



Area of Previous Heavy CLP in Spring Lake, June 2019

Aquatic Plant Surveys and Curlyleaf Pondweed Evaluation for Spring Lake, Scott County, Minnesota in 2019

Curlyleaf Pondweed Meandering Survey: April 29, 2019

CLP Treatment: May 20, 2019, 15.17 ac (diquat)

Curlyleaf Pondweed Assessment Using Meandering and Transect Surveys: June 10, 2019

Summer Point Intercept Plant Survey: August 30, 2019

Prepared for:
Prior Lake/Spring Lake
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Aquatic Plant Surveys and Curlyleaf Pondweed Evaluation for Spring Lake, Scott County, Minnesota in 2019

Summary

Early Season CLP Delineation and Assessment: Curlyleaf pondweed (CLP) distribution and abundance were delineated in Spring Lake on April 29, 2019 to determine if curlyleaf control was needed. Curlyleaf growth was observed at 29 out of 144 sample sites (Figure S1). Growth ranged from light to heavy. Two areas totaling 15.17 acres were projected to produce abundant growth and were delineated for treatment (Figure S1).

Treatment of 15.17 acres occurred on May 20, 2019 using a diquat herbicide.

A post-treatment assessment survey included a line transect survey and a meandering survey and was conducted on June 10, 2019 to check the status of curlyleaf pondweed and native plant community in Spring Lake. CLP was observed at a few sites of light growth and one site of moderate growth but no nuisance growth. Curlyleaf pondweed was not a navigational or recreational nuisance in June (Figure S1).

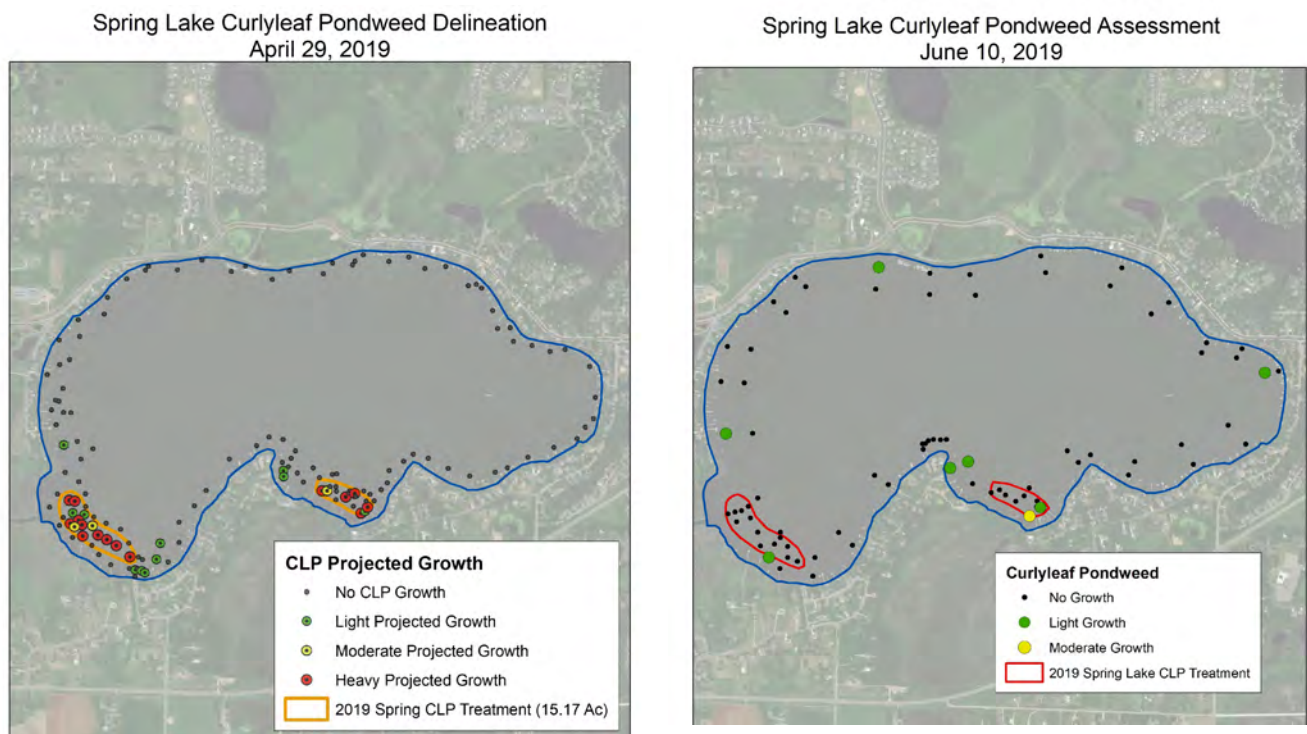


Figure S1. [left] curlyleaf pondweed Delineation. [right] curlyleaf pondweed assessment (post treatment).

Point Intercept Survey: A grid with points spaced 50 meters apart was put over the entire lake and sites were sampled throughout the growing zone. A total of 214 sites were sampled out to a plant growing depth of 8 feet and plants were observed at 150 sites. Results of the summer aquatic plant point intercept survey conducted on August 30, 2019 found 10 submerged aquatic plant species with no CLP or EWM observed in August. Native plants were found around the perimeter of the basin of Spring Lake (Figure S2).

Native aquatic plants were estimated to cover 17% of the lake bottom (98 acres). Coontail was the dominant aquatic plant. The 10 aquatic plant species found in this survey represents a fair to good diversity for Spring Lake in late summer.

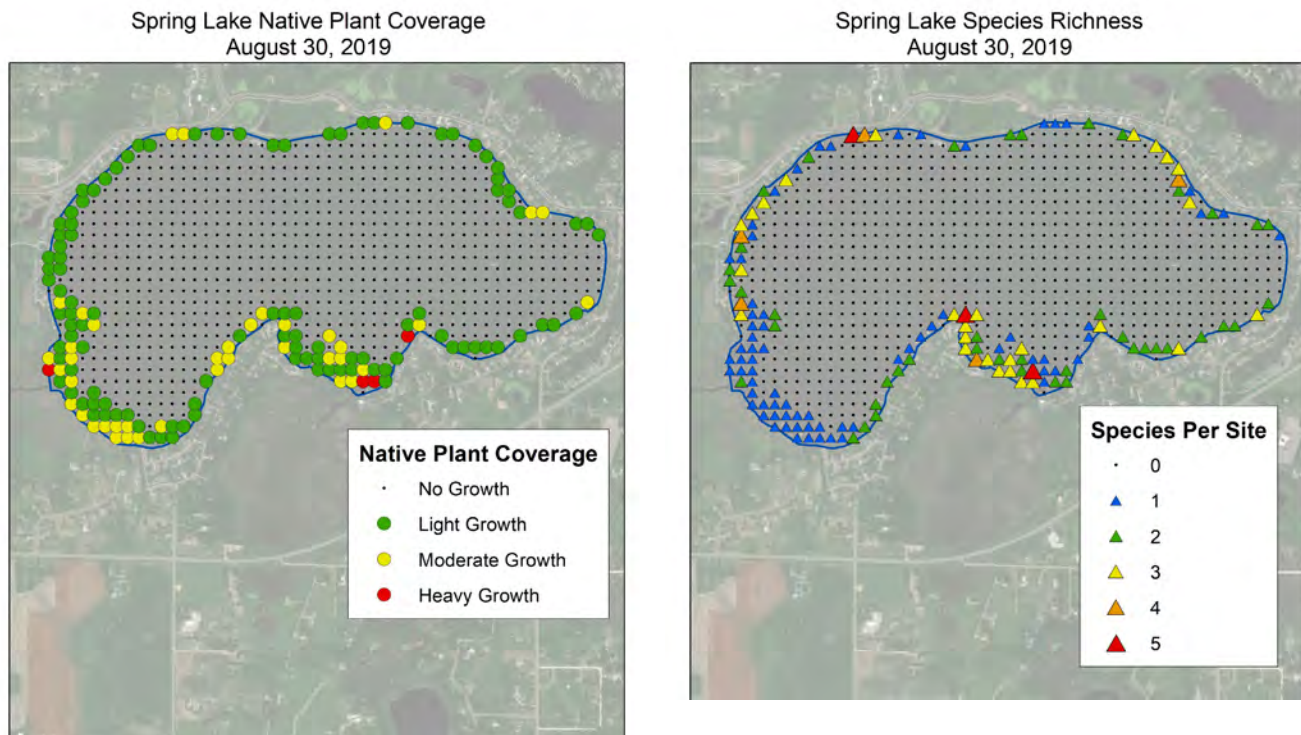


Figure S2. [left] Native plant distribution and abundance for the August 30, 2019 point intercept survey. [right] Species Richness for the August 30, 2019 point intercept survey. Key: green = light growth, yellow = moderate growth, red = heavy growth, and black dot = no growth.

Aquatic Plant Surveys and Curlyleaf Pondweed Evaluation for Spring Lake, Scott County, Minnesota in 2019

Introduction

Spring Lake has an area of 592 acres with a littoral area of 290 acres (source: MnDNR). The objectives of the plant surveys were to delineate and recommend areas to treat nuisance curlyleaf pondweed and to monitor the non-native and native plants over the summer.

A curlyleaf pondweed delineation survey was conducted on April 29, 2019.

Treatment occurred on May 20, 2019 and covered 15.17 acres.

A curlyleaf pondweed assessment was conducted on June 10, 2019.

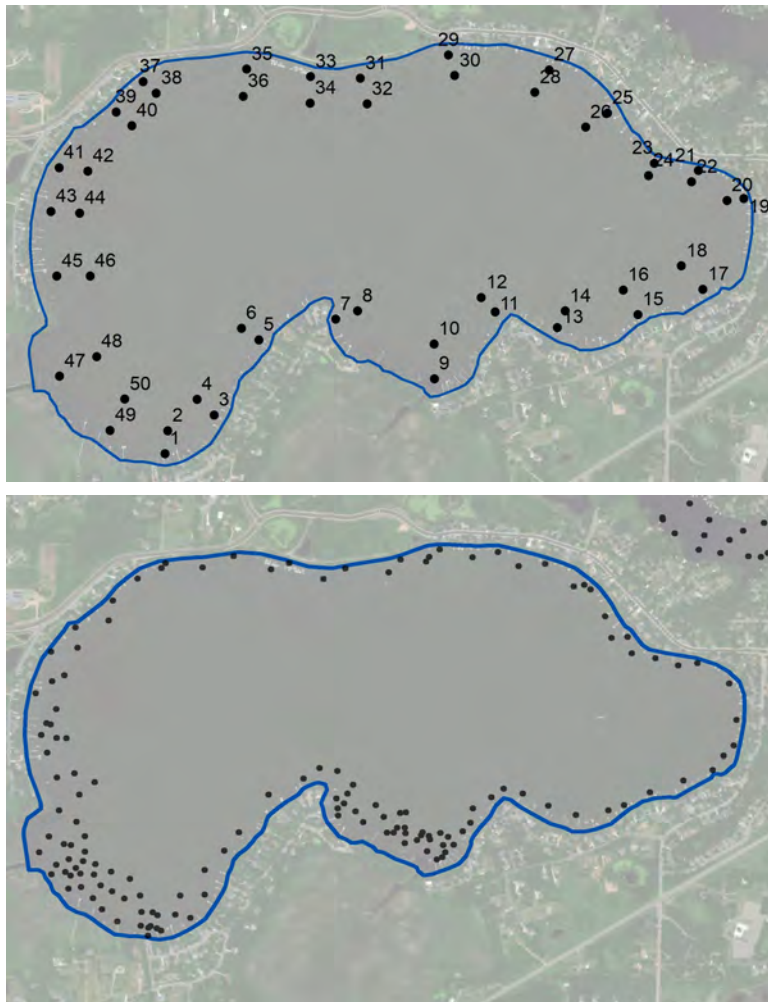
A summer aquatic plant point-intercept survey was conducted on August 30, 2019 to check and inspect the native plant community in Spring Lake.



Figure 1. Rake sample of aquatic submerged plants sampled on June 10, 2019 in Spring Lake.

