Lake Shirley
2013 Aquatic Vegetation Survey

Project Report
October 18, 2013

Prepared For:

Lake Shirley
Improvement Corporation

Geosyntec consultants
engineers | scientists | innovators

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 2013. 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.

SECTION 2: AQUATIC VEGETATION SURVEY

2.1 Methodology

Geosyntec conducted a macrophyte survey of Lake Shirley on August 30, 2013. Aquatic vegetation was sampled from a boat. Plant species were identified at 66 sampling locations (see Figure 3), based on the sampling stations established by Geosyntec's 2002-2012 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 2002-2013 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 2013, followed by a more detailed discussion of the 2013 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. 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 4.27 species richness index (avg. number of species per station).

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 stations and dominant at 17%, a slight decrease from 2002. • Although Fanwort was well-distributed, 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. • 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 growth (61% of stations). However, stations with sparse growth increased to 27%. A corresponding decrease in stations with dense or very dense growth was also observed. • 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 during summer 2006. The effects on plant growth related to the winter drawdown conducted since 2003 are also a likely factor. • Eurasian milfoil continued to be the most well distributed and dominant plant in the lake, although its abundance and growth density declined since 2005. 90% of the stations 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 to 3.36, approximately half of its 2005 level.
2007	• During the post-herbicide treatment survey, most areas exhibited either no growth or very sparse growth. • 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. • 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) emerged as the dominant macrophyte in the lake, found at 56% of sampling stations and dominant at 36% of 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. • European Naiad declined compared to 2009. This plant was present at 29% of the sampling stations, but not dominant 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 density and biomass was similar to 2009, following several years of declining abundance. • 24 macrophyte species observed, with a species richness index of 2.88 (similar to 2009).
2011	• European Naiad to become the most dominant plant in the lake. Prior to its decline in 2010, European Naiad had been the most dominant plant in 2008-2009. Its 2011 abundance (observed at 70% of stations, dominant at 23%) was significantly higher than its previous reported peak in 2009. • Fanwort had a modest increase in abundance, observed at 18 stations (27%) and dominant at 3 stations. Fanwort was still well below its 2005 level, when it was present at 62% of all stations. • Eurasian Milfoil and Variable Milfoil were observed in low quantities, similar to 2009-2010. • Native Wild Celery continues to be the most well distributed plant in Lake Shirley, found at 73% of the sampling stations. This plant was also dominant at 20% of the stations, second only to European Naiad. • The 2011 plant density index and biomass index were slightly higher but similar to 2009 and 2010. . • 19 macrophyte species were observed, representing a modest decline from recent years. The 2011 species richness index was 2.92, similar to 2008-2010.
2012	• Growth density and biomass increased for the third consecutive year, with both being at the highest levels observed since 2006. European Naiad increased significantly in distribution and growth density. • Wild Celery was the second most abundant species. This beneficial native plant can cause nuisance conditions for boating in some areas. This plant has spiral flower stalks that extend to the water surface and are prone to becoming wrapped around boat propellers. • Fanwort had a modest decline in abundance, observed at 12 stations and dominant at 2 stations. Fanwort appeared to be more abundant than in recent years within the cove near sampling station #36. • Eurasian Milfoil and Variable Milfoil were observed in low quantities, similar to 2009-2011. • Six species were observed at 20% or more of the sampling stations, compared to five species in 2010 and 2011. Four of these species were native and two were non-native (European Naiad, Fanwort). • 20 macrophyte species were observed. Species richness index (3.32) was highest observed since 2006.
2013	• Overall growth density and biomass was slightly lower than reported in 2012. Most of the sampling stations (65%) had sparse plant growth (0-25% density), just as in 2012. 23% of the stations had moderate growth (26-50% density) and 12% had dense to very dense growth. • Bushy pondweed has increased significantly in distribution and dominance since 2012, and was the most dominant plant in the lake. Wild celery was the second most abundant plant. • The number of sampling stations dominated by non-native species decreased significantly compared to 2012, when non-natives (predominantly European Naiad) dominated 28 stations. In 2013, non-natives (European Naiad and Fanwort) dominated only six stations. • 19 species (see Table 3) of macrophytes were documented in Lake Shirley during the 2013 survey. This result is similar to recent years (i.e., 20 species in 2012 and 19 species in 2011). • Five species were observed at 20% or more of the stations, compared to six species in 2011 and five species in 2010. Three of these species were native and two were non-native (European Naiad, Fanwort). • Species richness in 2013 (average of 3.18 species per station) was half of the highest observed level for the 2002-2013 period of record (6.36 in 2005).

