Lake Shirley
Lunenburg/Shirley, Massachusetts
2018 Year-End Report

November 30, 2018

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Report Prepared for: Ms. Joanna Bilotta, President
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Dear Joanna:

In accordance with the aquatic plant management contract between SŌLitude Lake Management (SOLitude) and the Lake Shirley Improvement Corporation (LSIC) for Lake Shirley, the following document serves to provide this year's treatment and survey results, as well as management recommendations for next season. The continued objective of the program is to manage non-native and nuisance aquatic vegetation as well as potentially harmful cyanobacteria (blue-green algae) blooms. Multiple monitoring events, herbicide/algaecide treatments and reporting are key tasks of the project.

All management activities were consistent with the Order of Conditions [DEP File #284-0388 (Shirley), DEP File #208-1064 (Lunenburg)] and the License to Apply Chemicals issued by MA DEP (#18237)

With the most recent Order of Conditions (OOC) issued by the Lunenburg Conservation Commission in the fall of 2015, the management program is now being conducted under more stringent and detailed monitoring and reporting requirements. A Lake Management Plan (LMP) was also developed in 2016 as dictated by the new OOC, containing approved guidelines for determining treatment activities. A chronology of the 2018 program's primary milestone activities is as follows:

- Issuance of License to Apply Chemicals permit from MA DEP ..... May 16th
- Early-Season pre-treatment inspection ..... May 30th
- Mid-season pre-treatment inspection and point survey ..... July 3rd
- Mid-season Reward (diquat)/Nautique (copper) herbicide treatment for tapegrass/naiad ..... July 25th
- Monitoring of microscopic algae and Secchi Disk water clarity by LSIC ..... May-October
- Post-treatment, late summer plant inspection ..... September 21st

Early Season Pre-Treatment Survey

The early season pre-treatment survey is conducted specifically to document early emerging target vegetation, such as curly-leaf pondweed (*Potamogeton crispus*) and Eurasian milfoil (*Myriophyllum spicatum*). Due to the growth cycle of curly-leaf pondweed, it is especially important to manage this plant early, before reproductive structures (turions) are developed and released. Milfoil is also typically an early emerging species, but its frequency of occurrence has been minimal over recent years.

This year's early season survey, conducted on May 30th, showed one small area of dense curlyleaf pondweed growth and two areas of more sparse growth totaling less than 40-acres (See **Figure 1**). Due to various logistical and funding factors, no early season treatment was conducted this year, but early season target species should continue to be monitored in future years and treated is necessary.

Mid-Season Pre-Treatment Survey

The objective of the mid-season, pre-treatment plant survey is to document the lake-wide density and distribution of plant species throughout the lake. Typically, under the two-treatment approach, the timing and methodology of the mid-season survey is intended to better represent potentially problematic, native species such as tapegrass (*Vallisneria americana*) and European (spiny) naiad (*Najas minor*) among others. The 2018 mid-season survey served to assess the growth of all invasive species [fanwort (*Cabomba caroliniana*), curly-leaf pondweed, Eurasian milfoil and variable milfoil (*Myriophyllum heterophyllum*)] as well as identify any nuisance growth of native plant species.

The survey was conducted using an expanded methodology, which is a combination of SLM's historical qualitative assessment and Geosyntec's more quantitative procedures. In addition to recording data on the general plant assemblage, point data was collected at 66 data points throughout the lake (See **Figure 2**). At each point, data was collected on the species composition (species present), plant growth density and plant biomass. These are the same locations and point #'s used by Geosyntec in past reports.

The mid-season, pre-treatment survey was conducted on July 3rd. Fanwort and tapegrass were the most commonly observed plant in the lake followed closely by bladderwort (*Utricularia* spp.). Curly-leaf pondweed was observed at three locations, and neither Eurasian nor variable milfoil were observed during the survey. Substantial areas of fanwort were also observed, but this plant is currently not being actively managed with herbicides due to funding and other constraints. The practice of winter drawdown at the Lake has provided some control of fanwort.

Based on criteria put forth in the LMP, any areas of the lake with non-native species and other areas with either a density or biomass index of 3 or greater, would be potentially targeted for treatment. Due to the presence of non-native spiny naiad and nuisance growth of native plants, approximately 37 acres were designated for treatment. The mid-season, pre-treatment report, which includes plant survey data and the proposed treatment map, is **attached**. The Commission approved this treatment at their July 24th meeting.

Herbicide Treatment

As previously mentioned, no early-season treatment, targeting curly-leaf pondweed, was performed. A mid-season treatment was conducted on July 25th, for tapegrass, naiad and any remaining curly-leaf pondweed that persisted at the end of the growing cycle. Treatment was conducted with Reward (diquat) and Nautique (copper) herbicides. Based on observations made on the day of treatment, the proposed treatment areas were reduced from 37 to 28 acres.

As with all treatments, the lake community and the two towns were notified prior to treatment by LSIC. Several means of notification were utilized: placement of a written notice in the newspaper(s); placement of large, printed signs at major road intersections/locations around the lake and posting of numerous 8.5 inch by 11-inch orange colored, printed signs around the lake shoreline and other means of communication/notification.

The treatment was performed with an 18-foot Jon boat equipped with tank, pump, and sub-surface injection system. By injecting the diluted herbicide sub-surface, it eliminates the potential for aerial drift. GPS guidance was used to monitor the position of the boat and its relation to the treatment areas. The treatment proceeded smoothly and without difficulty, **Figure 3** shows the GPS recorded treatment tracks. A summary of the treatment specifications is as follows.

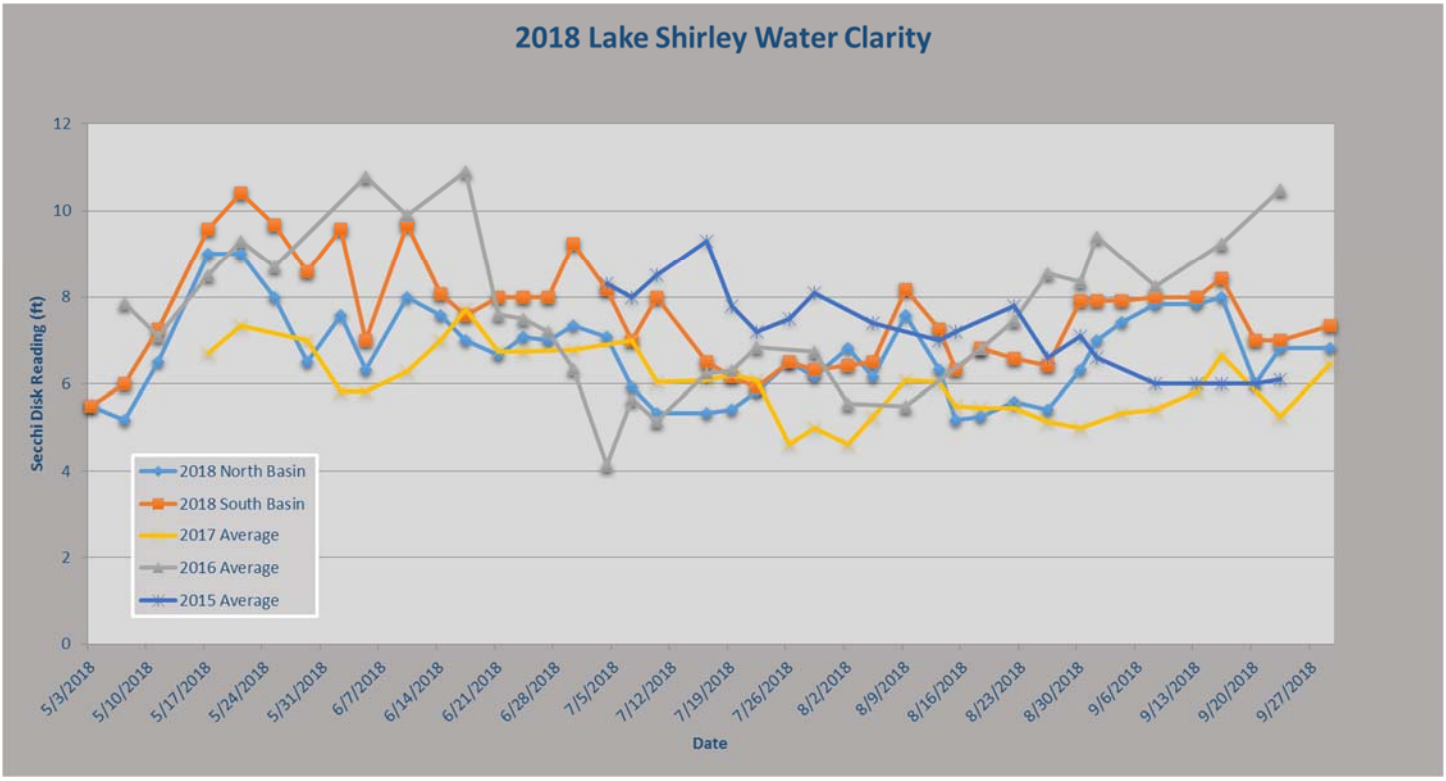
Table 1 – Mid-Season Treatment Specifications