Survey Methods for Meandering and Line Transect Surveys: Determining what areas to treat to control excessive growth of curlyleaf pondweed has been an ongoing challenge. Curlyleaf growth in April and May is just starting to go into a rapid growth phase. However, not all early season curlyleaf growth will result in heavy curlyleaf growth in June. It appears there are factors that limit curlyleaf growth and significant variables are associated with sediment conditions. The question is how to best delineate areas to treat what could be heavy growth in June but not overtreat areas where growth wouldn't be a nuisance for the season. Currently, for Spring Lake, the method has been to use past treatment history combined with early season scouting and then a recheck to evaluate any treatment effects and see if curlyleaf areas were missed. A meandering survey was used to delineate CLP and a meandering survey was combined with a line transect survey to assess the CLP treatment (Figure 2).

Meander Delineation Survey: A meandering survey consists of using a meandering path around the nearshore area of the entire lake. Visual inspection along with plant sampling was conducted. At each sample point, plants were sampled with a rake sampler.



Line Transect Survey: We used 25 line transects with 2 depths per transect. The same transects have been used from 2000 through 2019. Plants were sampled with a rake attached to a pole to characterize species presence and its density. A total of 50 sites were sampled (Figure 1). For the assessment transect survey, plant density was estimated on a scale of 1 to 3 with 3 being the densest.

Figure 2. [top] Full lake transect survey sample sites; [bottom] meander GPS sample points. The transect survey can be used for year to year comparisons and the meander GPS surveys help target abundant and nuisance non-native species.

Survey Methods for the Point Intercept Survey: An aquatic plant point-intercept survey of Spring Lake was conducted by Blue Water Science on August 30, 2019. A total 222 points in the growing zone out to 15 feet were sampled. Sample points were spaced 50 meters apart on a grid that covered the lake (Figure 3). At each sample point, a sampling rake was lowered into the water and a plant sample was taken. The plant species were recorded and the density of each species was assigned. Densities were based on the coverage on the teeth of the rake. Density ratings ranged from 1 to 3 with 1 being sparse and 3 being heavy growth. Based on these sample sites, plant distribution maps were constructed.

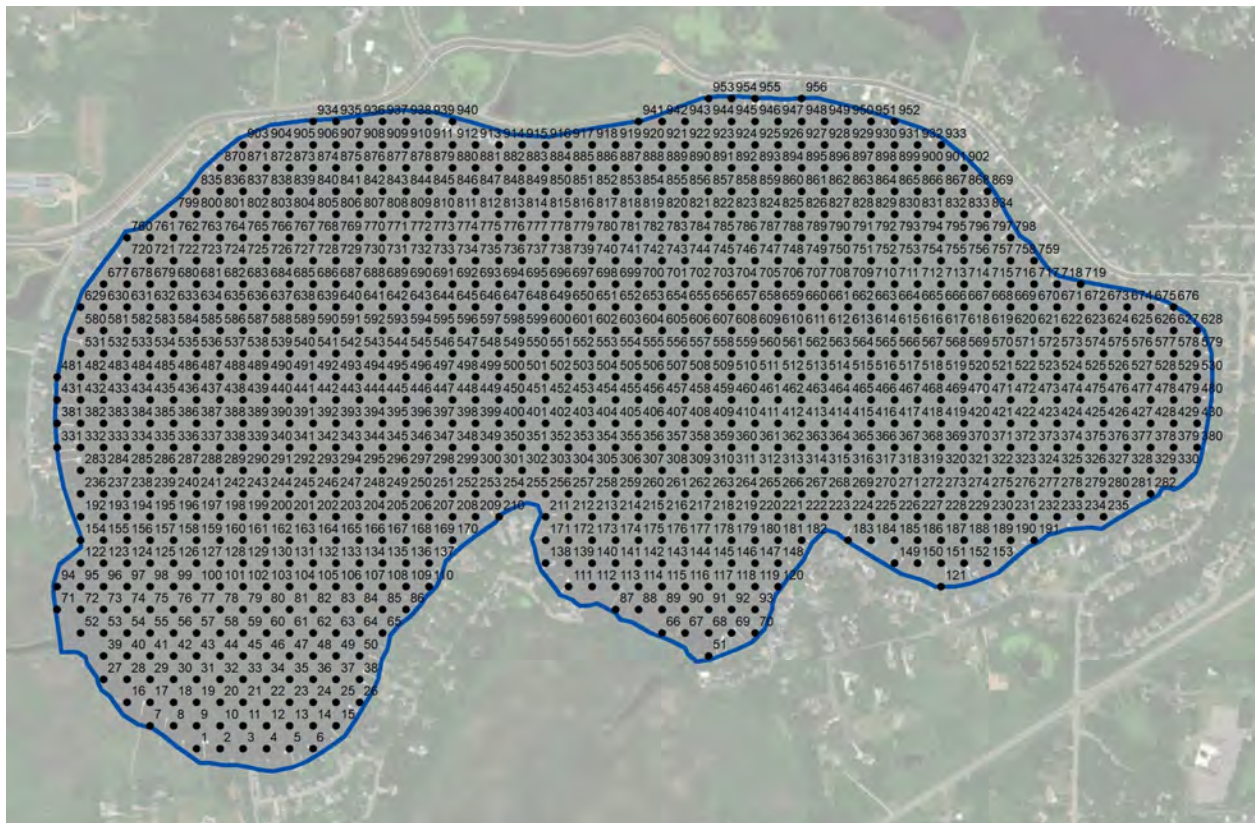


Figure 3. Point-intercept sample sites for Spring Lake in 2018. Sample sites were spaced 50 meters apart.

Results of Curlyleaf Pondweed Delineation April 29, 2019: A curlyleaf delineation using a meandered survey collected a total of 144 GPS points around the lake. Curlyleaf was found at 29 out of 144 sites (Table 1 and Figure 4). Curlyleaf was observed growing in water depths of 3- 7 feet. A total of 15.17 acres were delineated for treatment (Figure 4).

Spring Lake Curlyleaf Pondweed Delineation
April 29, 2019

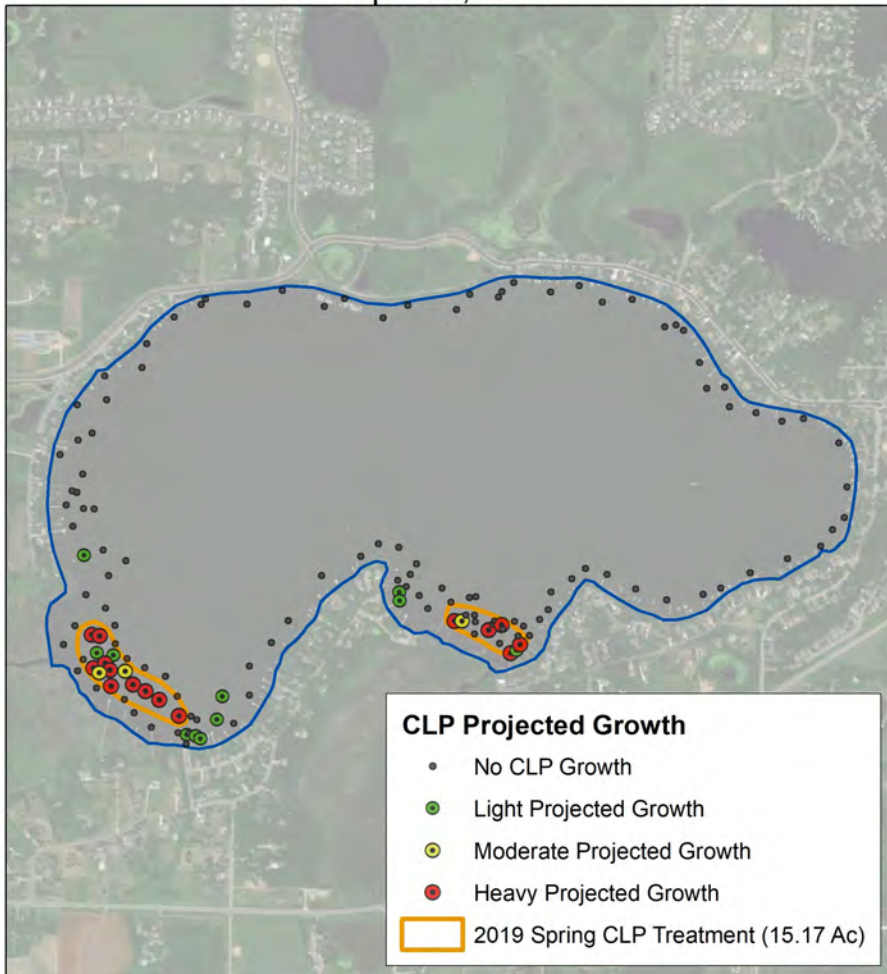


Figure 4. Map of curlyleaf pondweed for April 30, 2019. Colored sample areas indicate the growth in April of 2019 for curlyleaf pondweed. Key: green = light potential growth, yellow = moderate potential growth, red = heavy potential growth, and black dot = no curlyleaf.

Table 1. Aquatic plant densities based on rake sampling for April 29, 2019. Densities are based on a scale from 1 to 3 with 3 being the densest. Curlyleaf stems per rake sample were also noted.

Way point	Depth (ft)	CLP-stems	Chara	Coontail	Elodea	Water stargrass	No plants
1	4				1		
2	4	1					
3	5			1			
4	4	1		1			
5	3	1					
6	6						1
7	6	2		1			
8	3			1	1		
9	7	1					
10	5			1			
11	8						1
12	8						1
13	7						1
14	10						1
15	5						1
16	4						1
17	4					1	
18	8						1
19	7			1			
20	4						1
21	5		1	1			
22	4	2		1			
23	4	1		1			
24	5		1	1			
25	5		2				
26	8						1
27	6						1
28	5	4					
29	3	3					
30	4						1
31	5			1	1		
32	9						1
33	4						1
34	4						1
35	5						1
36	4	4					
37	5			1			
38	6			1			
39	5	6					
40	5			1	1		
41	4						1
42	4	6		2			
43	5	1		1			
44	5	4		1			
45	5			1			
46	7			1			
47	6						1
48	5			1			
49	7						1
50	6			1			
51	8						1
52	5						1
53	4						1
54	8						1
55	7						1
56	6						1
57	8						1
58	5					1	
59	6						1
60	8						1
61	5						1
62	9						1
63	6			1			
64	13						1
65	8						1
66	5						1
67	7						1
68	9					1	
69	6						1
70	4						1
71	7						1
72	5						1
73	4						1
74	5						1
75	7						1
76	5						1
77	12						1
78	5						1
79	7						1
80	5						1
81	7						1
82	10						1
83	7						1
84	10						1
85	4						1
86	8						1
87	4						1
88	9						1
89	5				1		
90	9						1
91	5						1
92	5						1
93	5						1
94	5						1
95	8						1
96	4						1
97	7						1
98	3						1
99	7						1
100	5						1
101	4						1
102	7						1
103	6						1
104	5			1			
105	7						1
106	7			1			
107	7						1
108	5			1			
109	5	1		1			
110	6			1			
111	7						1
112	6						1
113	4				1		
114	8						1
115	5			1	1		
116	4						1
117	6	10		1			
118	6	6		1			
119	8						1
120	8						1
121	7	1		1			
122	6	2					
123	4			1	1		
124	4			1			
125	5	6					
126	6	8					
127	6	6					
128	8						1
129	6	3		2			
130	5	6					
131	5	3					
132	4			1			
133	5			2			
134	6	5		1			
135	8						1
136	6	12					
137	5			2			
138	4			1			
139	6	12					
140	9						1
141	7						1
142	5	5		1	1		
143	4			1			
144	6						1
Average		4.2	1.3	1.1	1.0	1.0	
Occur (144 sites)		29	3	41	9	3	81
% occurrence		20	2	28	6	2	

Curlyleaf Pondweed Assessment, June 10, 2019: A curlyleaf assessment was conducted on June 10, 2019, the survey included meandering survey collecting 30 GPS points and a line-transect survey which collect data on 50 sites. Curlyleaf was found at 8 out of 80 of the total sites (Figure 5). Curlyleaf did not expand and the curlyleaf treatment was good. Results for individual sample sites are found in Table 2.