2.2.2 2013 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 2013 vegetation survey is as follows:

General Notes

- The 2013 vegetation survey reflects conditions following an herbicide application (diquat) over 100 acres of Lake Shirley on June 27, 2013.
- The overall growth density and biomass of vegetation in Lake Shirley were similar to, but slightly lower than, what was reported in 2012. The most significant observation with regard to plant abundance was the lakewide increase in the distribution and growth density of Bushy Pondweed (*Najas flexilis*).
- Most of the sampling stations (65%) had sparse plant growth (0-25% density), just as in 2012. 23% of the stations had moderate growth (26-50% density) and 12% had dense to very dense growth.
- The number of sampling stations dominated by non-native species decreased significantly compared to 2012, when non-natives (predominantly European Naiad) dominated 28 stations. In 2013, non-natives (European Naiad and Fanwort) dominated only six stations.
- 19 species (see Table 3) of macrophytes were documented in Lake Shirley during the 2013 survey. This result is similar to recent years (i.e. 20 species in 2012 and 19 species in 2011).
- Five species were observed at 20% or more of the sampling stations, compared to six species in 2011 and five species in 2010. Three of these species were native and two were non-native (European Naiad, Fanwort).

European naiad

Fanwort

Eurasian Milfoil

Variable Milfoil

Invasive/Non-native Species

- **European Naiad** (*Najas minor*) declined significantly in abundance compared to 2012, when it was the most dominant and widely dispersed plant in Lake Shirley. Its distribution declined from 82% of sampling stations in 2012 to 55% in 2013. The number of stations dominated by this plant decreased from 26 stations in 2012 to only 3 stations. Also known as Spiny Naiad, the leaves of this plant have prominent serrations that are visible without magnification.
- **Fanwort** (*Cabomba caroliniana*) was observed at 25 stations in 2012, nearly doubling its observed distribution from 2013 (13 stations). Fanwort was most abundant in the coves where stations 36 and 37 are located. Dense near-monoculture stands of fanwort were observed in these coves.
- **Eurasian milfoil (***Myriophyllum spicatum*) was not observed at any of the sampling stations. Although this plant has only been present in very small quantities in recent years, this is the first time since Geosyntec began conducting surveys in 2002 that Eurasian milfoil was not observed.
- As observed in 2008-2012, **Variable milfoil** (*Myriophyllum heterophyllum*) was found in small quantities at only one sampling station. As in recent years, this plant was observed at station 18, in the cove adjacent to the Bald Eagle nesting location on the western side of the lake.

- **Curlyleaf Pondweed** was observed in small quantities at one station in the northern basin. This plant is typically reaches its peak of growth by late June/early July, yielding to other plants later in the growing season.

Curlyleaf Pondweed

Native Species

A summary of the native plant species most commonly observed during the 2013 vegetation survey is provided below.

- **Bushy Pondweed** (*Najas flexilis*) was present at 51 stations (77%) and dominant at 19 stations (29%), continuing a significant increase in abundance that was noted in 2012. Bushy Pondweed was the most well distributed and dominant plant in the lake during the 2013 survey. This naiad species can be distinguished from European Naiad by its leaves, which taper to a point but lack prominent serrations.

Bushy Pondweed

- **Wild Celery** (*Vallisneria americana*) was present at 38 stations (58%) and dominant at 13 stations (20%), similar to the 2012 survey results when it was also second in distribution and dominance. Wild Celery is an important food source for many waterbirds, and this plant is particularly important as a food source for some duck species during winter migration. Although the strap-like submerged leaves of this plant are typically around 3-feet in length, the cord-like pistillate (female) flower stalks can be much longer and extend to the water surface. These flower stalks, which retract into the water in a spiral form following pollination/fertilization, can create a nuisance for boaters by becoming tightly wrapped around propellers.