Treatment Date	July 25th
Product	Reward (diquat) & Nautique (copper)
Treatment Area	28 acres
Quantity	30.5 gallons – Reward 44.5 gallons – Nautique
GPS Tracks	See Figure 3
Applicator name	Dominic Meringolo, MA Certification #24004
Site Conditions	Weather: Mostly Cloudy, light winds, 80^{o}F Water Temp: 29.2^{o}C at surface, 23.5^{o}C near bottom Dissolved Oxygen: 7.8 mg/l at surface; 2.5 mg/l near bottom (9-feet) Water clarity: 5’9”

Algae & Water Clarity Monitoring

Water clarity was monitored closely again this year and readings were taken starting in the beginning of May and continuing through the end of September. The following graph shows the water clarity in the North and South Basins over the course of the season along with the 2015-2017 basin averages for comparison.

Graph 1 – Water Clarity



Water clarity fluctuated this year but never dropped below 5-feet at any point during the sampling period. As has historically been the case, clarity improved through the end of May before slowly decreasing to typical summer conditions. Clarity was at its worst in July and then again in late August, but as the level was maintained above 5-feet, no additional clarity stations were monitored and no algae samples were collected this year. As usual, clarity was better in the south basin overall, but were periods in late July/early August and again in early/mid-September where clarity in both basins was similar.

We recommend maintaining the current trigger criteria and continuing to collect samples as a composite of the top three feet of the water column, when clarity drops below 5-feet. Additionally, during critical periods, SOLitude Biologists can also examine samples for a preliminary assessment. The lab has made available an expedited turnaround process (for a higher cost) that the LSIC will consider budgeting for next summer in order to get more timely results.

Late Season Survey

The late season survey was performed on September 21st. The survey followed the same methodology as the spring and prior year's surveys. At each point, data was collected on the species composition (species present), plant growth density and plant biomass. **Figure 2** (attached) shows the location of data points in Lake Shirley.

Table 2 (below) shows the number of points exhibiting each category of plant density along with the average density index for each year of the survey (2002-2018).

Table 2: Plant Growth Density Estimates, 2002-2018

Density Rating	% of stations														
	2002 (n=64)	2003 (n=65)	2004 (n=66)	2005 (n=66)	2006 (n=66)	2008 (n=66)	2009 (n=66)	2010 (n=66)	2011 (n=66)	2012 (n=66)	2013 (n=66)	2015 (n=66)	2016 (n=66)	2017 (n=66)	2018 (n=66)
1: Sparse 0-25%	14	11	17	27	45	59	79	77	77	65	65	32	12	17	19
2: Moderate 26-50%	36	72	58	61	42	33	17	17	14	20	23	50	24	38	26
3: Dense 51-75%	36	15	17	8	9	5	3	6	6	12	9	17	37	30	10
4: Very Dense 76-100%	14	3	9	5	2	3	2	0	3	3	3	2	27	15	4
Density Index	**2.50**	**2.09**	**2.18**	**1.89**	**1.64**	**1.52**	**1.27**	**1.29**	**1.35**	**1.53**	**1.47**	**1.82**	**2.80**	**2.35**	**1.84**

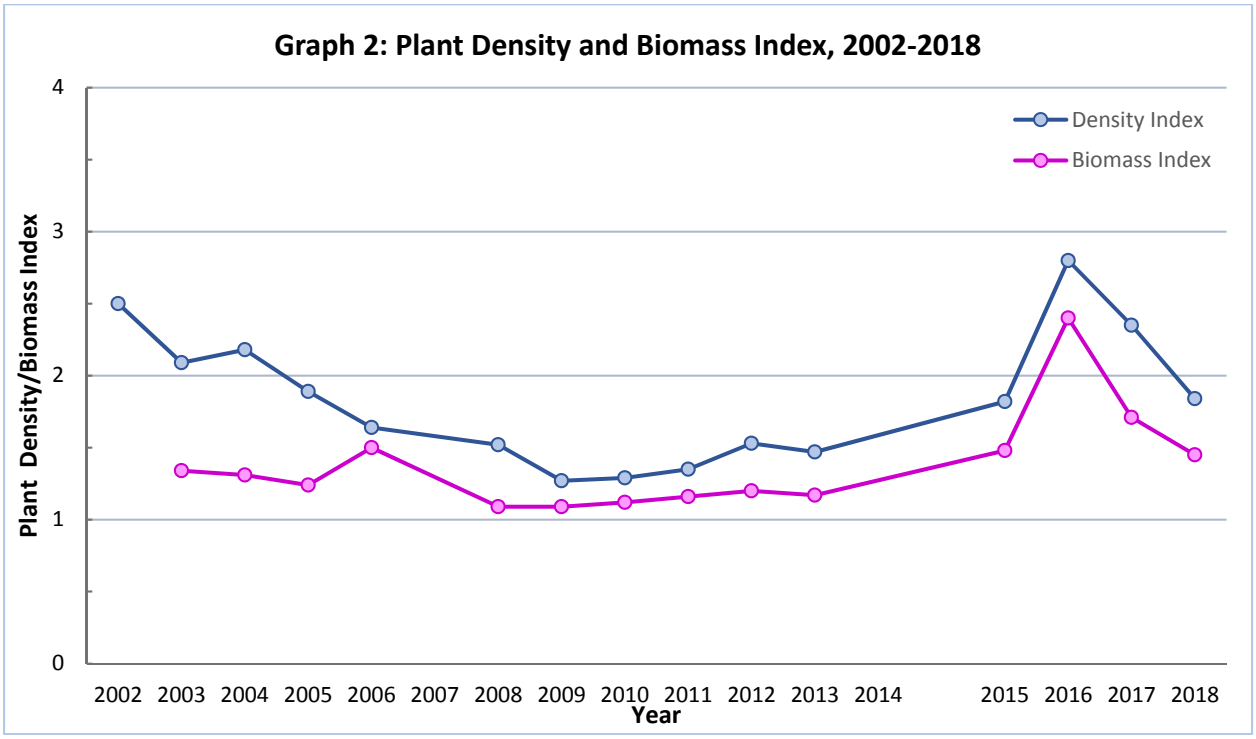
Table 3 (below) shows the number of points exhibiting each category of plant biomass, along with the average biomass index for each year of the survey.