Spring Lake Curlyleaf Pondweed Assessment
June 10, 2019

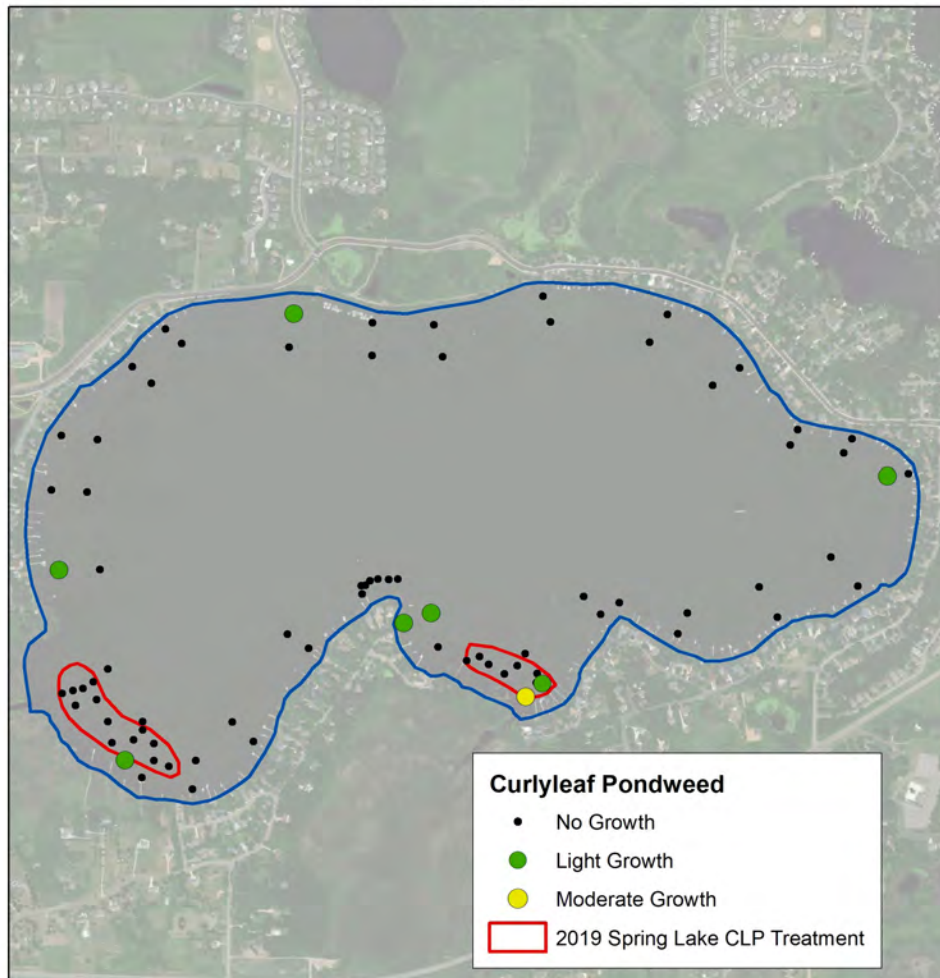


Figure 5. Curlyleaf pondweed assessment on June 10, 2019.
Key: green = light growth, yellow = moderate growth, red = heavy growth, and black = no curlyleaf.

Table 2. Aquatic plant densities based on rake sampling for June 10, 2019. Densities are based on a scale from 1 to 3 with 3 being the densest.

Way point	Transect Site	Depth (ft)	Chara	Clasplngl eaf	Coontail	CLP	Elodea	Moss	Naiads	Sago	Stringy	Water celery	Water stargrass	No plants
	1	5			1				1					
	2	7			1		1				1			
	3	5			1									
	4	7			1									
	5	5			1						1			
	6	7												1
	7	4		1	1	1						1	1	
	8	6			2	1					1		1	
	9	4			2	2								
	10	7			1									
	11	4									1			
	12	7						1						
	13	4			1						1	1		
	14	7											2	
	15	4			1						1	1	1	
	16													1
	17	4						1					1	
	18	8												1
	19	5					1						1	
	20	7				1	1	1			1		1	
	21	3		2				1			1			
	22	8												1
	23	4		1								1	1	
	24	7												1
	25	4	1	2							1		1	
	26	6												1
	27	5		2			1							
	28	7					1							
	29	4			1		2							
	30	7												1
	31	4			1					1			1	
	32	8												1
	33	4			1		1			1	1		1	
	34	7												1
	35	4		1		1	2							
	36	7					1							
	37	5			1						1			
	38	7			1									
	39	5			1						1			
	40	8												1
	41	4		1							1			
	42	7												1
	43	4			1		1				1			
	44	7			1									
	45	4			1	1					1			
	46	7			1		1							
	47	4			1					1				
	48	8												1
	49	5			1	1								
	50	7												1
	1	4		2										
	2	4		2										
	3	5		2										
	4	6		2										
	5	5		1										
	6	4			1									
	7	5			1									1
	8	5			1									
	9	4		2				1						
	10	4		2							1			
	11	4		1							1			
	12	3			1								1	
	13	6									2			
	14	5			3									1
	15	4			3									
	16	5			1	1								
	17	4		3										
	18	7												1
	19	6			1		1							
	20	4			1									
	21	5			2									
	22	6			1									
	23	5			2									
	24	5			1									
	25	6			1									
	26	7												1
	27	6			1		1							
	28	5			1									
	29	4			1									
	30	6			1									
ALL SITES:	Average		1.0	1.7	1.2						1.1		1.1	
	Occur (80 sites)		1	16	40						18		12	0
SITE: Average			1.0	1.4	1.1	1.1	1.2	1.0	1.0	1.0	1.0	1.0	1.1	13
	Occur (50 sites)		1	7	23	7	11	4	1	3	15	4	11	
	% occur		2	14	46	14	22	8	2	6	30	8	22	
WAYPOINT: Average			0.0	1.9	1.4	1.0	1.0	1.0	0.0	0.0	1.3	0.0	1.0	
	Occur (30 sites)		0	9	17	1	2	1	0	0	3	0	1	4

Curlyleaf Delineations for 2014 Through 2019: Full aquatic plant surveys using transects were combined with additional sampling to delineate areas of predicted heavy growth of curlyleaf in 2014 through 2019 (Figure 6). There appears to be a persistent bed of curlyleaf that grows on the south side of the lake, west of the public access and also on the south side of the mid-lake area. The hot spot map shows all treatment areas from 2014-2019 (Figure 6).

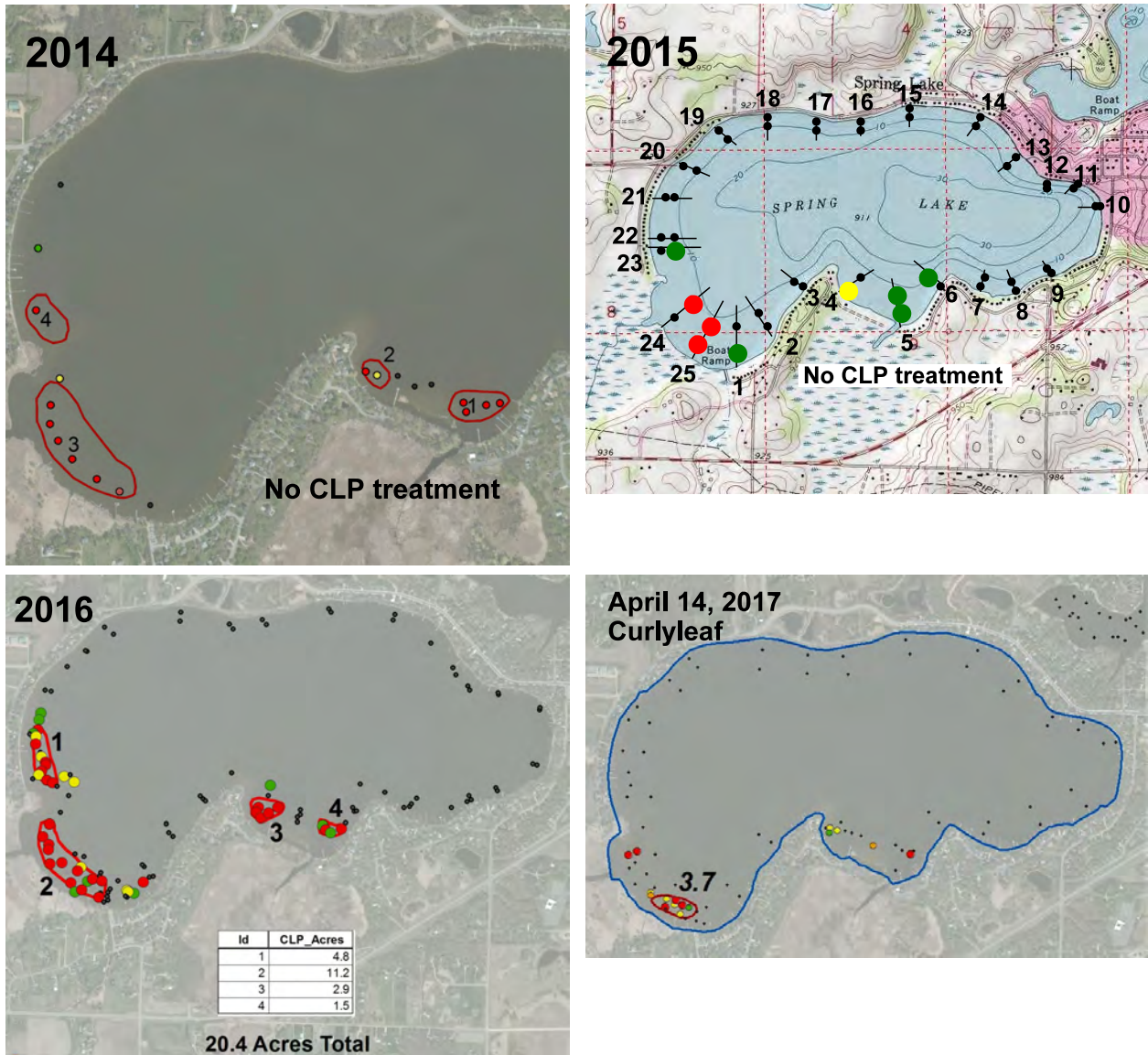
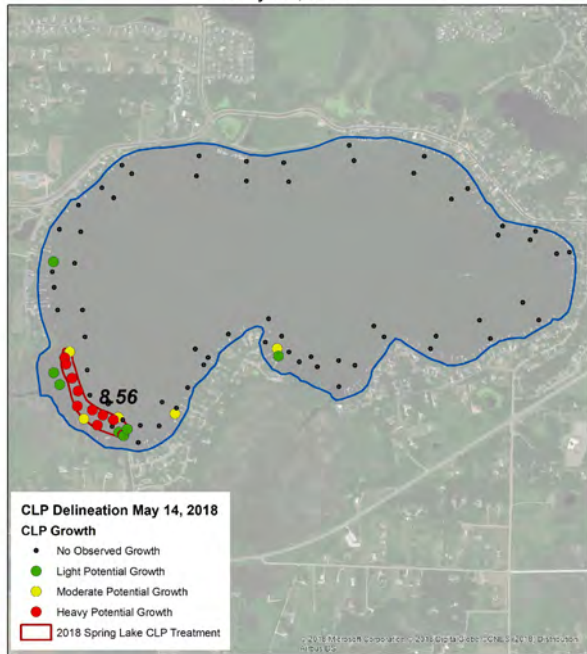
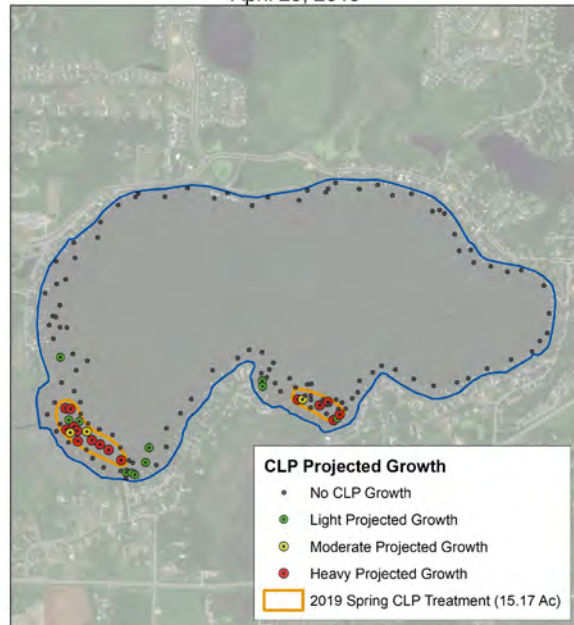


Figure 6. [top-left] Curlyleaf delineation in Spring Lake on May 21, 2014. [top-right] Curlyleaf delineation in Spring Lake on May 28, 2015. [bottom-left] Curlyleaf delineation in Spring Lake on April 20, 2016. [bottom-right] Curlyleaf delineation in Spring Lake on April 14, 2017. Key: black dot = no curlyleaf, green dot = light curlyleaf growth, yellow dot = moderate growth, red dot = heavy growth, and red outline = treatment area.