Wild Celery

- **Musk Grass** (Chara spp.) is a structured macroalgae that has been sporadically abundant in Lake Shirley. It was most recently a dominant plant in 2010. In 2013, Musk grass was observed at 20 stations and dominant plant at 10 stations, most commonly in the northern basin. Structured macroalgaes such as musk grass and stonewort (*Nitella spp.*) can play an important role in maintaining water clarity in lakes. By sequestering nutrients at the sediment-water interface (at the lake's bottom), these macroalgae can help prevent nutrients from fueling nuisance algal blooms at the surface.

Musk Grass

- **Thin-leaf Pondweed** (*Potamogeton pusillus*) declined in distribution from 20 stations in 2012 to 7 stations in 2013. Like many native *Potamogeton* species, the seeds and vegetation of this plant provide cover and food for aquatic animals.

Thin-leaf Pondweed

- **Yellow Water Lily (Nuphar variegatum)** was observed at 7 stations (mostly along the southwestern shore of the lake), and dominant at one station.

Data summary tables, a vegetation density map, and a species tally sheet from the 2012 vegetation survey are provided on the following pages.

Yellow Water Lily

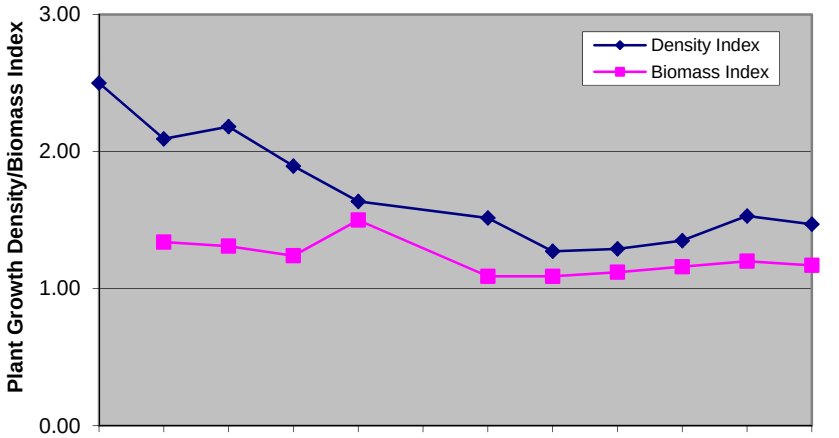
Table 1: Plant Growth Density Estimates, 2002-2013

Density Rating	% 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)	**2011** (66 stations)	**2012** (66 stations)	**2013** (66 stations)
1: Sparse 0-25%	14%	11%	17%	27%	45%	59%	79%	77%	77%	65%	65%
2: Moderate 26-50%	36%	72%	58%	61%	42%	33%	17%	17%	14%	20%	23%
3: Dense 51-75%	36%	15%	17%	8%	9%	5%	3%	6%	6%	12%	9%
4: Very Dense 76-100%	14%	3%	9%	5%	2%	3%	2%	0%	3%	3%	3%
Density Index	**2.50**	**2.09**	**2.18**	**1.89**	**1.64**	**1.52**	**1.27**	**1.29**	**1.35**	**1.53**	**1.47**

Table 2: Plant Biomass Estimates, 2003-2013

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)	**2011** (66 stations)	**2012** (66 stations)	**2013** (66 stations)
1: Scattered plant growth; or primarily at lake bottom	69%	80%	77%	59%	91%	92%	91%	88%	82%	88%
2: Less abundant growth, or in less than half of water column	29%	12%	21%	33%	9%	6%	6%	8%	17%	5%
3: Substantial growth through majority of water column	2%	6%	2%	6%	0%	2%	3%	5%	2%	8%
4: Abundant growth throughout water column to surface	0%	2%	0%	2%	0%	0%	0%	0%	0%	0%
Biomass Index	**1.34**	**1.31**	**1.24**	**1.50**	**1.09**	**1.09**	**1.12**	**1.16**	**1.20**	**1.17**