Table 3: Plant Biomass Estimates, 2003-2018

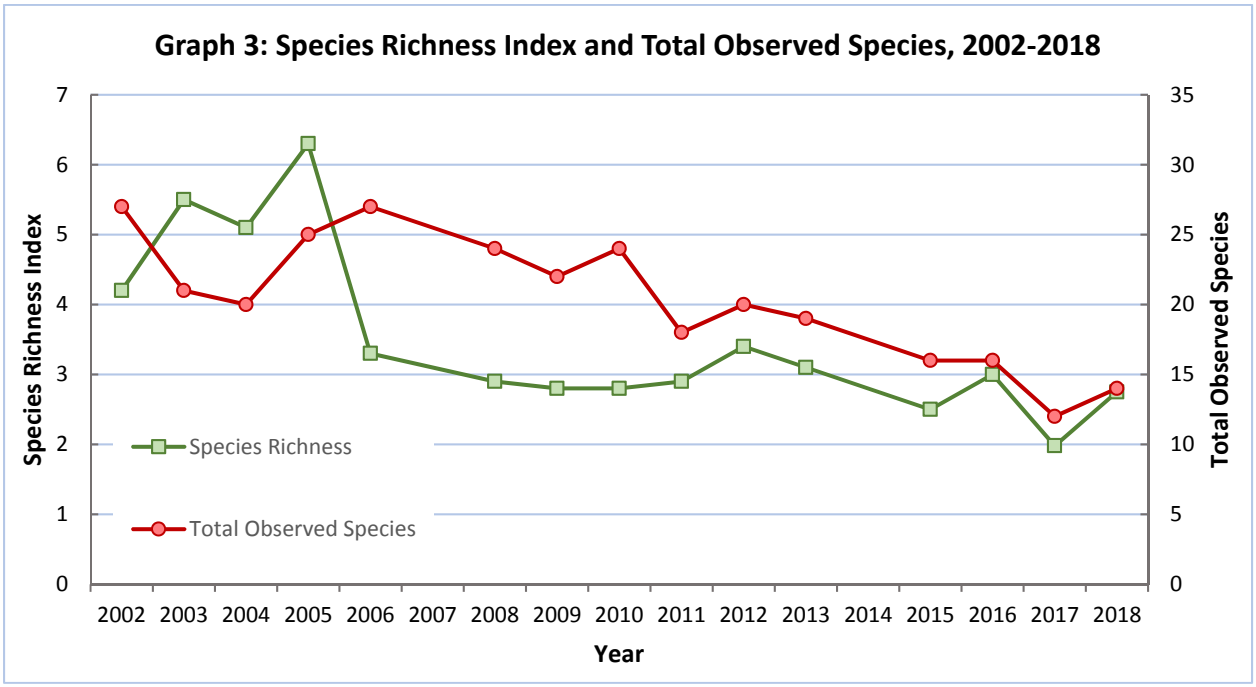
Biomass Rating	% of stations													
	2003 (n=65)	2004 (n=66)	2005 (n=66)	2006 (n=66)	2008 (n=66)	2009 (n=66)	2010 (n=66)	2011 (n=66)	2012 (n=66)	2013 (n=66)	2015 (n=66)	2016 (n=66)	2017 (n=66)	2018 (n=66)
1: Scattered plant growth; or primarily at lake bottom	69	80	77	59	91	92	91	88	82	88	73	21	33	34
2: Less abundant growth, or in less than half of water column	29	12	21	33	9	6	6	8	17	5	21	35	56	17
3: Substantial growth through majority of water column	2	6	2	6	0	2	3	5	2	8	6	30	8	8
4: Abundant growth throughout water column to surface	0	2	0	2	0	0	0	0	0	0	0	14	3	1
Biomass Index	**1.34**	**1.31**	**1.24**	**1.50**	**1.09**	**1.09**	**1.12**	**1.16**	**1.20**	**1.17**	**1.48**	**2.40**	**1.71**	**1.45**

Both the average plant density and biomass indices were noticeably lower than in 2017, but still generally higher for the density index as compared to the period 2006-2015. In 2016, only one treatment was conducted in mid-June and mostly targeted a large expansion of curlyleaf pondweed, allowing an abundance of late season growth of native species to drive high density and biomass conditions. The data from this year indicates that the

management program prevented the conditions of dense, problematic growth seen in 2016 while maintaining a healthy population of vegetation in the lake. The graph below shows the change in the average indexes over time.



Another useful metric is the species richness index (average number of species observed at each point) and the total number of species observed. The following graph shows these metrics over time.



The total observed species has fluctuated from year to year although there has been a general decrease since 2006. The species richness decreased significantly in 2006 and since then has fluctuated around 3±. In 2018, however, both the species richness and total observed species saw increases. In general, species with very low occurrence can be difficult to observe from year to year and substantially account for the drop in the number of species observed, or similarly, an increase in the number of observed species. The continued increased dominance of bushy pondweed and tapegrass over recent years is also likely a significant cause of the decrease in species richness. Another significant factor may be extended periods of poor water clarity, which can affect growth patterns and surveyor visibility.

The following are some general notes on this year's vegetation assemblage. Older data and summaries of historical growth can be found by referring to the information contained in the last Geosyntec report, issued on October 18th, 2013. The complete point data table from the 2018 surveys are shown on the next page. **Figure 4 & 5** shows the late season plant density and biomass represented by color coded points.

General Notes

- Continuing with the two survey/treatment approach better matches the varied growth patterns of potential target species in the lake, but does put a strain on resources. This year growth of curlyleaf pondweed was observed at lower quantities, but treatment was not feasible given several factors.
- Curlyleaf pondweed was again much less prolific indicating that the heavy growth in 2016 was an anomaly likely doe to a confluence of different factors. Non-native milfoil species are essentially absent from the lake based on survey data.
- Tapegrass continue to be one of the most dominant species in the lake, observed with similar occurrence to 2017, but dominant at fewer points.
- European naiad made a resurgence this year to become the most frequently observed plant during the fall survey. A third species of naiad was observed this year as well.
- Naiad species can sometimes be difficult to distinguish depending on phenology and there could be some issues with identification during historical surveys.
- Bladderwort, a beneficial native species, maintained substantial presence in the lake.
- The number of stations dominated by non-native species (fanwort and European naiad) increased in 2018.
- Clasping leaf pondweed was found at 11% of the points this year as compared to 5% of the points in 2017.
- The continued presence of a number of pondweed species, including ribbonleaf, Robbins and flatstem pondweed was observed this year.
- Fanwort occurrence was substantially higher this year.

Table 5: Aquatic Vegetation Survey Results

Date: September 21, 2018 | X= Present | D = Dominant

Common Name	Scientific Name	# 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
European Naiad	*Najas minor*	39	11	59%	17%	X	X	X	X	X		X	D	D	X	X			X								
Wild Celery	*Vanlisneria americana*	30	7	45%	11%	X				X	X	X				D	D		X							X	
Macro-algae	*(Nitella sp.; Chara sp.)*	29	12	44%	18%					X	D	X				X	X	D								D	X
Slender Waternymph	*Najas gracillina*	20	1	30%	2%																						
Fanwort	*Cabomba caroliniana*	18	9	27%	14%	D	D	D	D	D	X		X		D								X				X
Bladderwort	*Utricularia Sp.*	16	2	24%	3%							D	X										X			X	
Bushy Pondweed	*Najas flexillis*	10	4	15%	6%																						
Clasping-leaf Pondweed	*Potamogeton perfoliatus*	7	5	11%	8%							X							D	D		D					
Coontail	*Ceratophyllum demersum*	3	1	5%	2%																		X				
Aquatic Moss	*Musci sp. (Fontinalis?)*	3	1	5%	2%																		X				D
Watershield	*Brasenia schreberi*	2	0	3%	0%																						
Ribbon-leaf Pondweed	*Potamogeton epihydrus*	2	0	3%	0%																						
Robbin's Pondweed	*Potamogeton robbinsii*	1	1	2%	2%																		D				
Flatstem Pondweed	*Potamogeton zosteriformis*	1	0	2%	0%																						X
Species Richness						3	2	2	2	4	3	5	3	1	2	3	2	1	3	1	0	1	5	0	0	3	4
Plant density Index						2	2	2	3	3	1	1	2	1	2	3	1	1	1	1	0	1	4	0	0	2	3
Plant biomass index						2	2	2	2	2	1	1	2	1	3	1	1	1	3	1	0	1	3	0	0	1	1

Common Name	23	24	24a	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
European Naiad								X	X	X			X	X		X		X	X	X	D	X
Wild Celery	D							X	D	X	X	X	X	X		X			D	X	X	
Macro-algae	X		X		D						D	D	D		X			X		D	X	
Slender Waternymph		D	X	X			X				X				X	X		X				X
Fanwort								D		X				D	D	D						
Bladderwort								X	X	X	X				X	X		X				
Bushy Pondweed		X	D	D	X				X	D												
Clasping-leaf Pondweed																		D			X	D
Coontail																X						
Aquatic Moss																						
Watershield									X													X
Ribbon-leaf Pondweed																						X
Robbin's Pondweed																						
Flatstem Pondweed																						
Species Richness	2	2	3	2	2	0	1	4	5	5	4	2	3	3	4	6	0	5	2	3	4	5
Plant density Index	1	1	2	2	1	0	1	2	2	2	2	2	4	2	3	2	0	2	1	4	2	2
Plant biomass index	1	1	1	1	1	0	1	3	4	1	1	2	2	1	3	2	0	3	1	1	2	2