Spring Lake Curlyleaf Pondweed Delineation
May 14, 2018



Spring Lake Curlyleaf Pondweed Delineation
April 29, 2019



Spring Lake Curlyleaf Pondweed Hot Spots 2014- 2019

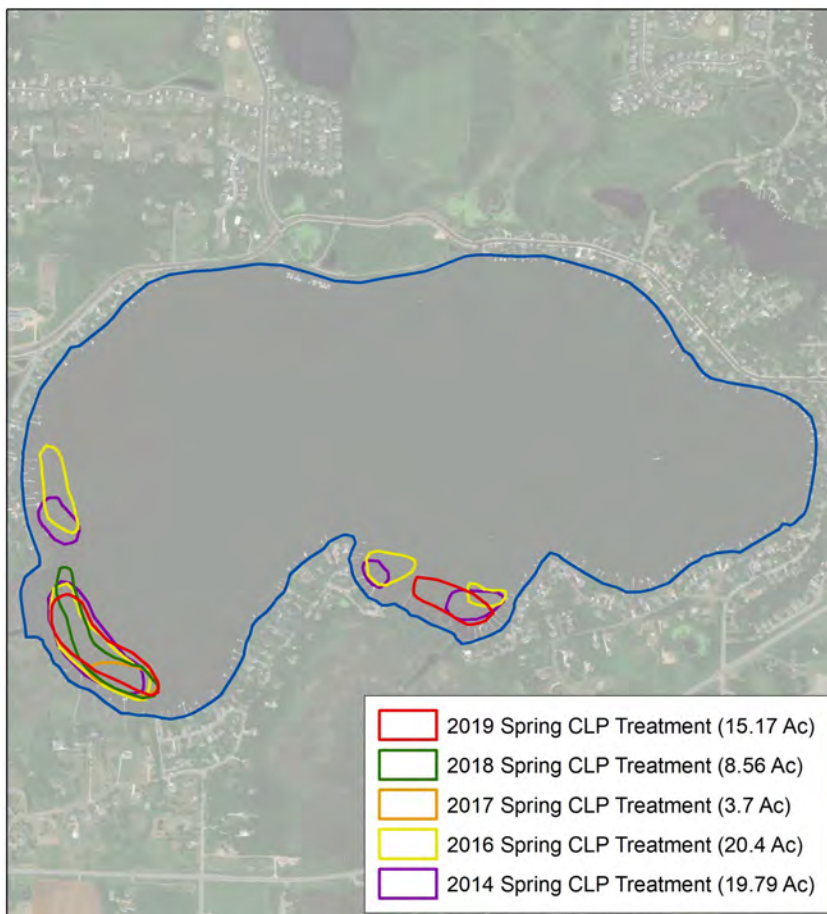


Figure 6. Concluded. [top left] Curlyleaf delineation in Spring Lake on May, 2018. [top right] Curlyleaf delineation on April 29, 2019 [bottom] Spring Lake Curlyleaf Hot Spot map, showing areas of CLP treatment 2014-2019
Key: Green dots = light curlyleaf growth, yellow dots = moderate growth, and red dots = heavy growth. Black dots = no curlyleaf.

Summary of Curlyleaf Pondweed 2000 to 2019

Curlyleaf pondweed growth has been variable from 2000 through 2018 but there has been less curlyleaf from 2007 through 2019 compared to the time frame of 2000 through 2006. There may be a correlation to the use of an iron dosing station on the County 13 ditch where ditch flows eventually enter Spring Lake and a reduction in Spring Lake curlyleaf. The amount of iron dosed is listed in Table 3. Likely only a small percentage of the dosed iron makes its way into Spring Lake. Iron in the water column that may inhibit CLP growth is speculative but heavy CLP growth, as shown in Figure 7, has not occurred since iron dosing has occurred in Spring Lake.

Table 3. Curlyleaf pondweed occurrence and acres either harvested or treated with herbicides from 2000 to 2018.

	Iron (kg)	FeCl ₃ (gallons)	Curlyleaf Occurrence (based on 50 sites)	Harvesting Acres	Herbicide Treatment Acres	Total Curlyleaf Treatment (acres)
2000	?		49			
2001	?					
2002	?		43	60	14	74
2003	0	0	35	74	14	88
2004	0	0	40		59	59
2005	2,629	4,232	29		59	59
2006	895	1,440	32		59	59
2007	920	1,481	22			
2008	726	1,168	4			
2009	109	176	5			
2010	0	0	25			
2011	1,491	2,390	10			
2012	0	0	6			
2013	1,248 (J-A)	?	3			
2014	?	?	10			
2015	?	?	10			
2016	4,284	6,910	11		20.4	20.4
2017	3,286	5,300	11		3.7	3.7
2018	3,281	5,250	4			
2019					15.7	15.7



Figure 7. Curlyleaf pondweed growth was very heavy in 2000.

Curlyleaf Pondweed Density at Individual Sites from 2000-2019: Curlyleaf growth was found to growing in 2018 (Table 4). From 2007 through 2015 and 2018 there were no open water herbicide applications except in 2016 and 2017.

Table 4. Summary of Curlyleaf Pondweed Distribution and Abundance from 2000 - 2018. For 2000-2017, curlyleaf density is shown on a scale from 0.5 - 5 (with 5 being most dense) for each depth zone on all 25 transects for each survey. In 2018 the density rating was on a scale of 1 to 3. Colors are coded for density. A sediment survey was conducted on Spring Lake in 2008. Predicted curlyleaf growth (far right column) has been close to actual curlyleaf growth conditions. Purple shading in transect column indicates transect areas that were harvested or treated with herbicides from 2002-2006 and 2016-2017 (blue shading for years of treatment). There has been no treatment from 2007-2015 and 2018.

Transect	Depth	2000	2002	2003	2004		2005		2006		2007		2008		2009		2010		Predicted growth based on lake soils
		Jun 3	Jun 7	May 15	May 2	Jun 14	Apr 20	Jun 1	Apr 26	Jun 2	Apr 15	Jun 5	Apr 29	Jun 13	Apr 23	Jun 10	Apr 27	Jun 2	
1	S	5	0.5	0	0	0	0	0	0	0	0	2	0	0	0.5	2	0	0	
	M	4	2	2	1	0	1	1	0.5	0	0	0	0	0.7	1	1	0	0	Heavy
2	S	4	0.5	0	0.5	0	0	2	1	0	0	0	0	0	0	0	0	0	
	M	5	2	4	0.5	0	0	0.3	0.7	0	0	1.8	0	1	0	0	0	0	Moderate
3	S	2	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0.5	1	Light
	M	4	2	0.5	0.5	0	0.5	1	0.8	0.5	0	1.5	0	0	0	0	0	0	Light
4	S	4	2	0.5	1	0	1	0	0	0	0	0	0	0.5	0	0	1	0	Moderate
	M	5	2.5	4	1	0	2	0.8	1.3	0.7	0	1	0	0.5	0	0	0	0	
5	S	2	2	0.5	1	0	2	1	1	0.5	0	0.7	0	0	0	0.5	1	1	
	M	5	3	2	2.5	0	0.5	0	2	1	0	0	0	0	0	0	1	1.3	Light
6	S	1.8	0	0	0.5	0	0	1	0	0	0	0	0	0	1	0	0	0	
	M	2	2	1	1	0	0.5	0.5	2	0.3	1	0	0	0	0	0	0.5	0	Moderate
7	S	1	0.5	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	
	M	4.5	1.5	1	0	0.5	0.5	1	1.8	1	0.5	1.5	0	0	0	0	0	0	Light
8	S	1	1	0	0.5	0	0.3	1	0	0	0	0	0	0	0	0	0.5	0	
	M	3	1	1	0	0	0.5	1	0	0.3	0	0	0	0	0	0.5	0	0	Moderate
9	S	4	0.5	0	0	0	0	1	0	1	0	1	0	0	0	0	1	0.5	Moderate
	M	4	0.5	0.5	0.5	0	0	1	0.8	0.5	0.5	1.8	0	0	0	0.5	0	0.5	
10	S	2	0	0	0	0	0	0	0	0	0	0.5	0	0	0	0	0	0	
	M	4	0	0	0.5	0	0	0	0	0	0	1	0	0	0	0	0	0	Light
11	S	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	M	3	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	Moderate
12	S	3	0.5	0	0.5	0	0	0	0	0	0	1	0	0	0	1	1	0	
	M	3	0.5	0	0.5	0	0	0	0	0	0	1	0	0.3	0	0	0	0	
13	S	0	0.5	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	M	2.7	1	0.5	0.5	0	0.5	0.7	1	1.7	0.8	3.5	0	3	0	0	0	0	Moderate
14	S	3	0.5	0.5	0.5	0	0	1	2	0.5	1	1	0	1	0	0	0.5	1	
	M	4	1.5	2	1	0	2	1.5	2	3	1	2.8	0	1.5	0	0	0.5	1	Moderate
15	S	2	1	0.5	2	0	0.3	1	1	2	0	3.5	0	1	0	2	1	1	
	M	2	0.5	3	1	1	1	1.5	1	2.5	1.3	2.8	0	2	0	0.3	1	1	Moderate
16	S	2	0	0.5	0.5	0	0.5	1	1.3	0	0	1	0	0	0	0	1	1	
	M	4	4	1	1	1	1	1	0.5	1.5	0.5	1.8	0	0	0	0	1	1	Moderate
17	S	2	1	0.5	1	0	1.5	1	1.5	2	0.5	0	0	0	0	0	1	0	Light
	M	4	2	2	1	0	1	0	1.5	1.7	0.3	2	0.3	0	0	0.3	1	1	
18	S	2	0	0.5	0.5	0	1	1	0	2	0.5	0	0	1	0	0	1	0	
	M	4	3	2	1	0	2	1.8	0.8	2.5	0.5	1	0.3	0	0	0	1	0	Light
19	S	3	1	3	0.5	0	0.5	1	0	3	0	1	0	0	0	0.5	1	1	
	M	5	1.5	2	0.5	0	0.3	0.3	0	0	0	0	0	0	0	0	0	1	Moderate
20	S	3	1	0.5	0.5	0	0	2	1.5	3	0.5	2.8	0	0	0	0	0.5	1	Moderate
	M	5	1.5	2	0.5	0	1.5	2	0.3	3	0.5	0	0	1	0.3	0	0.5	0.5	
21	S	2.5	0.5	0.5	0.5	0	0	1	0.5	3	0	1.5	0	0	0	0	1	0.5	Moderate
	M	5	2.5	3.5	0.5	0	2	0.5	1.3	3	0	4	0	0	0	0	0	0	
22	S	3	0.5	0	0	0	0	0	0.5	2	1	1	0	1	0	0	1	0	
	M	5	2	3	1	0	1	1	0.2	1	1	0	0	0	0	0	0.5	0	Moderate
23	S	2	1	0	0.5	0	0	0	0	1	1	0	0	0	0	1	0	1	
	M	4.7	4.5	3	0.5	0	1	1	0.8	1.3	0.5	1	0	0.5	0	0	0	0	Moderate
24	S	3	1	0.5	0.5	0	0	4	0.5	0	1	0	0	1	1	2	0	1	
	M	5	1.5	4	2	0	1.5	0.5	0.5	1.3	0.5	0	0	1	0	0	1	1	Moderate
25	S	2	1	0.5	0.5	0	1	2	1.8	2	1	0.5	0	1	1	1	0	2	
	M	4.7	3	4	0	0	1	1	1.7	0.5	0	0	0	1	0	0	1	0	Moderate
Number of Reds		23	2	4	0	0	0	1	0	0	0	1	0	0	0	0	0	0	
Number of Sites		49	43	35	40	3	29	37	32	32	22	29	4	19	5	14	25	21	

Depth Zones: S = 0 - 4 feet; M = 5 - 8 feet

Table 4. Concluded.