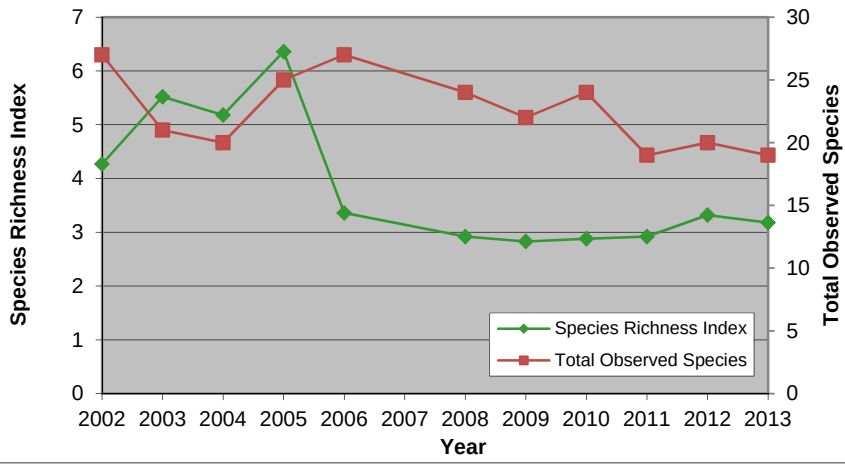
Figure 1: Lake Shirley Plant Growth Density and Biomass Index, 2002-2013



Density Index and **Biomass Index** are averages of the density ratings biomass ratings for each of the vegetation survey years. For each year, the numeric rating (1 to 4) for each station is summed and 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, 2002-2013



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 2002-2013, species richness peaked in 2005 at an average of 6.36 species per station. Species richness declined dramatically between 2005 and 2006, and has been relatively stable since that time.

Table 3: Aquatic Vegetation Survey Tally Sheet

Location: Lake Shirley (Lunenburg, MA)
Date: August 30, 2013 **Surveyed by:** Bob Hartzel