Common Name	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	62a	63	64
European Naiad	D	D	D	X		X		X	X	D		D	X	X	D	X			D	X	D	X
Wild Celery		X		X	D	D	X	X	X		X	X					X					
Macro-algae			X	X	X		D	D	D				X	X			X			D		X
Slender Waternymph		X	X	X		X								X		X	X		X	X	X	X
Fanwort		X		X							X	X										
Bladderwort		X		D				X				X										X
Bushy Pondweed	X						X							D			X					
Clasping-leaf Pondweed																						
Coontail											D											
Aquatic Moss						X																
Watershield																						
Ribbon-leaf Pondweed		X																				
Robbin's Pondweed																						
Flatstem Pondweed																						
Species Richness	2	6	3	6	2	4	3	4	3	1	3	4	2	4	1	2	4	0	2	3	2	4
Plant density Index	2	3	2	4	1	2	4	3	3	1	2	2	2	3	1	2	1	0	1	2	1	3
Plant biomass index	1	2	1	3	1	1	2	2	1	1	2	3	2	2	1	1	1	0	1	1	1	1

***Non-native, invasive species**

Key to Density and Biomass Indices

Value	Density (% cover)	Biomass
0	Absent: 0%	No growth
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

Drawdown Report

The following tables presents lake level and outflow data for the 2017/2018 drawdown period

Table 6 – Water Level Log During 2017/2018 Drawdown

10/815/17	Draw Down			
10/15/2017	4:25 PM	Open	Open	0
10/16/2017	3:00 PM	Open	Open	-3
10/17/2017	3:30 PM	Open	Open	-7
10/15/2017	4:45 PM	Open	Open	-11
10/20/2017	10:20 AM	Open	Open	-18
10/23/2017		Open	Open	-27
10/27/2017		Open	Open	-25
10/28/2017		Open	Open	-24
10/29/2017	10:15 AM	Open	Open	-27
10/30/2017	10:30 AM	Open	Open	-22
10/31/2017	10:30 AM	Open	Open	-9 (Heavy rain =3")
11/1/2017	10:30 AM	Open	Open	-7
11/2/2017	10:20 AM	Open	Open	-6
11/3/2017	10:30 AM	Open	Open	-7
11/4/2017	12:00 PM	Open	Open	-8 (Clean Top Valve)
11/5/2017	10:30 AM	Open	Open	-10
11/6/2017	10:30 AM	Open	Open	-12
11/7/2017	10:10 AM	Open	Open	-13
11/8/2017	10:40 AM	Open	Open	-15
11/9/2017	10:30 AM	Open	Open	-18
11/10/2017	10:40 AM	Open	Open	-20
11/11/2017	10:15 AM	Open	Open	-22(clean valve to clean inlet)
11/12/2017	10:15 AM	Open	Open	-25
11/13/2017	10:20 AM	Open	Open	-26
11/15/2017	10:00 AM	Open	Open	-30
11/17/2017	3:15 PM	Open	Open	-34
11/18/2017	11:10 AM	Open	Open	-37 (Clean leaves at inlet)
11/20/2017	10:30 AM	Open	Open	-39 (Clean inlet)
11/21/2017	10:20 AM	Open	Open	-41 (Clean inlet)
11/24/2017	10:30 AM	Open	Open	-43
11/25/2017	11:00 AM	Open	Open	-45
11/26/2017	10:30 AM	Open	Open	-47
11/27/2017	10:20 AM	Open	Open	-48
11/28/2017	10:15 AM	Open	Open	-49 (Clean inlet)
12/1/2017	10:30 AM	Open	Open	-50
12/3/2017	10:30 AM	Open	Open	-51
12/5/2017	10:15 AM	Open	Open	-52
12/7/2017	10:30 AM	Open	Open	-53
12/10/2017	10:15 AM	Open	Open	-55
12/12/2017	10:20 AM	Open	Open	-57
12/15/2017	10:20 AM	Open	Open	-59
12/16/2017	10:30 AM	Open	Open	-60
12/19/2017	3:00 PM	Open	Open	-62 (Clean inlet)
12/22/2017	1:15 PM	Open	Open	-64
12/28/2017	10:00 AM	Open	Open	-65
1/12/18	11:00	Open	Open	-54"
1/16/18	9:30	"	"	-45"
1/20/18	10:30	"	"	-48"
1/26/18	10:00	"	"	-48"
1/30/18	11:00	"	"	-48"
2/3/18	11:00	"	Closed 150	-52"
2/13/18	9:00	"	"	-40"
2/17/18	9:00	"	"	-38"
2/21/18	9:30	"	Closed	-40"
2/24/18	9:00	Closed 150	"	-38"
2/28/18	4:30	"	"	-32"
3/4/18	8:00	Closed 220	"	-20"
3/7/18	8:00	"	"	-14"
3/11/18	9:30	Closed 230	"	-7"
3/15/18	9:00	"	"	-1"
3/16/18	10:00	"	"	Water over top

Table 7 – Outflow Rates During Refill (2018)

Outflow Rates during refilling of Lake Shirley at Catacunemaug Bridge

Date	Reading	Flowrates CFS
3/01/18	1.66	19.85 CFS
3/04/18	1.54	14.23 CFS
3/07/18	1.45	10.37 CFS
3/11/18	1.45	10.37 CFS
3/15/18	1.45	10.37 CFS
3/16/18 water flowing over spillway		

Table 8 – Water Level Log During 2018/2019 Drawdown as of 12/5/18

10/15/18	10:00	"	Open	+5	
10/16/18	10:40	"	"	+3	
10/17/18	10:15	"	"	0	
10/18/18	4:00	"	"	-3	
10/19/18	9:30	"	"	-5	
10/20/18	10:15	"	"	-8	
10/21/18	9:50	"	"	-11	
10/22/18	4:20	"	"	-14	
10/23/18	4:30	"	"	-17	
10/24/18	9:15	"	"	-19	
10/25/18	10:00	"	"	-21	
10/26/18	9:45	"	"	-23	
10/27/18		"	"	-23	Rain
10/28/18		"	"	-22	
10/29/18		"	"	-24	Rain
10/30/18		"	"	-24	Clean leaves off T
10/31/18		"	"	-25	
11/1/18	3:30	"	"	-22	
11/2/18	9:00	"	"	-24	Fri. & Sat. Rain
11/3/18	10:15	"	"	-24	Heavey Rain Early
11/4/18	9:03	"	"	-12	
11/5/18	10:00	"	"	-11	Rain
11/6/18	9:30	"	"	-10	Rain
11/7/18	9:15	"	"	-8	
11/8/18	9:00	"	"	-6	
11/9/18	9:15	"	"	-4	Heavey Rain, Clea
11/10/18	10:50	"	"	-2	
11/11/18	9:30	"	"	0	
11/12/18	12:00	"	"	+1	
11/13/18	8:45	"	"	+3	Heavy Rain
11/15/18	8:45	"	"	+4	Rain
11/17/18	8:30	"	"	+5	
11/20/18	9:00	"	"	+6	Rain
11/21/18	9:00	"	"	+5	
11/22/18		"	"	+4	
11/24/18		"	"	+2	
11/25/18	9:15	"	"	+1	
11/26/18	9:00	"	"	+5	Heavy Rain
11/27/18	10:45	"	"	+8	Rain
11/28/18	9:15	"	"	+6	
11/29/18	9:00	"	"	+7	
11/30/18	9:00	"	"	+8	
12/1/18	10:30	"	"	+8	
12/2/18	9:00	"	"	+8	Rain
12/3/18	9:10	"	"	+6	
12/4/18	9:15	"	"	+6	
12/5/18	9:05	"	"	+5	

Anticipated Management in 2019

Based on the results of the 2018 management program, we anticipate seeing continued, minimal growth of watermilfoil this coming summer, however there is a likelihood that curly-leaf pondweed will be present in significant proportions early in the season as well as fanwort a short time after. Native growth, primarily tapegrass and naiad will also likely require management later in the season. We will continue to proceed and determine treatment needs based on the established criteria.

The proposed plan for 2019 is as follows

Table 8 – Proposed Plan for 2019

Task	Schedule	Notes/Criteria
Early Season Survey	Mid/late April	Survey for early emerging plants, primarily curlyleaf pondweed but also milfoil. Survey will be conducted at established survey points but will not include full collection of data.
1st Treatment	Early/Mid May	Treat all areas of the lake with curlyleaf pondweed and milfoil
Mid-Season Survey	Late June/Early July	Full data point survey
2nd Treatment	Mid-Late July	Treat any additional areas of non-native growth, plus selected areas of problematic native plant growth based on density/biomass criteria.
Late Season Survey	Late September/early October	Full data point survey

Reward herbicide alone will provide good control of milfoil, curly-leaf pondweed and naiad. Tapegrass is sometimes more difficult to control and, if needed, a combination of Reward and a copper-based herbicide (Nautique) or algaecide (Captain/copper sulfate) should be used to increase effectiveness and produce more desirable results.