Transect	Depth	2011		2012		2013		2014		2015		2016		2017		2018		2019	Predicted growth based on lake soils
		May 12	Jun 10	Apr 17	Jun 5	May 29	Jun 24	May 21	June 19	May 28	Jul 30	Apr 20	June 1	Apr 14	Jun 1	May 14	Jun 18	June 10	
1	S	0	0	0	0	1	1	0	1	2	0	1	1	0	0	0	1	0	
	M	0	0.5	0	0	0	0	0	0	0	1	2	1	0	0	0	0	0	Heavy
2	S	0.5	0	0	0	0	0	0	0	0	0	0	0	1	2	2	0		
	M	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	Moderate	
3	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Light	
	M	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	Light	
4	S	0	0.5	0	0	0	0	2	1	3	0	4	0	1	0	2	1	Moderate	
	M	0	0.5	0	0	0	1	0	0	0	1	1	0	0	0	2	1		
5	S	0	2.5	0	0	0	0	2	2	2	0	0	0	0	0	1	2		
	M	0	0.3	0	1	0	3	2	0	2	1	0	0	0	0	1	0	Light	
6	S	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0		
	M	0	0	0.5	0	0	0	0	0	1	1	0	0	0	0	0	0	Moderate	
7	S	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	M	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	Light	
8	S	0.5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0		
	M	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Moderate	
9	S	0	2	0	1	0	1	0	0	0	0	1	0	0	0	0	0	Moderate	
	M	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0		
10	S	0	1	0	1	0	0	0	0	0	0	1	0	1	0	0	0		
	M	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	Light	
11	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Moderate	
12	S	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0		
	M	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0		
13	S	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0		
	M	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	Moderate	
14	S	0.5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	M	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Moderate	
15	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	M	0.5	0.5	0	0	0	0	0	1	0	1	0	0	0	0	0	0	Moderate	
16	S	0	0.8	0	0	0	1	0	1	0	0	0	0	0	0	0	0		
	M	0	0.5	0	0.5	0	0	0	0	0	1	0	0	0	0	0	0	Moderate	
17	S	0	0.5	0	0	0	0	0	1	0	0	0	1	0	0	0	0	Light	
	M	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0		
18	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
	M	0.5	0.5	0.3	0.5	0	0	0	0	0	0	0	0	0	0	0	0	Light	
19	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	M	0	0	0.5	0	0	1	0	0	0	1	0	0	0	0	0	0	Moderate	
20	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	Moderate	
	M	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0		
21	S	0.5	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	Moderate	
	M	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0		
22	S	0	0	0	0	0	0	0	1	0	0	1	0	0	1	1	1		
	M	0	0	0	0	0	0	1	1	0	0	3	1	0	0	0	1	Moderate	
23	S	0.5	0	0	0	0	0	2	1	0	0	1	0	0	1	0	1		
	M	0	0	0	0	0	1	1	0	1	1	1	0	0	0	1	0	Moderate	
24	S	0	0	0	0	0	0	2	1	4	0	3	0	0	0	1	1		
	M	0	0	0	0	1	1	3	1	4	1	3	0	0	1	0	0	Moderate	
25	S	0.5	1	0	0	0	2	1	1	5	1	2	0	1	2	3	3		
	M	0	0.8	0	0	0	1	3	1	3	5	1	0	0	2	0	0	Moderate	
Number of Reds		0	0	0	0	0	0	0	0	0	4	0	1	0	0	1	1	0	
Number of Sites		10	18	6	8	3	12	10	18	10	12	11	9	1	11	4	13		

Depth Zones: S = 0 - 4 feet; M = 5 - 8 feet

Peak Curlyleaf Abundance from 2007 Through 2019-Typically June

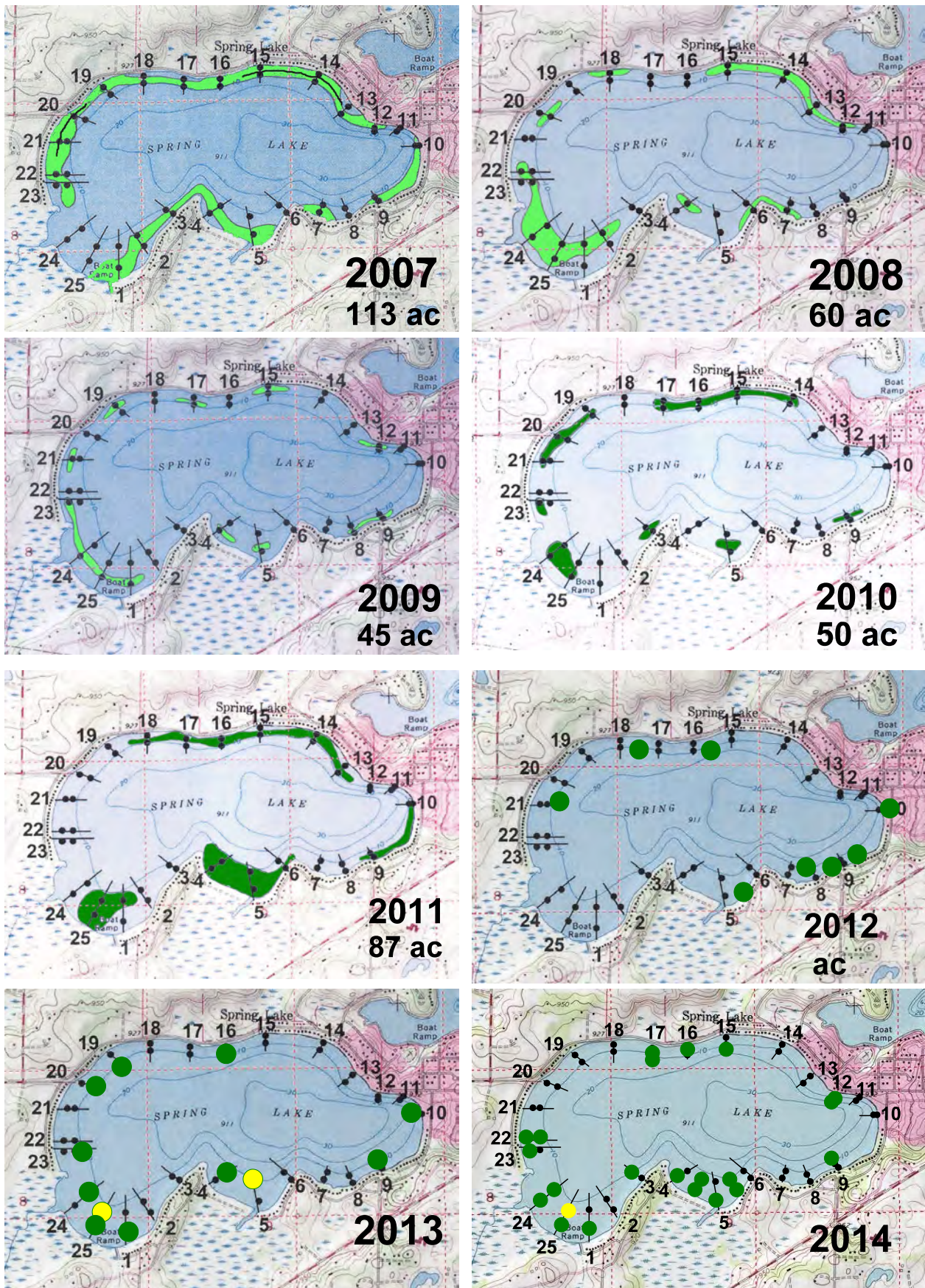


Figure 8. Curlyleaf pondweed distribution during the peak growing season from 2007 through 2017.

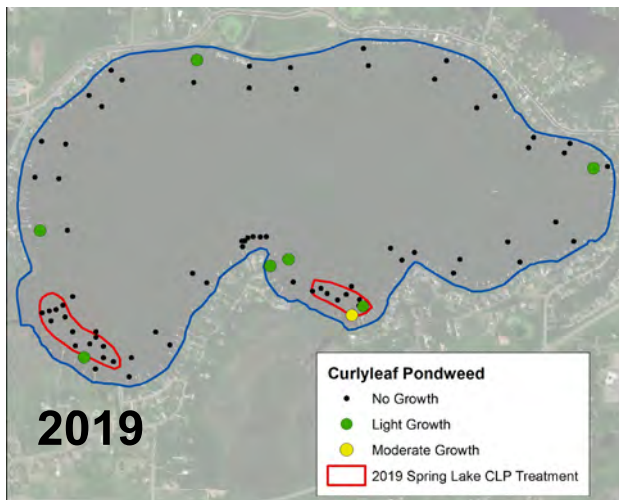
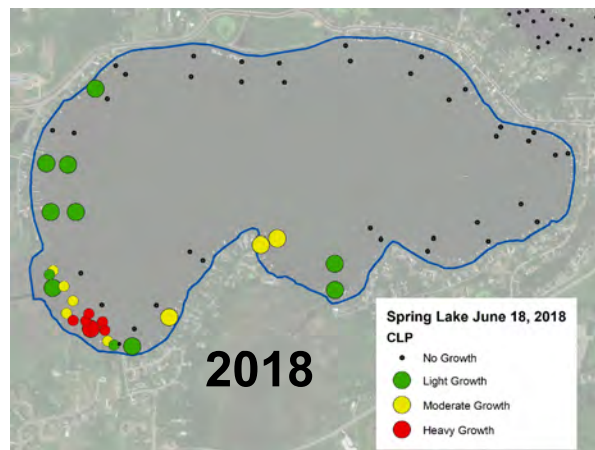
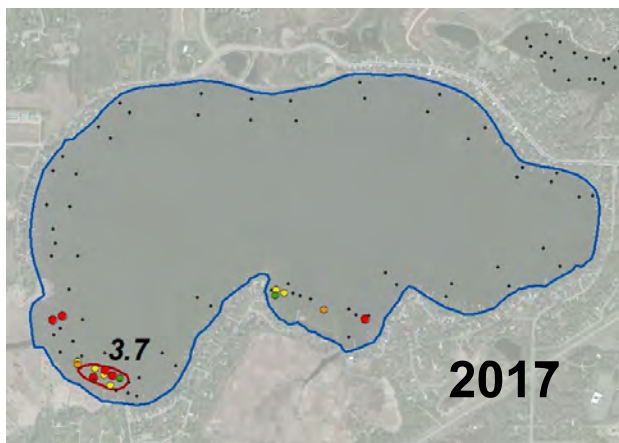
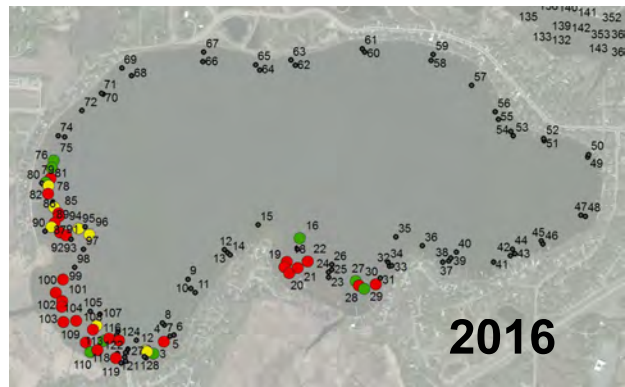
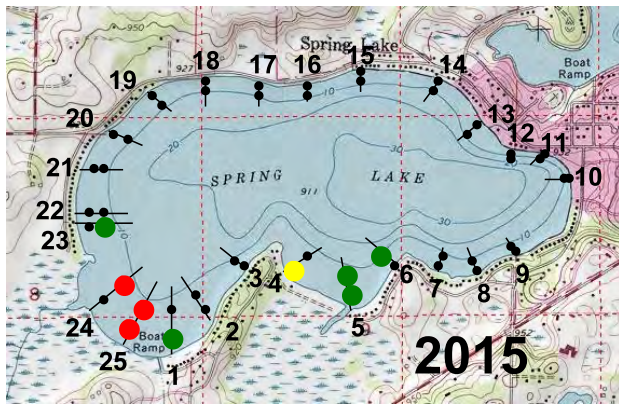


Figure 8. Curlyleaf pondweed distribution during the peak growing season from 2007 through 2019.