● species present at monitoring station

[●] species dominant at monitoring station

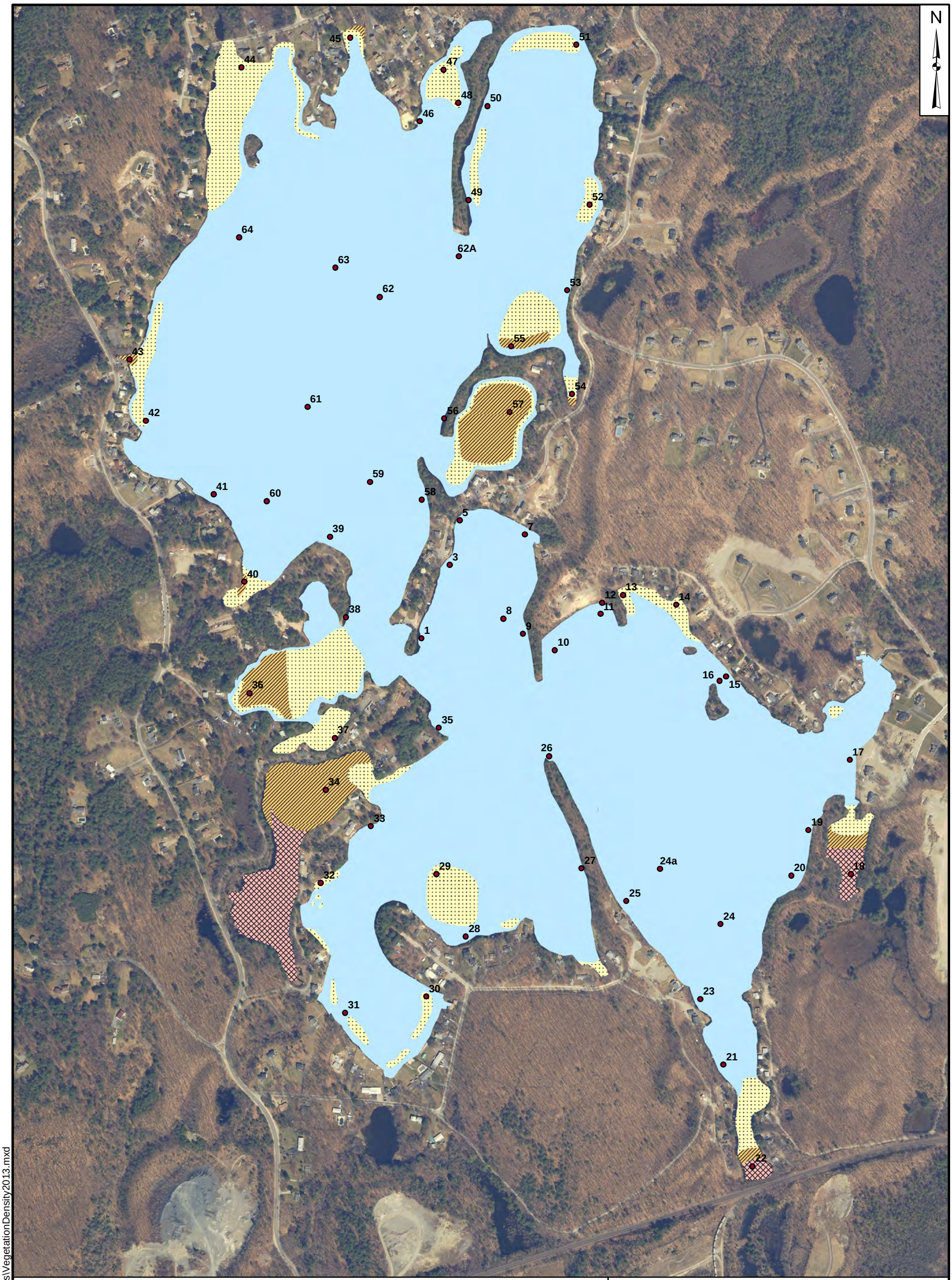
Plant Species	# stations present	# stations dominant	% stations present	% stations dominant	Monitoring Locations																					
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Bushy Pondweed *(Najas flexilis)*	51	19	77%	29%	[●]	[●]	[●]	[●]	●	●	●	●	●	●	●	●	●	[●]	●	●			●		[●]	
Wild Celery *(Vallisneria americana)*	38	13	58%	20%	●	●	●	●	●		●				[●]	[●]	●	[●]	[●]	[●]					●	
European Naiad *(Najas minor)* *	36	3	55%	5%		●	●	●	●			●					●	●		●				●		
Fanwort *(Cabomba caroliniana)* *	25	3	38%	5%		●	●		●					●	●	●	●			●		●	●		●	
Musk Grass *(Chara sp.)*	20	10	30%	15%													[●]			●					●	[●]
Yellow Water Lily *(Nuphar variegatum)*	7	1	11%	2%																						
Thin-leaf Pondweed *(Potamogeton pusillus)*	7	0	11%	0%														●								
Common Bladderwort *(Utricularia vulgaris)*	5	0	8%	0%																						
Coontail *(Ceratophyllum demersum)*	4	1	6%	2%				●	[●]													●				
Grassy Pondweed *(Potamogeton gramineus)*	3	0	5%	0%																			●			
Small Waterwort *(Elatine minima)*	3	0	5%	0%																			●			
Eastern Purple Bladderwort *(Utricularia purpurea)*	3	0	5%	0%																●		●				
Ribbonleaf Pondweed *(Potamogeton epihydrus)*	2	1	3%	2%																						
White Water Lily *(Nymphaea odorata)*	2	0	3%	0%											●											
Robbin's Pondweed *(Potamogeton robbinsii)*	1	1	2%	2%																		[●]				
Claspingleaf Pondweed *(Potamogeton perfoliatus)*	1	0	2%	0%																						
Variable Milfoil *(Myriophyllum heterophyllum)* *	1	0	2%	0%																		●				
Watershield *(Brasenia schreberi)*	1	0	2%	0%																						
Curly-leaf Pondweed *(Potamogeton crispus)* *	1	0	2%	0%																						
# of Species Observed					2	4	4	3	5	1	2	2	1	2	4	3	5	4	2	6	0	5	4	1	4	1
Plant Density Rating					1	1	1	1	1	1	1	1	1	1	1	1	2	2	1	1	0	4	1	1	1	4
Plant Biomass Rating					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	3	1	1	1	2

