	**51** (77%)	**39** (59%)	**60** (91%)	**61** (92%)	**60** (91%)
2: Less abundant growth, or in less than half of water column	**19** (29%)	**8** (12%)	**14** (21%)	**22** (33%)	**6** (9%)	4 (6%)	4 (6%)
3: Substantial growth through majority of water column	**1** (2%)	4 (6%)	**1** (2%)	**4** (6%)	**0** (0%)	**1** (2%)	**2** (3%)
4: Abundant growth throughout water column to surface	**0** (0%)	**1** (2%)	**0** (0%)	**1** (2%)	**0** (0%)	**0** (0%)	**0** (0%)
Biomass Index*	**1.34**	**1.31**	**1.24**	**1.50**	**1.09**	**1.09**	**1.12**

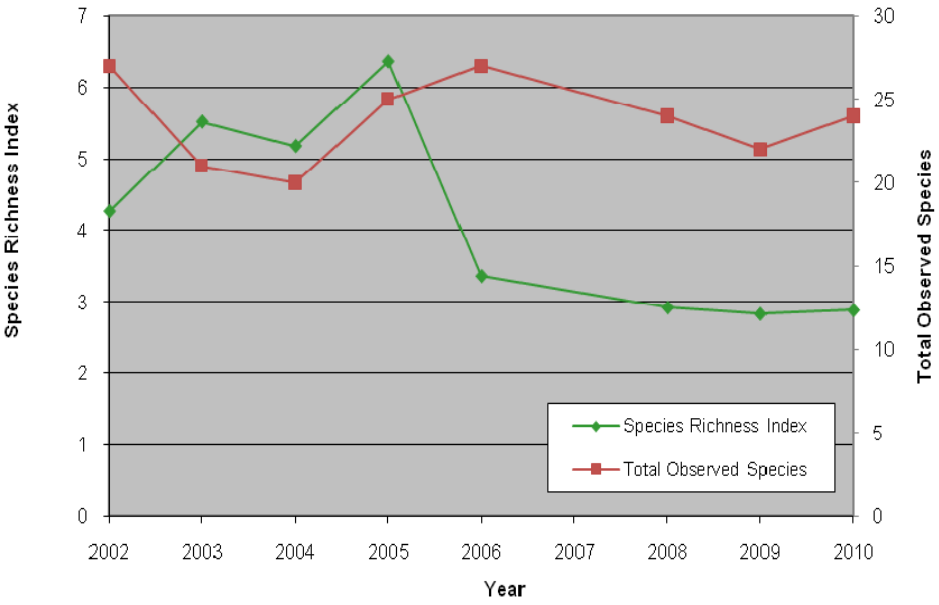
Figure 1: Lake Shirley Plant Growth Density and Biomass Index, 2002-2010



Density Index and **Biomass Index** are weighted averages of the density ratings and biomass ratings for each of the vegetation survey years listed in Table 1 and 2. For each year, the numeric rating (1to 4) is multiplied by the number of survey stations with that rating. The sum of these values is divided by the total number of sampling stations, resulting in the index value.

These indices allow for a comparison of relative changes in plant growth density and biomass over time.

Figure 2: Lake Shirley Species Richness Index and Total Observed Species, 2002-2010



* **Species Richness Index** and **Total Observed Species** are measures of biological diversity within the Lake Shirley aquatic plant community. The species richness index is calculated by averaging the number of plant species observed at each sampling station for each vegetation survey. Total observed species is the number of all species observed throughout the lake during a specific survey.

For the period of 2002-2010, species richness peaked in 2005 at an average of 6.36 species per station. Species richness has declined dramatically since 2006, although the number of total observed species has been relatively stable.

Geosyntec consultants

Table 3: Aquatic Vegetation Survey Tally Sheet

Location: Lake Shirley (Lunenburg, MA)

Date: 8/26/2010 **Surveyed by:** Bob Hartzel

● species present at monitoring station

● species dominant at monitoring station

Monitoring Locations (stations 1–32)