Results - Point Intercept Aquatic Plant Survey on August 30, 2019:

Results of the summer aquatic plant survey conducted on August 30, 2019 found 10 submerged aquatic plant species, CLP was not present in August. Plant growth was restricted to water depths of 8 feet or less in Spring Lake (Table 5). Native plants were found around the perimeter of the basin of Spring Lake. Plant distribution and abundance are shown in Table 5.

Table 5. Spring Lake aquatic plant occurrence and density for the August 30, 2019 survey based on 214 sites. Density ratings are 1-3 with 1 being low and 3 being most dense.

Spring Lake August 30, 2019	All Stations (n=214)		
	Occur	% Occur	Average Density
White water lilies (<i>Nymphaea ordata</i>)	10	5	1.0
Coontail (<i>Ceratophyllum demersum</i>)	104	47	1.3
Chara (<i>Chara sp</i>)	4	2	1.3
Moss (<i>Drepanocladus sp</i>)	5	2	1.0
Elodea (<i>Elodea canadensis</i>)	7	3	1.0
Naiads (<i>Najas flexilis</i>)	21	9	1.1
Curlyleaf pondweed (<i>Potamogeton crispus</i>)	--	--	--
Claspingleaf pondweed (<i>P. Richardsonii</i>)	22	10	1.1
Stringy pondweed (<i>P. sp</i>)	8	4	1.0
Sago pondweed (<i>Stuckenia pectinata</i>)	20	9	1.1
Water celery (<i>Vallisneria americana</i>)	50	23	1.3
Water stargrass (<i>Zosterella dubia</i>)	23	10	1.0

Spring Lake Point Intercept Survey Statistics: A summary of plant statistics from the point intercept survey is shown in Tables 6 and 7 and Figure 9. A total of 214 points were sampled and plants were found out to 8 feet of water. Plant occurrence and abundance for individual sites are shown in the Appendix.

Table 6. MnDNR Template Statistics

Total # Points Sampled	214
Depth Range of Rooted Veg	1-8 feet
Maximum Depth of Growth (95%) in feet	5.0
# Points in Max Depth Range	214
# Points in Littoral Zone (0-15 feet)	222
% Points w/ Submersed Native Taxa	68%
Mean Submersed Native Taxa/Point	0.89
Mean Density of Submersed Native Taxa	1.1
# Submersed Native Taxa	10

Table 7. Aquatic plants sampled by depth.

Depth Bin (Feet)	# points sampled	% Sampling points with submersed species observed
0		
1	5	80%
2	30	97%
3	59	98%
4	36	89%
5	34	80%
6	31	3%
7	10	10%
8	9	11%
9	3	0%
10	1	0%
11	0	0%
12	1	0%
13	1	0%
Sites with Plants	214	

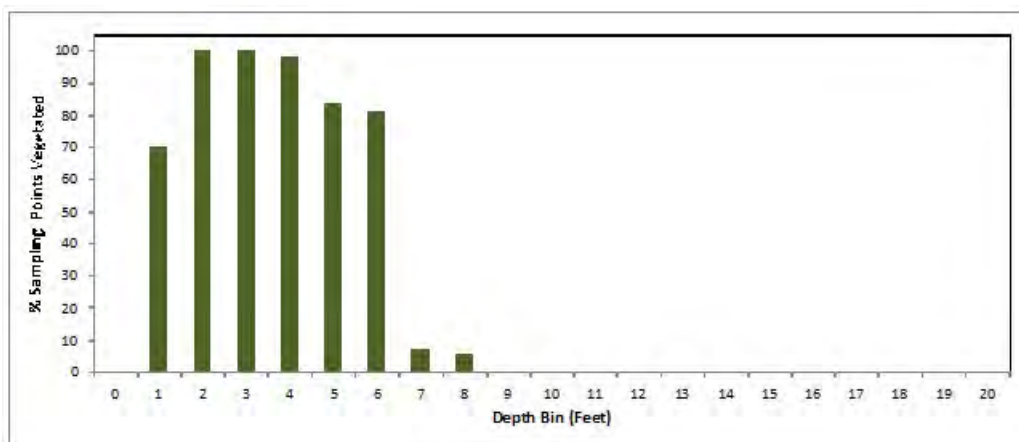


Figure 9. Depth of plant colonization (in feet).

Aquatic Plant Maps: Coverage of the select native plants species found in the August survey are shown in Figures 10 and 11. Native plant coverage was estimated at of the lake area in 2019 (Figure 10).

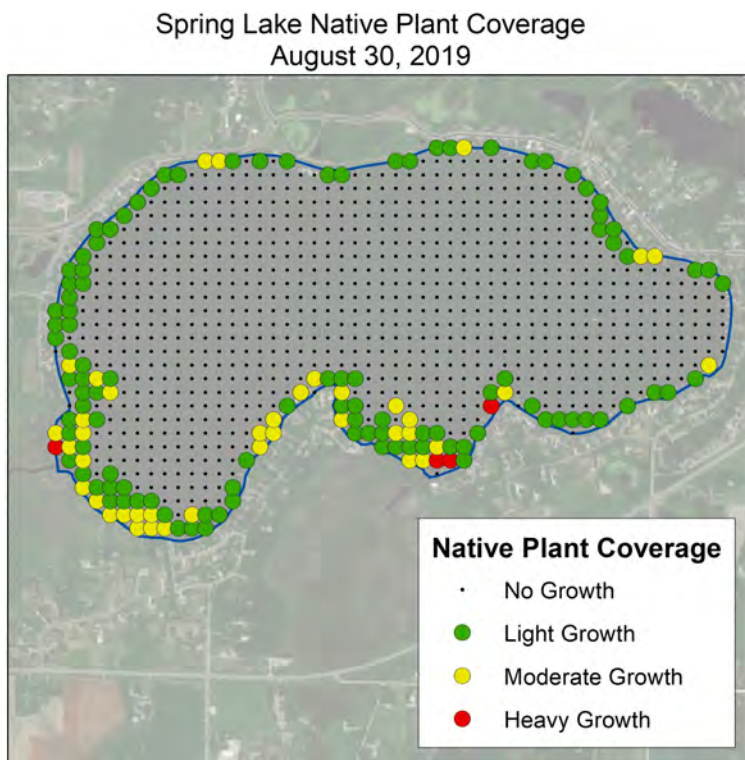
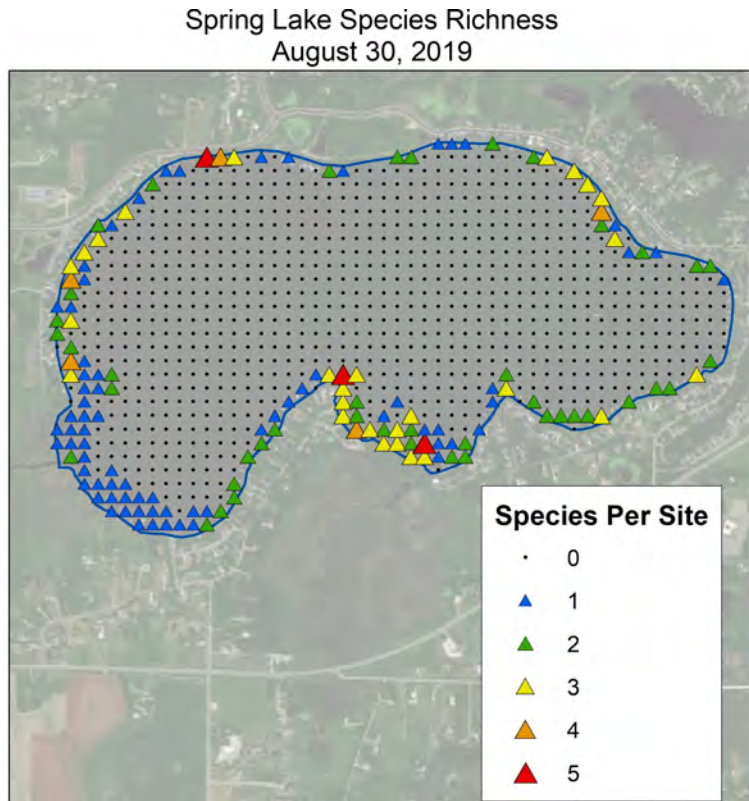


Figure 10. Distribution and abundance maps for native submerged aquatic plant species. Key: green = light growth, yellow = moderate growth, and red = heavy growth.

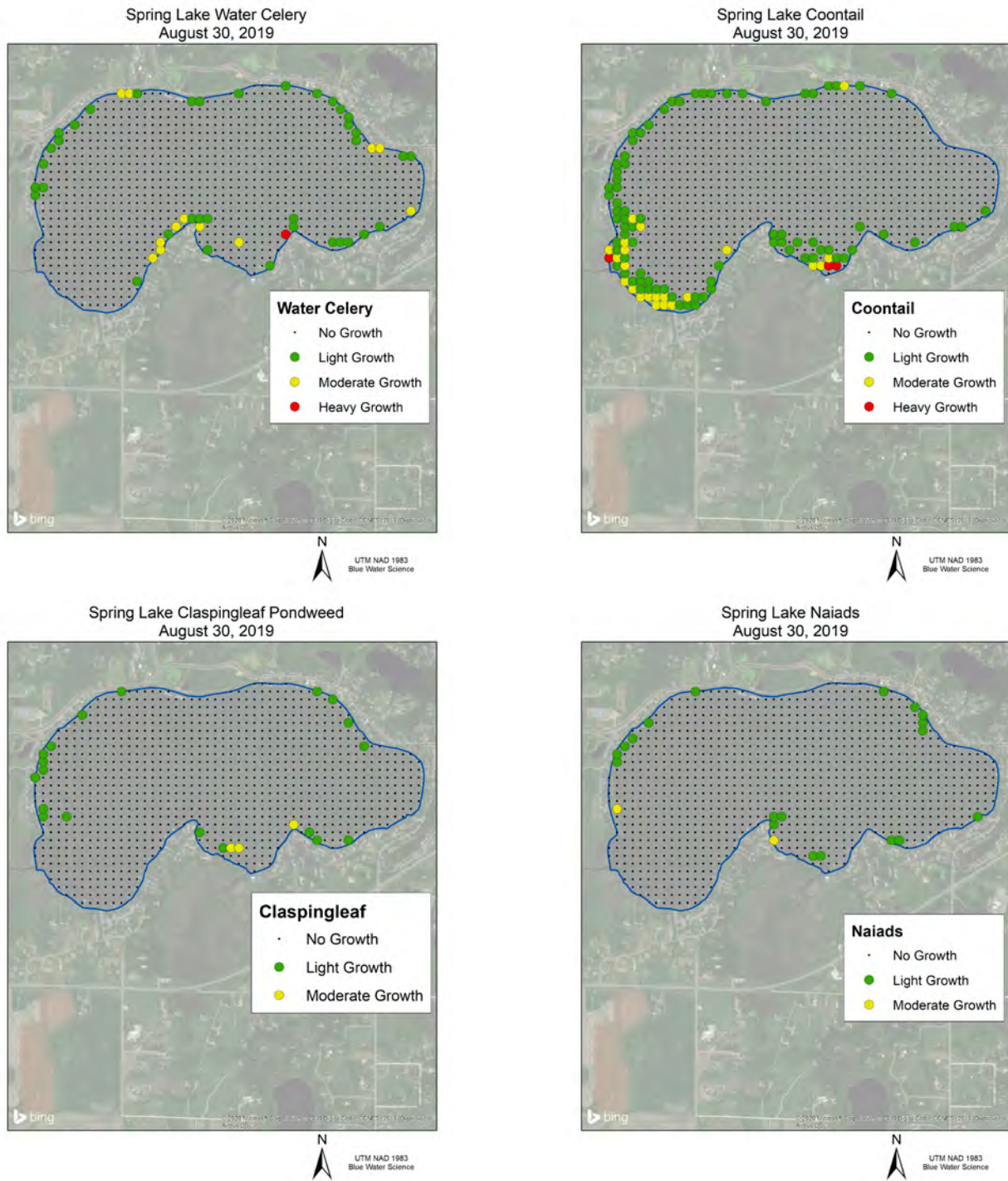


Figure 11. Distribution and abundance maps for select submerged aquatic plant species. Key: green = light growth, yellow = moderate growth, and red = heavy growth.