Plant Species	23	24	24A	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Bushy Pondweed *(Najas flexilis)*	[●]	[●]	●	●		[●]	●			●	●		●	●			●	●	●	●	[●]
Wild Celery *(Vallisneria americana)*				[●]	●	[●]	[●]	[●]	●	●	●	●	●	[●]		●	[●]	●	[●]	●	●
European Naiad *(Najas minor)* *	●	●				●	●	●	●	●	●	●	[●]	●			●		[●]	●	●
Fanwort *(Cabomba caroliniana)* *						●								●	[●]	[●]					●
Musk Grass *(Chara sp.)*									●	●	[●]		●			[●]				[●]	
Yellow Water Lily *(Nuphar variegatum)*									●	[●]			●	●		●					
Thin-leaf Pondweed *(Potamogeton pusillus)*				●			●									●					
Common Bladderwort *(Utricularia vulgaris)*																					●
Coontail *(Ceratophyllum demersum)*																					
Grassy Pondweed *(Potamogeton gramineus)*							●			●											
Small Waterwort *(Elatine minima)*																			●		
Eastern Purple Bladderwort *(Utricularia purpurea)*		●																			
Ribbonleaf Pondweed *(Potamogeton epihydrus)*																			●		
White Water Lily *(Nymphaea odorata)*										●											
Robbin's Pondweed *(Potamogeton robbinsii)*																					
Claspingleaf Pondweed *(Potamogeton perfoliatus)*																			●		
Variable Milfoil *(Myriophyllum heterophyllum)* *																					
Watershield *(Brasenia schreberi)*							●														
Curly-leaf Pondweed *(Potamogeton crispus)* *																					●
# of Species Observed	2	3	1	3	1	4	6	2	4	7	4	2	5	5	1	5	3	2	6	4	6
Plant Density Rating	1	1	1	1	1	1	1	2	2	2	2	1	3	1	2	3	1	1	3	1	2
Plant Biomass Rating	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1	3	1	1	3	1	1

Plant Species	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	62A	63	64
Bushy Pondweed *(Najas flexilis)*	●		●		●	●	[●]	[●]	●				●	[●]	[●]	●	[●]	●	[●]	[●]	[●]	●	[●]
Wild Celery *(Vallisneria americana)*		[●]					●	●	●		●			●	●			●					
European Naiad *(Najas minor)* *	●	●	●					●			●			●		[●]		●	●	●	●		●
Fanwort *(Cabomba caroliniana)* *	●	●	●		●	●						●	[●]					●				●	
Musk Grass *(Chara sp.)*		●	●		[●]	[●]	●	●	[●]	[●]	[●]			●									
Yellow Water Lily *(Nuphar variegatum)*	●												●										
Thin-leaf Pondweed *(Potamogeton pusillus)*	●										●										●		
Common Bladderwort *(Utricularia vulgaris)*			●		●	●						●											
Coontail *(Ceratophyllum demersum)*												●											
Grassy Pondweed *(Potamogeton gramineus)*																							
Small Waterwort *(Elatine minima)*	●																						
Eastern Purple Bladderwort *(Utricularia purpurea)*																							
Ribbonleaf Pondweed *(Potamogeton epihydrus)*	[●]																						
White Water Lily *(Nymphaea odorata)*																							
Robbin's Pondweed *(Potamogeton robbinsii)*																							
Claspingleaf Pondweed *(Potamogeton perfoliatus)*																							
Variable Milfoil *(Myriophyllum heterophyllum)* *																							
Watershield *(Brasenia schreberi)*																							
Curly-leaf Pondweed *(Potamogeton crispus)* *																							
# of Species Observed	7	4	5	0	4	4	3	4	3	1	4	3	3	4	2	2	1	4	2	2	3	2	2
Plant Density Rating	3	1	1	0	2	2	2	1	1	2	2	2	3	1	3	1	1	1	1	1	1	1	2
Plant Biomass Rating	3	1	1	0	2	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1

* **Non-native, invasive plant**

Key to Density and Biomass Ratings		
Rating	Density (% cover)	Biomass
0	Absent: 0%	Plants absent
1	Sparse: 1-25%	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



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
Survey Date: September 2013

Geosyntec consultants

ACTON, MASSACHUSETTS

17-OCT-2013

Figure 3

Q:\GISProjects\BW0101-Lake Shirley\Projects\VegetationDensity2013.mxd