If desired and approved by the LSIC, areas of fanwort could be treated with the Clipper (flumioxazin) herbicide, which was registered by the State in 2013. Unlike Sonar (fluridone) which has been discussed in the past, Clipper works quickly and can be used effectively to spot-treat relatively small areas of fanwort. The timing for treatment of the fanwort will most likely coincide with the 2nd treatment for later season growth. The on-going issue with the use of Clipper is that under current regulations, the same areas of the lake can only be treated once every 4 years unless it's in the immediate vicinity of a high-use area such as a beach or boat launch. While it's possible this condition may be lifted in the future, for it will be necessary to either rotate the areas treated with Clipper or treat subsections of larger areas of fanwort over the course of multiple years.

In order to use Clipper and other forms of copper besides copper sulfate, approval for use of the new products must be sought from the Shirley Conservation Commission. The Order of Conditions from the Town of Lunenburg allows the use of alternate products pending approval of annual treatment plans.

Monitoring of water clarity and algal populations (as necessary) provides timely information to guide algaecide treatments should such treatments be warranted. It continues to be of paramount importance to ensure that the water clarity monitoring is conducted on a regular basis (weekly or bi-weekly depending on general observation)

from May-October and that results are provided to SOlitude and other project partners so that algaecide treatments are scheduled in a timely manner. Should treatment of the algae be required in 2019, copper sulfate is again proposed for use.

We recommend LSIC continue to pursue an integrated approach to manage nuisance plants and algae utilizing drawdown and herbicide/algaecide as required. To address overall lake management and long-term goals, the LSIC should continue the investigation and implementation of alternative in-lake methods, watershed management, public education and diagnostic assessments.

We hope this report will be of help to LSIC in planning for 2019 and beyond. If you have any questions regarding this report, please feel free to contact me. We look forward to working you again in the year ahead.

2018 Year-End Report

ATTACHMENTS

- Figures
  - Figure 1 – Early Season Curlyleaf Pondweed Locations
  - Figure 2– Survey Points
  - Figure 3 – Mid-Season Treatment Map with Tracks
  - Figure 4 – Late Season Survey Plant Density Map
  - Figure 5 – Late Season Survey Plant Biomass Map
- 2018 Mid-Season Pre-Treatment Report

CURLY-LEAF PONDWEED LOCATIONS
May 30, 2018

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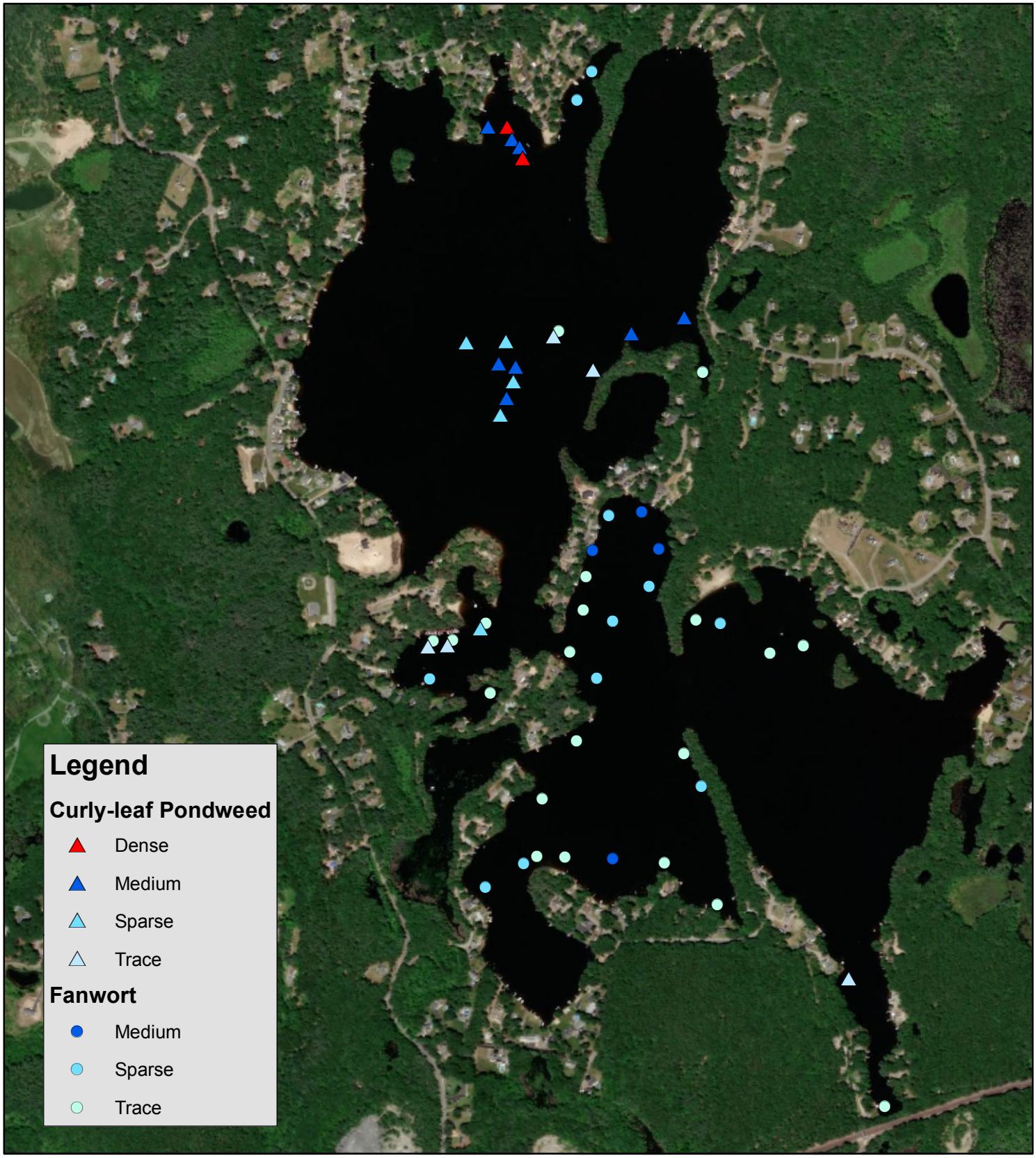
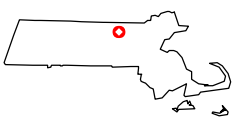


Lake Shirley
Lunenburg, MA



Lake Shirley

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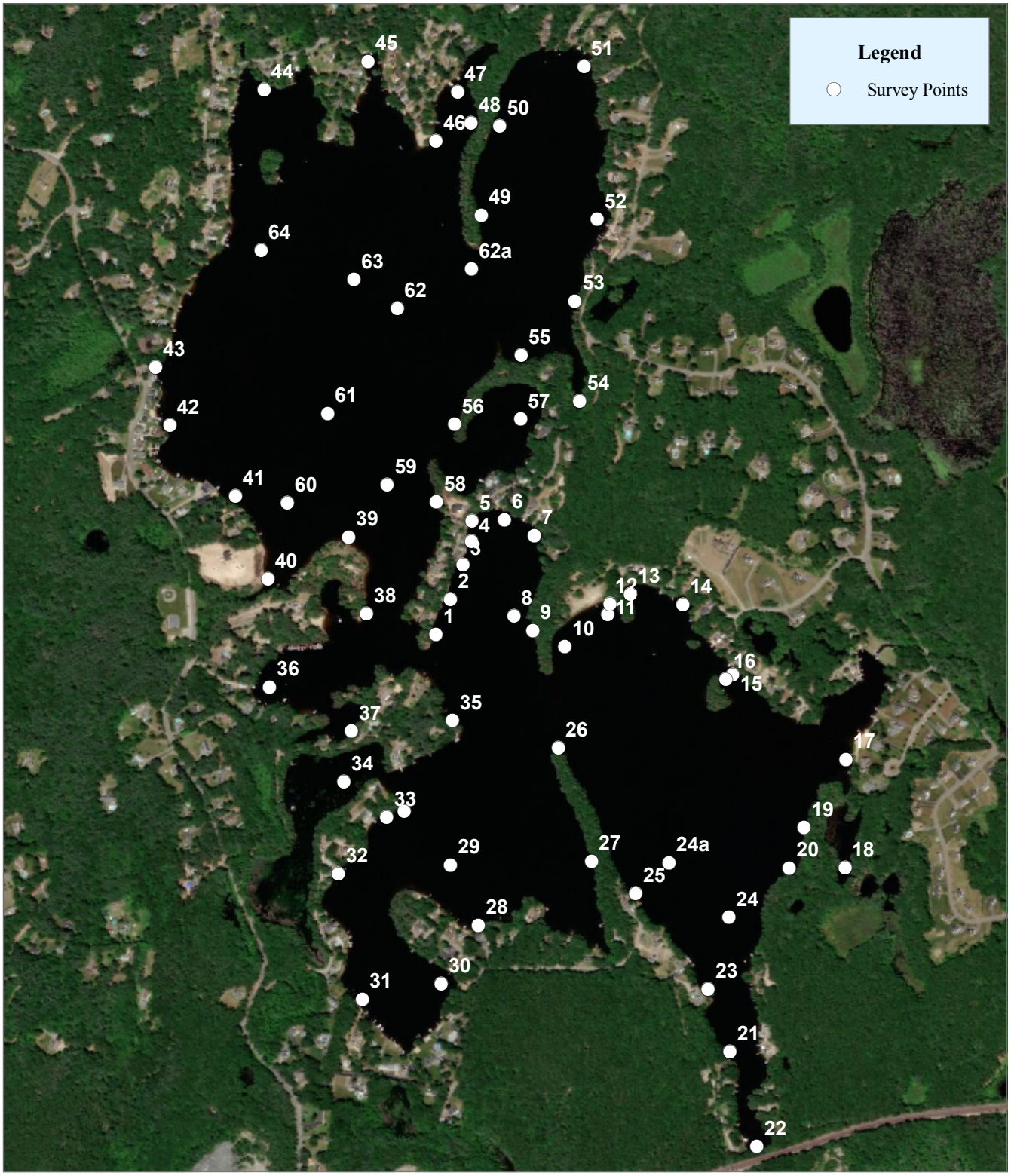
Map Date: 06/11/18
Prepared by: BNA
Office: SHREWSBURY, MA