Comparison of 2015, 2018, and 2019 Point Intercept Surveys

Point intercept surveys were conducted in 2015 and 2018 and results are shown in Table 8. In 2015, elodea was the dominant plant and in 2018 it was coontail. Several species decreased in occurrence from 2015 to 2018 including stringy pondweed and sago pondweed. Several species increased including coontail, claspingleaf pondweed, water celery, and water stargrass. Also the number of submerged plant species increased from 10 in 2015 to 13 in 2018 (Table 8).

Table 8. Spring Lake aquatic plant occurrence for the point intercept surveys conducted in 2015 and 2018.

	2015 % Occur (113 sites)	2018 % Occur (248 sites)	2019 % Occur (214 sites)
Cattails (<i>Typha sp</i>)		1	
Duckweed (<i>Lemna sp</i>)		1	
White water lilies (<i>Nymphaea ordata</i>)		1	5
Coontail (<i>Ceratophyllum demersum</i>)	15	56	47
Chara (<i>Chara sp</i>)	4	2	2
Chara - 2 (<i>Chara sp</i>)		1	
Moss (<i>Drepanocladus sp</i>)		1	2
Elodea (<i>Elodea canadensis</i>)	42	36	3
Naiads (<i>Najas flexilis</i>)	21	23	9
Curlyleaf pondweed (<i>Potamogeton crispus</i>)	12	6	0
Claspingleaf pondweed (<i>P. Richardsonii</i>)	4	10	10
Stringy pondweed (<i>P. sp</i>)	29	7	4
Sago pondweed (<i>Stuckenia pectinata</i>)	17	11	9
Bladderwort (<i>Utricularia vulgaris</i>)		1	
Water celery (<i>Vallisneria americana</i>)	9	20	23
Water stargrass (<i>Zosterella dubia</i>)	5	12	10
Number of submerged species	10	13	10

Native Plant Coverage Comparisons : Native aquatic plant distribution may have decreased slightly from 2015 to 2019 based on point intercept survey results (Figure 12). In 2015, plants grew to a depth of 9 feet and covered an estimated 175 acres of the lake (29%). In 2018, plants were found out to a depth of 8 feet and covered an estimated 122 acres of the lake (198 sites with plants 21%). In 2019, plant coverage was estimated at 98 acres or about 17% of the lake area (150 sites with plants).

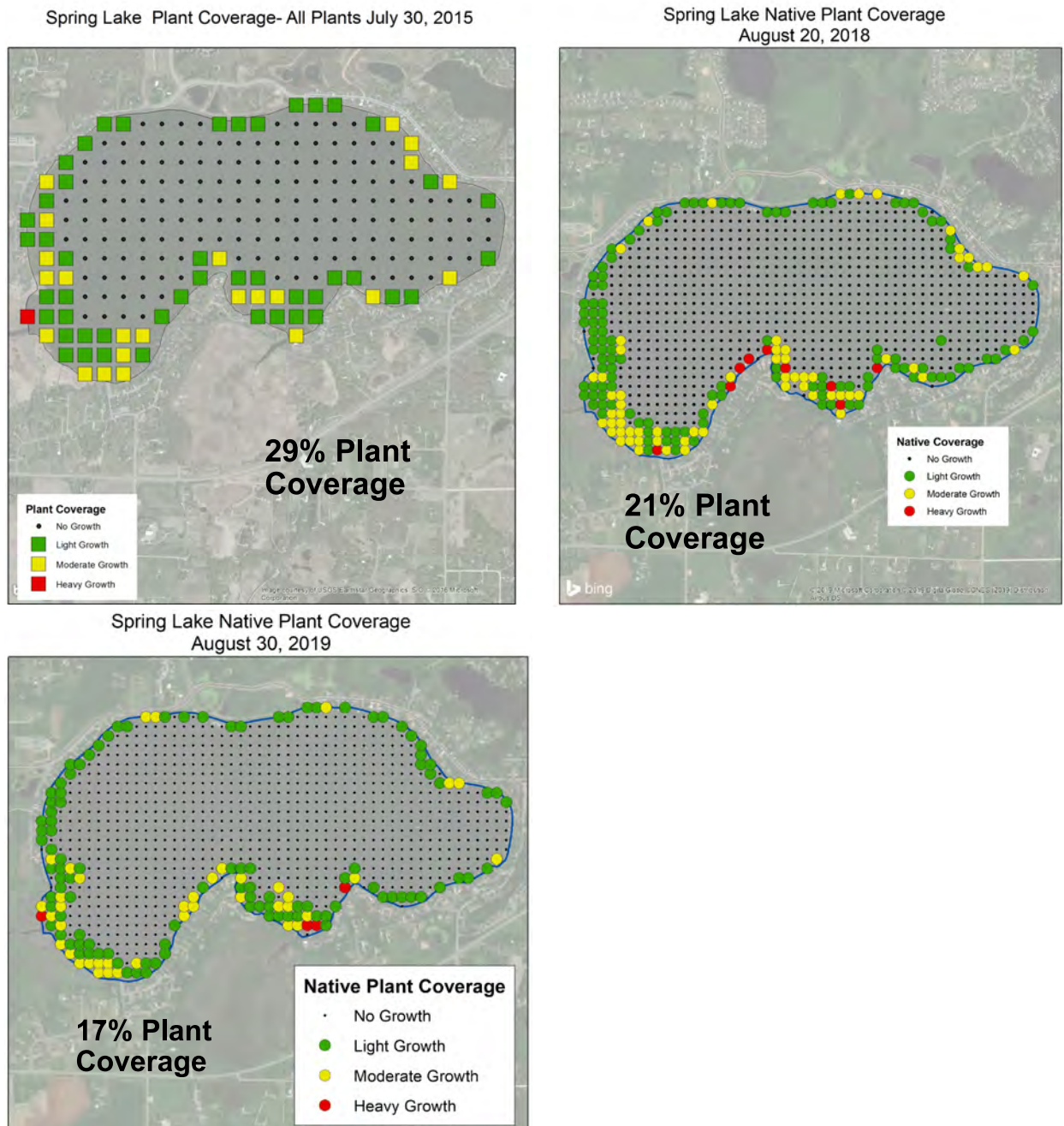


Figure 12. [top left] All plants distribution and abundance for the point intercept survey July 30, 2015. [top right] Native plant distribution and abundance for the August 20, 2018 point intercept survey. [bottom left] Native Plant distribution and abundance for the August 30, 2019 point intercept survey. Key: green = light growth, yellow = moderate growth, red = heavy growth, and black dot = no growth.

Summary of Aquatic Plant Surveys from 1948 - 2018

Since 1948, specific plant species in Spring Lake have appeared and disappeared (Table 9). For a number of years, stringy pondweed, likely a *P. pusillus*, was the dominant plant species. However, in 2018, coontail was the dominant plant (Table 9).

The number of aquatic plant species has range from a low of 5 to a peak of 13 which was recorded in 2018 (Table 9).

A summary of the percent occurrence of aquatic plant species for surveys from 1948 through 2018 is shown in Table 10.

Table 9. Aquatic plant status for 1948 to 2018.

	Dominant Plant Occurrence (% occurrence based on transect surveys, except for 2015 and 2018)	Dominant Species in Mid Summer Survey	Number of Plant Species
1948	Rare (MnDNR)	All rare	7
1973	Rare-Common (MnDNR)	5 - common	8
1982	Rare-Common (MnDNR)	Coontail	8
1986	Present (MnDNR)	3 species	5
1988	Present-Occasional (MnDNR)	Sago + water stargrass	8
2000	40	Curlyleaf	9
2002	36	Sago	9
2004	68	Elodea	9
2005	76	Elodea	9
2006	48	Coontail	8
2007	30	Coontail	6
2008	24	Stringy	9
2009	66	Stringy	9
2010	34	Stringy	7
2011	64	Stringy	6
2012	72	Stringy	4
2013	19	Stringy	5
2014	48	Stringy	5
2015	42 (PI survey)	Elodea	10
2016	38	Elodea	6
2017	86	Stringy	8
2018	56 (PI survey)	Coontail	13
2019	47 (PI survey)	Coontail	10

Table 10. List of aquatic plants found in past surveys. Surveys from 1948 to 1988 were conducted by MnDNR. Surveys in 2000 and 2002 through 2019 were conducted by Blue Water Science. Numbers for plant species in 2000 and 2002 through 2019 represent percent occurrence. Key: A = Abundant, C = Common, O = Occasional, P = Present, R = Rare, and X = Present

Year	1948	1973	1982	1986	1988	2000		2002		2003	2004			2005			2006			
Date (month.day)	9.18	7.9	8.16	7.2	8.15	6.3	9.3	6.7	9.3	5.15	5.2	6.14	8.27	4.20	6.1	8.18	4.26	6.2	9.1	
Secchi disc (ft)	2.6	3.0	3.3	--	2.5	7.0					7.1	7.2	3.5	16.7	6.9	2.0	4.7	5.0	2.0	
Lesser duckweed (<i>Lemna minor</i>)				X	R															
Duckweed (<i>Lemna sp</i>)			O													6				
White waterlilies (<i>Nymphaea sp</i>)																				
Greater duckweed (<i>Spirodela polyrhiza</i>)				X									2							
Coontail (<i>Ceratophyllum demersum</i>)	R	O	A	X	O		29	4	22		13	28	40	8	14	58	16	26	50	
Chara (<i>Chara sp</i>)							4		2			4								
Elodea (<i>Elodea canadensis</i>)			O		O		25	8	18	6	25	48	68	22	54	76	64	68	48	
Moss (<i>Drepanocladus sp</i>)																				
Star duckweed (<i>Lemna trisulca</i>)		C																		
Naiads (<i>Najas flexilis</i>)																				
Berchtold's pondweed (<i>Potamogeton berchtoldi</i>)	R	O																		
Curlyleaf pondweed (<i>P. crispus</i>)			R	X		98	40	86	4	72	78	6	10	58	72	12	64	64	2	
Variable pondweed (<i>P. gramineus</i>)	R	C	O																	
Floatingleaf (<i>P. natans</i>)	R	C			P															
Stringy pondweed (<i>P. pusillus</i>)							2	6	8	2			4		6	8			20	
Claspingleaf (<i>P. Richardsonii</i>)	R	C			O				10				6		2	4			2	4
Stringy pondweed (<i>P. strictifolius</i>)																				2
Narrowleaf pondweed (<i>P. sp</i>)			O	X																
Sago* (<i>Stuckenia pectinata</i>)	R	C			C	40	15		36	2		24	6		6	14				6
Bladderwort (<i>Utricularia sp</i>)																				
Wild celery (<i>Vallisneria americana</i>)			O		P		6		16			2	22		2	32			2	18
Mud plantain* (<i>Zosterella dubia</i>)	R	R	C		C		17		22				24			30				4
Number of submerged species	7	8	7	3	7	2	8	4	9	4	3	6	9	3	7	9	3	6	8	

* *Stuckenia pectinata* = *Potamogeton pectinatus* Mud plantain = water stargrass *Zosterella dubia* = *Heteranthera dubia*

Table 10. Continued.