Plant Species	# stations present	# stations dominant	% stations present	% stations dominant	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	24A	25	26	27	28	29	30	31	32
Wild Celery *(Valisneria americana)*	44	7	67%	11%		●	●	●	●		●	●		**●**	**●**	●	●	**●**	●	●					●	●	●				●		**●**		**●**	**●**	●
Musk Grass *(Chara spp.)*	39	24	59%	36%	●	●		●	●				**●**	●			**●**	●		●						**●**		**●**	**●**		**●**			**●**	**●**		
European Naiad *(Najas minor)* *	21	0	32%	0%			●	●		●					●	●		●							●		●		●		●			●	●		
Bushy Pondweed *(Najas flexilis)*	16	3	24%	5%	●	●			**●**	●				**●**	●		**●**								●							●				●	
Thin-leaf Pondweed *(Potamogeton pusillis)*	14	2	21%	3%	●	●			●	●	●					●													●				●			●	
Fanwort *(Cabomba caroliniana)* *	12	2	18%	3%					●							●						**●**										●		●	●		
Yellow Water Lily *(Nuphar variegatum)*	6	1	9%	2%			●		●					●																					●		●
Ribbonleaf Pondweed *(Potamogeton epihydrus)*	6	1	9%	2%															●			●															
Grassy pondweed *(Potamogeton gramineus)*	5	1	8%	2%												**●**								●													
Small Waterwort *(Elatine minima)*	5	0	8%	0%							●					●		●	●					●													
Bog Moss *(Aulacomnium palustre)*	4	0	6%	0%																		●				●											
White Water Lily *(Nymphaea odorata)*	3	1	5%	2%												●																					
Eurasian Milfoil *(Myriophyllum spicatum)* *	3	0	5%	0%																				●													
Robbin's Pondweed (*Potamogeton robbinsii*)	2	1	3%	2%																		**●**					●										
Coontail *(Ceratophyllum demersum)*	2	0	3%	0%										●								●															
Watermeal *(Wolffia sp.)*	2	0	3%	0%													●																				
Variable Milfoil *(Myriophyllum heterophyllum)* *	1	0	2%	0%																		●															
Eastern Purple Bladderwort *(Utricularia purpurea)*	1	0	2%	0%																●																	
Common Bladderwort *(Utricularia vulgaris)*	1	0	2%	0%																																	
Water Purslane *(Ludwigia palustris)*	1	0	2%	0%																																	
Clasping Pondweed *(Potamogeton perfoliatus)*	1	0	2%	0%																													●				
Plant Density Rating					1*	1*	1*	1*	1	1	1	1*	1	2	2	2	1	1	1*	1*	0	3	0	1*	1*	2	1*	1	1	0	1*	1*	2	1	2	1	1
Plant Biomass Rating					1*	1*	1*	1*	1	1	1	1*	1	1	1	1	1	1	1*	1*	0	3	0	1*	1*	1	1*	1	1	0	1*	1*	1	1	1	1	1

Monitoring Locations (stations 33–64)

Plant Species	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	62A	63	64
Wild Celery *(Valisneria americana)*	●	**●**	●	●	●	●		●	●	●	●	●		●	●	●	●	●	●	●	●	●			●			●			●		
Musk Grass *(Chara spp.)*		**●**			**●**	**●**		●	**●**	**●**	●	**●**	●	**●**	**●**		●	**●**		●	**●**	●			**●**		**●**	**●**	**●**	**●**	**●**	●	●
European Naiad *(Najas minor)* *	●	●						●			●		●									●					●	●	●				
Bushy Pondweed *(Najas flexilis)*			●							●	●	●							●			●											
Thin-leaf Pondweed *(Potamogeton pusillis)*								**●**			●		●						●	●		●											
Fanwort *(Cabomba caroliniana)* *			●	**●**	●						●					●						●											
Yellow Water Lily *(Nuphar variegatum)*		**●**																															
Ribbonleaf Pondweed *(Potamogeton epihydrus)*				●				●			**●**											●											
Grassy pondweed *(Potamogeton gramineus)*		●					●				●																						
Small Waterwort *(Elatine minima)*																																	
Bog Moss *(Aulacomnium palustre)*		●	●																														
White Water Lily *(Nymphaea odorata)*		●									●																						
Eurasian Milfoil *(Myriophyllum spicatum)* *											●											●											
Robbin's Pondweed (*Potamogeton robbinsii*)																																	
Coontail *(Ceratophyllum demersum)*																																	
Watermeal *(Wolffia sp.)*																						●											
Variable Milfoil *(Myriophyllum heterophyllum)* *																																	
Eastern Purple Bladderwort *(Utricularia purpurea)*																																	
Common Bladderwort *(Utricularia vulgaris)*											●																						
Water Purslane *(Ludwigia palustris)*											●																						
Clasping Pondweed *(Potamogeton perfoliatus)*																																	
Plant Density Rating	1*	3	1	2	2	1	1	2	2	2	3	1	1	0	1	1	1	1	1	1	1	3	0	0	1	0	1	1	1	1	1	1	1
Plant Biomass Rating	1*	2	1	2	1	1	1	2	1	1	3	1	1	0	1	1	1	1	1	1	1	2	0	0	1	0	1	1	1	1	1	1	1

*** Listed as a non-native, invasive plant by the Massachusetts Biodiversity Initiative (MA-DFW)**

Key to Density and Biomass Ratings

Rating	Density (% cover)	Biomass
0	Absemt: 0%	Plants absent
1*	Trace: 1-5%	Trace plant growth; plants nearly absent
1	Sparse: 6-25%	Scattered plant growth; or primarily at lake bottom
2	Moderate: 26-50%	Less abundant growth, or in less than half of water column
3	Dense: 51-75%	Substantial growth through majority of water column
4	Very Dense: 76-100%	Abundant growth throughout water column to surface

N

Legend

- Vegetation Stations

Vegetation Density

- Sparse: 0-25%
- Moderate: 26-50%
- Dense: 51-75%
- Very Dense: 76-100%

Notes

2005 aerial image from MassGIS

500 0 500 1,000

Feet

Lake Shirley Vegetation Density September 2010

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ACTON, MASSACHUSETTS

01-OCT-2010

Figure 3

Q:\GISProjects\BW0101-Lake Shirley\Projects\VegetationDensity2010.mxd