Figure 2: Survey Point Locations



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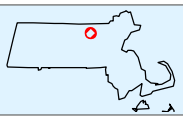
Lunenburg/Shirley, MA



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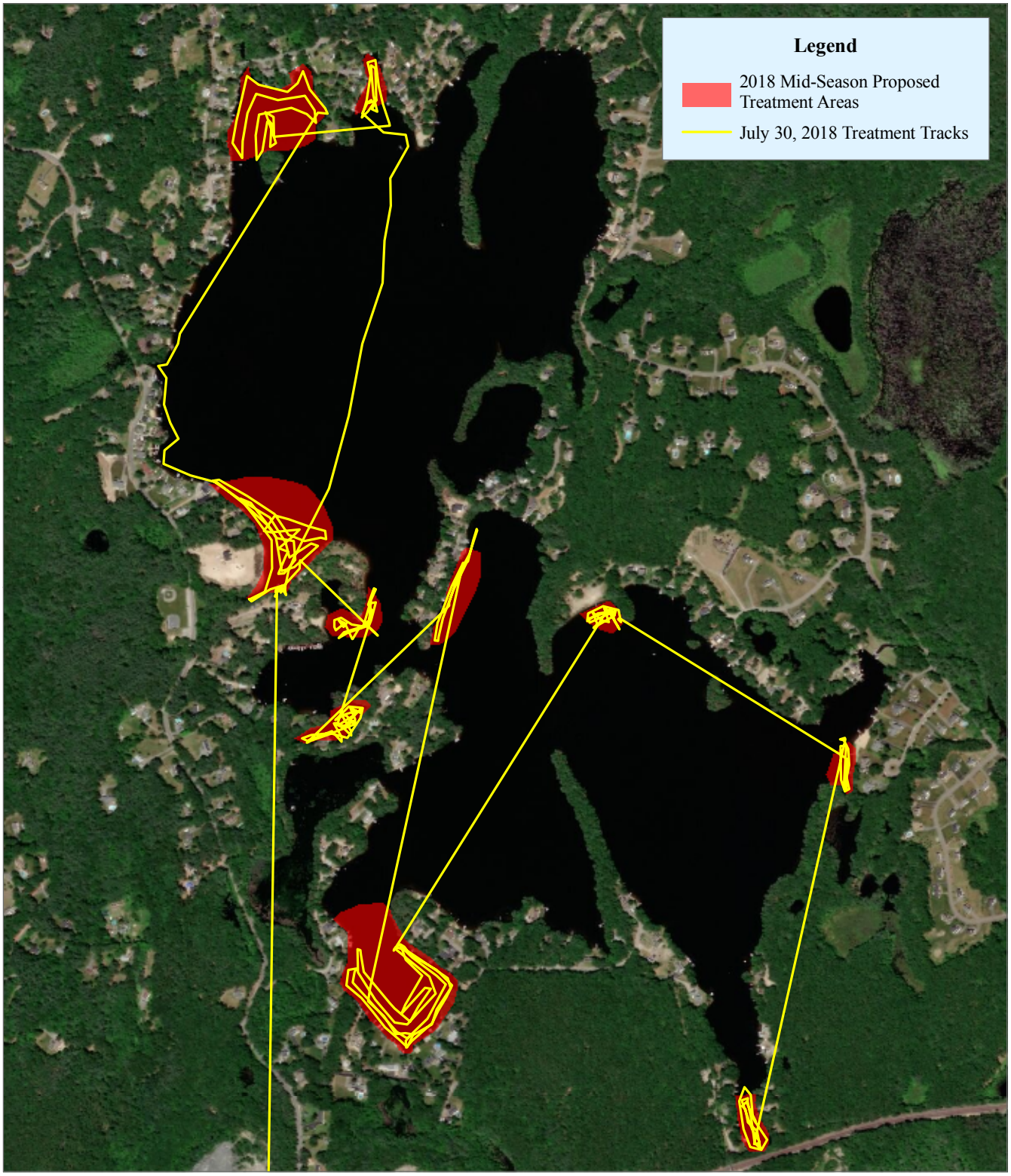
SOLITUDE LAKE MANAGEMENT

Figure 3: 2018 Mid-Season Proposed Treatment Areas & Treatment Tracks



Shirley, Lake
Lunenburg/Shirley, MA

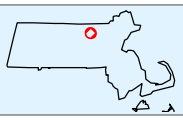


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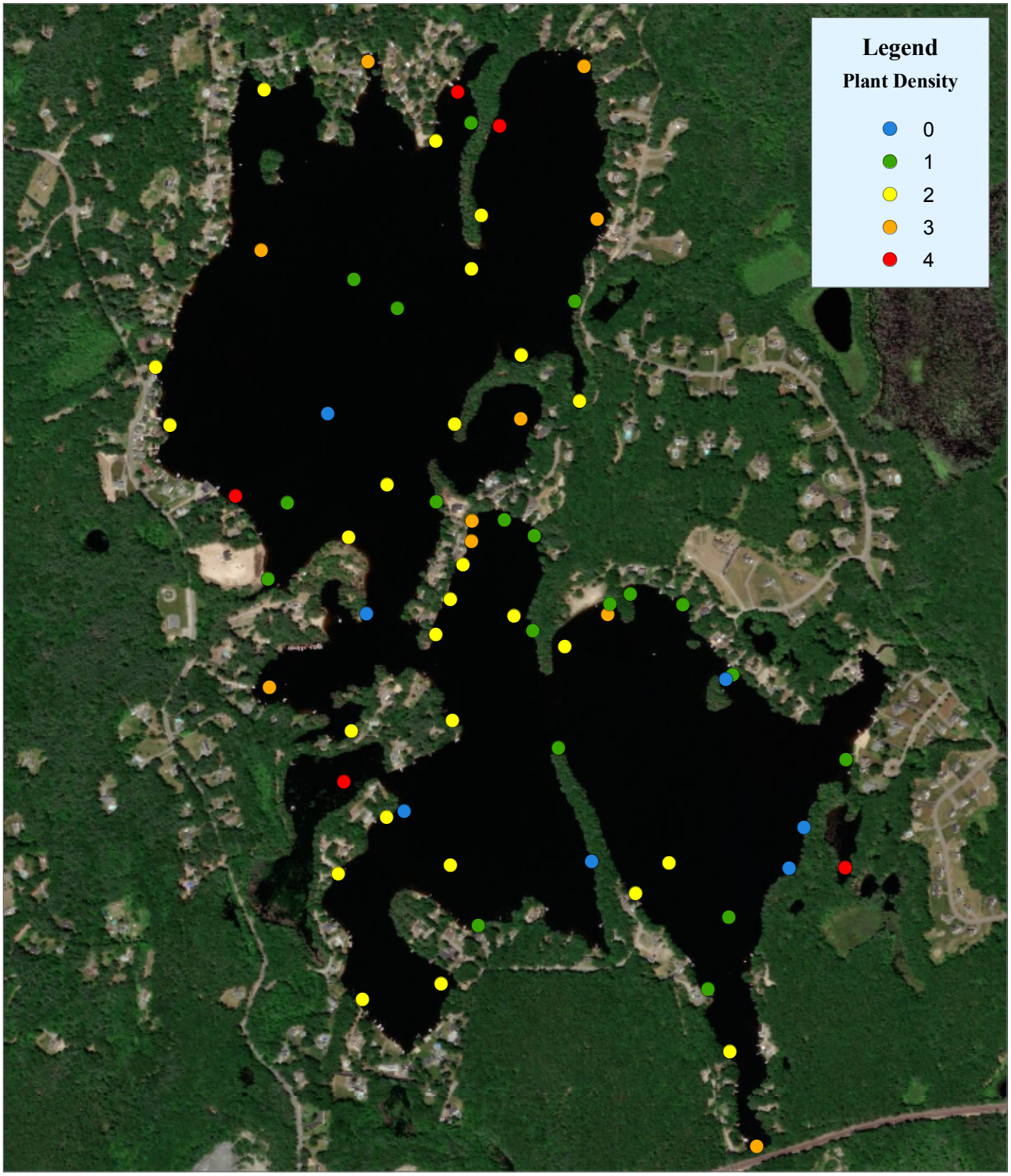
Figure 4: Late Season Plant Density



Shirley, Lake
Lunenburg/Shirley, MA

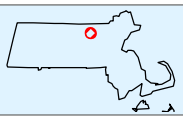


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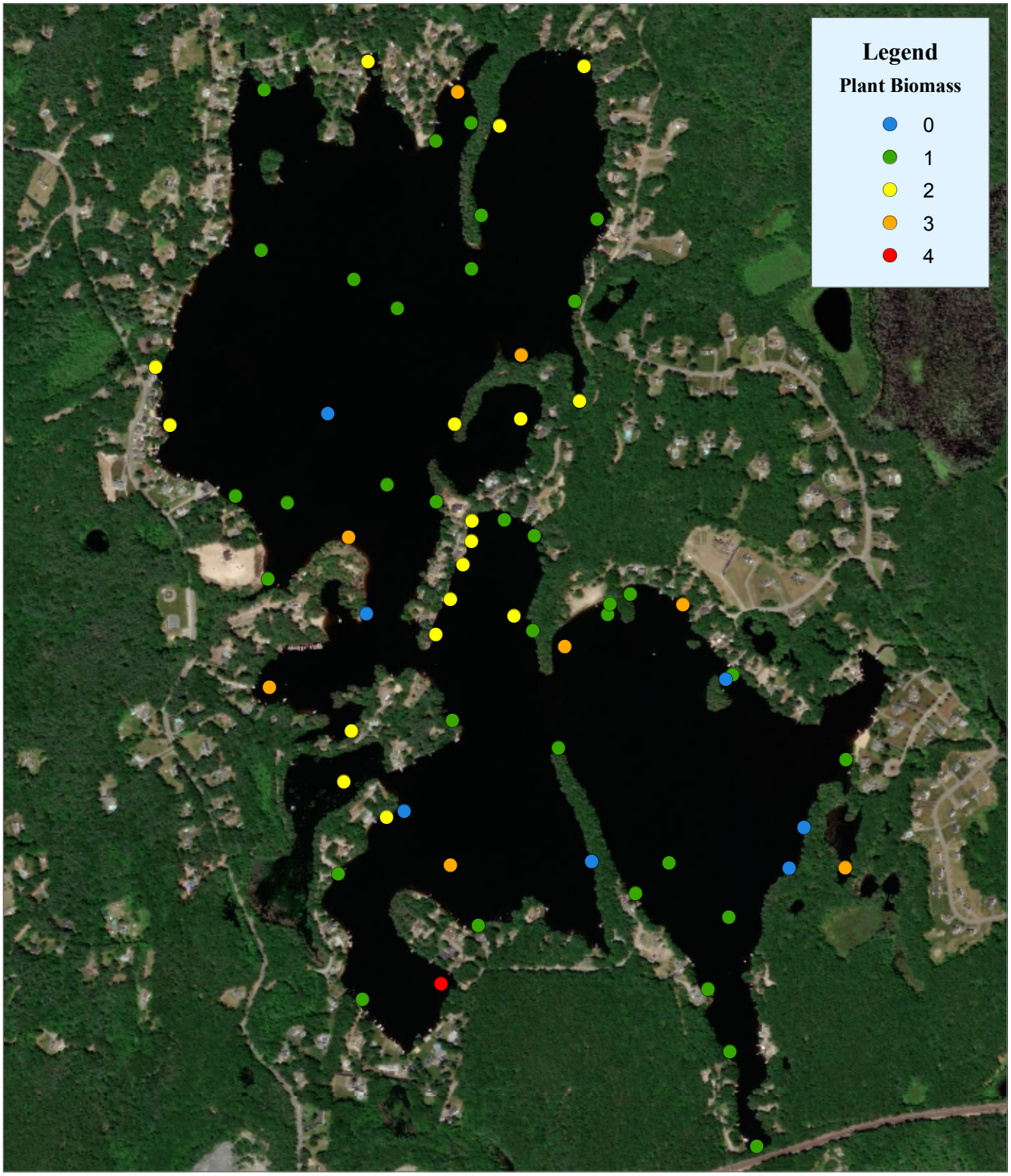
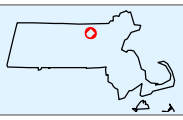
Figure 5: Late Season Plant Biomass



Shirley, Lake
Lunenburg/Shirley, MA



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SOLITUDE LAKE MANAGEMENT

590 Lake Street
Shrewsbury, MA 010545

Phone: (508) 865-1000
FAX: (508) 865-1220
e-mail: info@solitudelake.com
Internet: www.solitudelakemanagement.com

Date: July 16, 2018

To: Lunenburg Conservation Commission

From: Dominic Meringolo, Senior Environmental Engineer/Territory Leader

Re: Lake Shirley – Surveys and Treatment Plan for Mid-Season Weed Treatment

---

Dear Commissioners,

Based on a survey conducted by our Biologists on July 3rd, we are recommending treatment to approximately 40-acres of Lake Shirley to manage nuisance weed growth, primarily naiad (*Najas sp*.) and tapegrass (*Vallisneria Americana*). Per the Lake Management Plan, areas of the lake that exhibit either density or biomass factors of 3 or greater (>50%) are candidates for management. Additionally, any growth of non-native species, in this case European (spiny) naiad (*Najas minor*) and curlyleaf pondweed (*Potamogeton crispus*) can also be treated. Some candidate areas were not designated for treatment due to their proximity to undeveloped shorelines and/or the presence of non-nuisance species (ex. Stonewort/Chara) or unmanaged species such as fanwort (*Cabomba caroliniana*).

The Southwest cove of the middle basin (bordered by Round Road, Parmenter Street and Johnson Street) has been designated for treatment based on observations of tapegrass growth not captured by data points. This shallow cove has historically been one the most heavily grown in areas of the lake with tapegrass.

Treatment is tentatively scheduled for July 25th. The Reward (diquat) herbicide will be used for this treatment at a rate of 1.0-1.5 gallons per acre and a copper-based product, either Nautique or copper sulfate will also be applied in areas dominated by tapegrass.

A map of the recommended treatment areas is attached. I will be attending the July 23rd meeting of the Conservation Commission to discuss this plan and answer any questions.

Regards,
SOLitude Lake Management

Dominic Meringolo
Senior Environmental Engineer/Territory Leader

FIGURE 1: Mid-Season Proposed Treatment Areas

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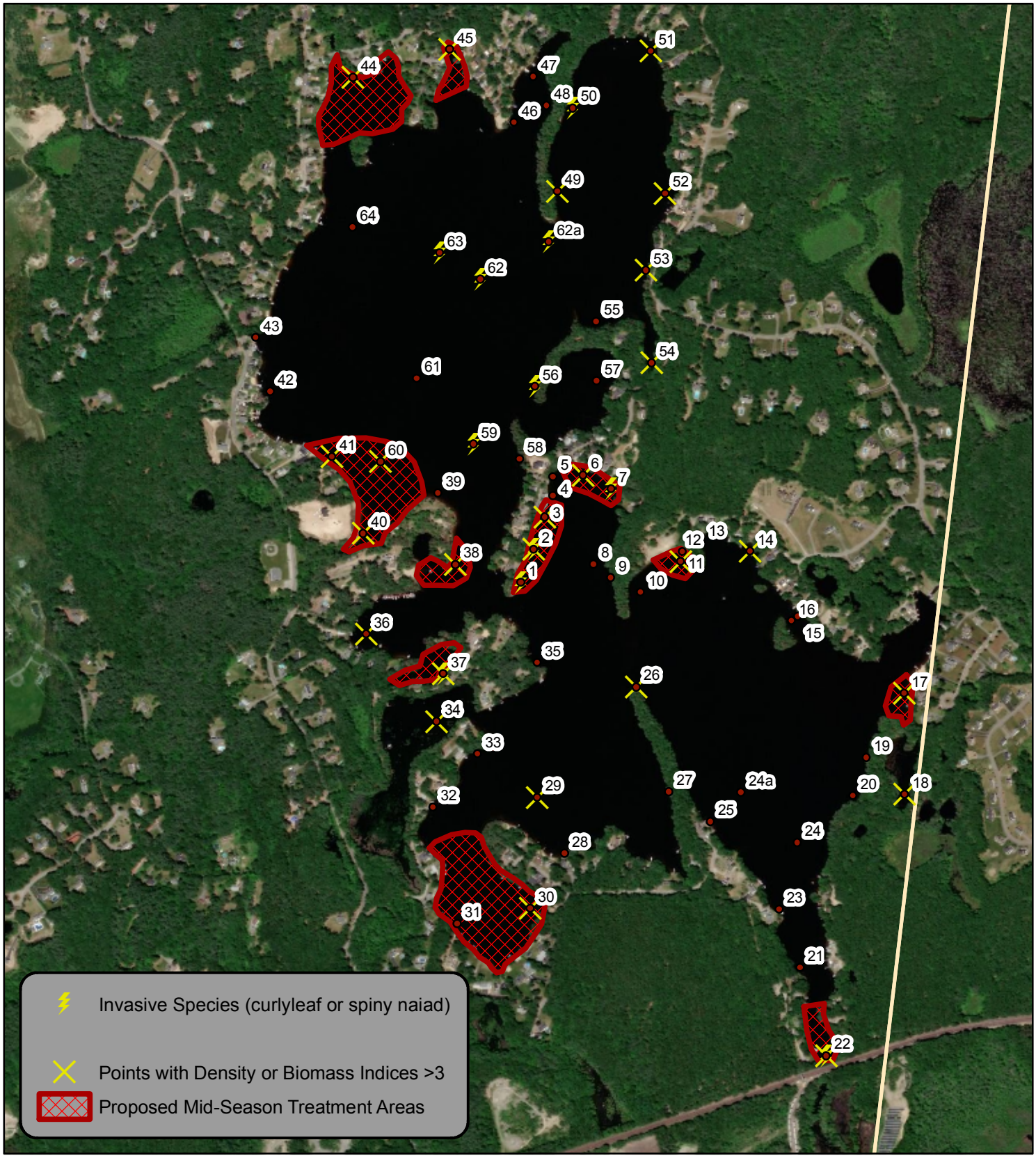
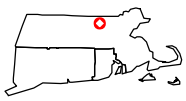


Lake Shirley
Lunenburg, MA



Lake Shirley

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Map Date: 11/27/17
Prepared by: DMM
Office: SHREWSBURY, MA

Table 1: Aquatic Vegetation Survey Results

Date: July 3, 2017 X= Present D = Dominant

Plant Species: Common Name	Scientific Name	# stations present	# stations dominant	% stations present	% stations dominant
Fanwort	*Cabomba caroliniana*	23	14	35%	21%
Wild Celery	*Valisneria americana*	22	8	33%	12%
Bladderwort	*Utricularia Sp.*	18	4	27%	6%
Musk Grass	*Chara sp.*	14	11	21%	17%
Stonewort	*Nitella sp.*	13	5	20%	8%
Thin-leaf Pondweed	*Potamogeton sp.*	11	3	17%	5%
Bushy Pondweed	*Najas flexillis*	10	2	15%	3%
European Naiad	*Najas minor*	10	3	15%	5%
Filamentous Algae	*Various*	6	2	9%	3%
Northern Naiad	*Najas gracilima*	3	0	5%	0%
Curlyleaf Pondweed	*Potamogeton crispus*	3	0	5%	0%
Ribbon-leaf Pondweed	*Potamogeton epihydrus*	3	0	5%	0%
Clasping-leaf Pondweed	*Potamogeton perfoliatus*	2	0	3%	0%
Coontail	*Ceratophyllum demersum*	2	0	3%	0%
Flatstem Pondweed	*Potamogeton zosteriformis*	2	1	3%	2%
Yellow Waterlily	*Nuphar variagata*	1	0	2%	0%
White Waterlily	*Nymphaea odorata*	1	0	2%	0%
Water Starwort	*Callitriche sp.*	1	0	2%	0%
Robbin's Pondweed	*Potamogeton robbinsii*	1	0	2%	0%

Monitoring Locations

Common Name	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
Fanwort	D	D	D	D	D	D	D	D	X	X	X							X				X			
Wild Celery						X			D	D	X											X	D		
Bladderwort		X					X		X	X	X		X	X		X	X	X				X	X	D	
Musk Grass											D		D	D		D	D								
Stonewort					X						X				X										D
Thin-leaf Pondweed																	X	X			D	D			X
Bushy Pondweed		X	X	X																					
European Naiad		X					X															X			
Filamentous Algae					X																				
Northern Naiad								X																	
Curlyleaf Pondweed	X																								
Ribbon-leaf Pondweed																									
Clasping-leaf Pondweed																		X							
Coontail																		X							X
Flatstem Pondweed																		D				X			
Yellow Waterlily																									
White Waterlily											X														
Water Starwort																									
Robbin's Pondweed																		X							
Species Richness	2	4	2	2	3	2	3	2	3	3	6	0	2	2	1	2	3	7	0	0	1	6	2	1	3
Plant density Index	2	3	3	2	2	3	1	1	2	2	3	0	2	3	1	2	4	4	0	0	1	4	1	2	2
Plant biomass index	2	2	2	2	2	3	1	1	2	2	1	0	1	1	1	1	2	4	0	0	1	3	1	2	1

Common Name	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Fanwort					D						D	D	D							X	D
Wild Celery								D		X	X		X	D		D	X		X	X	X
Bladderwort								X				X									
Musk Grass						D	D						X						D		
Stonewort	D	D															X				
Thin-leaf Pondweed		X								D										X	
Bushy Pondweed																	D				
European Naiad													X								
Filamentous Algae																				D	X
Northern Naiad																					X
Curlyleaf Pondweed																X					X
Ribbon-leaf Pondweed																				X	X
Clasping-leaf Pondweed																X					
Coontail																					
Flatstem Pondweed																					
Yellow Waterlily						X															
White Waterlily																					
Water Starwort																					
Robbin's Pondweed																					
Species Richness	1	2	0	0	1	2	1	2	0	2	2	2	4	1	0	3	3	0	2	5	6
Plant density Index	1	3	0	0	3	3	2	1	0	4	2	3	4	2	0	4	3	0	2	4	2
Plant biomass index	1	1	0	0	2	4	1	2	0	4	1	3	3	3	0	3	2	0	1	3	3

Common Name	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	62a	63	64
Fanwort	X	D							X										X	
Wild Celery	X	X	X	D	X										D					
Bladderwort			D						D	D										
Musk Grass						D	D	D						X						X
Stonewort	D		X	X						X	D				X					
Thin-leaf Pondweed					X							X		X						
Bushy Pondweed	X				D				X		X	X							X	
European Naiad					X						X			D			D	D	X	
Filamentous Algae			X						X										D	
Northern Naiad				X																
Curlyleaf Pondweed																				
Ribbon-leaf Pondweed									X											
Clasping-leaf Pondweed																				
Coontail																				
Flatstem Pondweed																				
Yellow Waterlily																				
White Waterlily																				
Water Starwort	X																			
Robbin's Pondweed																				
Species Richness	5	2	4	3	4	1	1	1	5	2	3	2	0	3	2	0	1	1	4	1
Plant density Index	2	1	2	2	1	3	3	3	4	1	2	2	0	1	3	0	1	1	2	1
Plant biomass index	2	3	1	3	3	2	2	2	3	1	1	2	0	1	4	0	1	1	2	1

*Non-native, invasive species