Year	2007			2008			2009			2010		2011		2012		2013		2014	
Date (month.day)	4.15	6.5	7.13	4.29	6.12	8.13	4.23	6.10	8.19	4.27	6.2	5.12	6.10	4.17	6.5	5.29	6.24	5.21	6.19
Secchi disc (ft)				2.3	3.9		3.5	6.2	2.9		2.2		5.6					15.5	
Lesser duckweed (<i>Lemna minor</i>)			2																
Duckweed (<i>Lemna</i> sp)																			
White waterlilies (<i>Nymphaea</i> sp)																			
Greater duckweed (<i>Spirodela polyrhiza</i>)																			
Coontail (<i>Ceratophyllum demersum</i>)	22	28	30	8	30	16	4	8	24	18	26	16	22	4	30	3	6		16
Chara (<i>Chara</i> sp)		2				8		2		12									
Elodea (<i>Elodea canadensis</i>)	20	6	2			4			4	2	2	2	4	2			2		
Moss (<i>Drepanocladus</i> sp)				1															
Star duckweed (<i>Lemna trisulca</i>)																			
Naiads (<i>Najas flexilis</i>)									6										
Berchold's pondweed (<i>Potamogeton bercholdi</i>)																			
Curlyleaf pondweed (<i>P. crispus</i>)	44	58		5	38	8	10	28	18	50	42	20	36	14	16	5	23	20	36
Variable pondweed (<i>P. gramineus</i>)																			
Floatingleaf (<i>P. natans</i>)																			
Stringy pondweed (<i>P. pusillus</i>)		26																	
Claspingleaf (<i>P. Richardsonii</i>)		2	2		2	2		2	6		4		2			2			
Stringy pondweed (<i>P. sp</i>)	2		2			24		14	66	52	34		64	36	92	5	16		48
Narrowleaf pondweed (<i>P. sp</i>)								2											
Sago* (<i>Stuckenia pectinata</i>)		8	2	1	24	8		24	20		26						16		6
Bladderwort (<i>Utricularia</i> sp)																			
Wild celery (<i>Vallisneria americana</i>)		6	12			18		2	18		4		2		6				10
Mud plantain* (<i>Zosterella dubia</i>)						8			24										
Number of submerged species	4	8	6	4	4	9	2	8	9	5	7	3	6	4	4	4	5	1	5

* *Stuckenia pectinata* = *Potamogeton pectinatus*

Mud plantain = water stargrass

Zosterella dubia = *Heteranthera dubia*

Table 10. Concluded.

Year	2015		2016		2017		2018			2019		
Date (month.day)	5.28	7.30	4.20	6.1	4.14	6.5	5.14	6.18	8.20	4.29	6.10	8.30 ¹
Secchi disc (ft)		4.5										
Lesser duckweed (<i>Lemna minor</i>)												
Duckweed (<i>Lemna sp</i>)							2	1				
White waterlilies (<i>Nymphaea sp</i>)								1				5
Greater duckweed (<i>Spirodela polyrhiza</i>)												
Coontail (<i>Ceratophyllum demersum</i>)		15		32	8	46	8	38	56	41	46	49
Chara (<i>Chara sp</i>)		4		2	6	4	2		2	3	2	2
Chara - 2 (<i>Chara sp</i>)	6	42		38					1			
Elodea (<i>Elodea canadensis</i>)					12	16	10	18	36	9	22	3
Moss (<i>Drepanocladus sp</i>)					2				1		8	2
Star duckweed (<i>Lemna trisulca</i>)		21						2				
Naiads (<i>Najas flexilis</i>)									23		2	10
Berchtold's pondweed (<i>Potamogeton berchtoldi</i>)	22	12	50	18								
Curlyleaf pondweed (<i>P. crispus</i>)					2	26	8	26	6	29	14	
Variable pondweed (<i>P. gramineus</i>)												
Floatingleaf (<i>P. natans</i>)												
Stringy pondweed (<i>P. pusillus</i>)		5										
Claspingleaf (<i>P. Richardsonii</i>)	12	29		38		2			10		14	10
Stringy pondweed (<i>P. sp</i>)						86		62	7		30	4
Narrowleaf pondweed (<i>P. sp</i>)		17										
Sago* (<i>Stuckenia pectinata</i>)									11		6	9
Bladderwort (<i>Utricularia sp</i>)		9							1			
Wild celery (<i>Vallisneria americana</i>)		5		4		4		12	20		8	23
Mud plantain* (<i>Zosterella dubia</i>)	3	10		6		4		10	12	3	22	11
Number of submerged species	4	11	1	7	5	8	4	8	13	5	11	10

* *Stuckenia pectinata* = *Potamogeton pectinatus*

Mud plantain = water stargrass

Zosterella dubia = *Heteranthera dubia*

¹Point Intercept Survey

APPENDIX

Individual sample site data for sites sample in Spring Lake point intercept survey on August 30, 2019.

Site	Depth (ft)	White lilies	Chara	Claspingleaf	Coontail	Elodea	Moss	Naiads	Sago	Stringy	Water celery	Water stargrass	No plants
1	2				2								
2	3				2								
3	3				2								
4	3				1								
5	4				1								
6	3				1				1				
7	2				2								
8	3				2								
9	3				2								
10	4				2								
11	5				1								
12	5												1
13	5				2								
14	5				1								
15	3				1					1			
16	3				2								
17	3				1								
18	4				1								
19	5				1								
20	5				1								
21	6												1
23	6												1
24	6												1
25	5												1
26	2				1					1			
27	2				2								
28	2				1								
29	4				1								
30	5				1								
31	6												1
32	6												1
34	6												1
35	7												1
36	7												1
37	6												1
38	4				1						1		
39	3				1								
40	4												1
41	5				1								
46	9												1
49	7												1
50	6												1
52	2				1	1							
53	3				2								
54	5												1
55	6												1
64	7												1
65	4				1							1	
66	1	1	1		2				1				
67	1	1			2	1							
68	3				3								
69	3				3	1							
70	2	1									1		
71	2				3								
72	3				2								
73	4				1								
74	6												1
84	9												1
85	6												1
86	3								2		2		
87	1	1	1						1				
88	2	1			1				1				
89	1.5				1			1					
90	2	1				1		1	1			1	
91	4				2								
92	5				1								
93	3	1			1								
94	2				2								
95	2				1								
96	4				2								
97	6												1
109	5				2								
110	3								1		2		

Site	Depth (ft)	White lilies	Chara	Claspingleaf	Coontail	Elodea	Moss	Naiads	Sago	Stringy	Water celery	Water stargrass	No plants
111	2	1							1		1	1	
112	3	1			1	1							
113	2			1					1				
114	3			2					1			1	
115	3			2								1	
116	5				1								
117	5				1								
118	6												1
119	6												1
120	2				1								
122	2				1								
123	3				2								
124	5				1								
137	4										2		
138	3				1			2	1				
139	3				1				1				
140	5												1
141	5				1								
142	4												1
143	4				1				1		2		
144	7												1
145	8												1
146	8												1
147	8												1
148	6.5												1
149	2			1				1					
150	2							1				1	
151	3										1	1	
152	5				1						1		
153	3			1							1	1	
155	3				1								
156	6												1
170	4										1		
171	3	1		1	1								
172	4				1				1				
173	6												1
174	6												1
175	8		2										
181	8												1
182	3										3		
183	2												1
184	3			1	1								
185	6												1
189	8												1
190	7												1
191	2										1	1	
193	2				1								
194	3				1								
195	4				2					1			
209	4										2		
210	land												1
211	2							1			2	1	
212	4												1
214	8												1
215	9												1
222	5				1								
223	2			2							1	1	
224	7												1
225	8												1
233	7												1
234	5				1						1		
235	5				1							1	
236	2			1	1				1				
237	4				1								
238	5				2								
239	2			1	1								
240	5												1
254	4										2		
255	3		1								1	1	
256	3					1		1	1		1	1	
257	3							1			1	1	
267	8												1
268	6						1				1		
281	6												1
282	3		1				1	1					
283	3			1	1			2		1			
284	5				1								
285	5.5												1
286	6												1
330	4				1						2		
331	1												1

Site	Depth (ft)	White lilies	Chara	Claspingleaf	Coontail	Elodea	Moss	Naiads	Sago	Stringy	Water celery	Water stargrass	No plants
332	4				1					1			
333	6												1
335	7												1
380	3												1
381	2				1						1		
382	3												1
393	6												1
430	7												1
431	2				1						1		
432	4				1					1	1		
433	6												1
480	10												1
481	2			1									
482	3				1								
483	6												1
530	13												1
531	3			1	1								
532	6												1
579	12												1
580	3			1	1			1			1		
581	5				1								
628	4						1						
629	2			1				1	1				
630	5				1								
675	5										1	1	
676	3						1				1		
677	3			1				1			1		
717	5			1									
718	4										2	1	
719	3										2		
720	4				1			1			1		
758	4						1		1		1		
759	3												1
760	2				1						1		
761	4				1								
797	5							1				1	
798	3										1		
799	3				1			1			1		
834	3			1				1			1	1	
835	4			1									
860													1
869	3							1			1	1	
870	4				1						1		
901	6												1
902	3							1			1	1	
903	3				1								
904	5				1								
915	4				1						1		
916	4										1		
917	5												1
932	6												1
933	3			1							1	1	
934	3			1	1	1		1			2		
935	3				1				1	1	2		
936	4				1					1	1		
937	6												1
938	5				1								
939	4												1
940	4				1								
941	3				1							1	
942	4				1						1		
950	6												1
951	5							1	1				
952	3			1	1						1		
953	3				1								
954	3				1								
955	3				2								
956	3				1						1		
Average		1.0	1.3	1.1	1.3	1.0	1.0	1.1	1.1	1.0	1.3	1.0	
Occur (214 sites)		10	4	22	104	7	5	21	20	8	50	23	72
% occur		5	2	10	49	3	2	10	9	4	23	11	

Individual sample site data for sites sample in Spring Lake point intercept survey on August 20, 2018.

Site	Depth (ft)	Cat-tails	Duck-weed	White lilies	Bladder wort	Chara	Chara-2	Clasp-ingleaf	Coon-tail	CLP	Elodea	Moss	Naiads	Sago	Stringy	Water celery	Water star-grass	Fila. algae	No plants
1	2								2		1								
2	3								1		1								
3	3								3		1								
4	3								2	1	1							1	
5	3								1	1	1								
6	2								1		2								
7	3								2		1								
8	3								2		1								
9	3								2		1								
10	3								1		1								
11	4								2										
12	5								1		1				1				
13	5								1	1	1								
14	4								1	1	2								
15	2							1	1		1			1		1			
16	2								2		1							1	
17	3								2	1	1							1	
18	4								2	1	1								
19	4								2										
20	5								1	1									
21	6								2		1				1				
22	6								1	1					1				
23	5								1										
24	5								1										
25	4								2						1				
26	2								1		2			1					
27	2								2									1	
28	3								2		1								
29	4								2		1								
31	5								1	1									
32	6								1										
33	7																		
37	5																		1
38	3								1		1		1			1			
39	3								1										
40	4								1		2								
41	4								2		1								
42	6										1								
43	7																		1
50	5										1								
51	1			1					2									1	
52	2								1		1								
53	2								1										
54	5								1	1									
55	6								2										
56	7																		1
64	7																		1
65	3												1				2		
66	1							1	1				1						
67	1		2						1					1				1	
68	2		1	2	1				3		1								
69	3								1	1									
70	2		2	1					1		1								
71	2								1		1								
72	2								1		1								
73	3								1	1	1								
74	5								2										
75	6								2										
76	8																		1
85	6									1	1		1						
86	3								1		1		1	1		1			
87	1	3																	
88	2							1	2					1					
89	1							1	1				1						
90	2								2		1			1	1				
91	4								2										

Individual sample site data for sites sample in Spring Lake point intercept survey on August 20, 2018.

Site	Depth (ft)	Cat-tails	Duck-weed	White lilies	Bladder wort	Chara	Chara-2	Clasp-ingleaf	Coon-tail	CLP	Elodea	Moss	Naiads	Sago	Stringy	Water celery	Water star-grass	Fila. algae	No plants
92	4								2	1	1						1		
93	2								1				2		1		1		
94	2								1										
95	3								1										
96	4								1										
97	5								1										
98	7																		1
99	8																		1
108	9																		1
109	4								1		1		1	1	1	1			
110	3								1		1		2	1		3	1		
111	3								2									1	
113	3							2											
114	2							1	1					1					
115	3																1	1	
116	4								3										
117	5								1						1			1	
118	6								1										
119	5																		1
120	3								1		1				1		1	1	
122	1								2										
123	2								2										
124	6								1										
125	8																		1
137	4						1		1		2					1			
138	2							1	1									1	
139	3							2	2		1			1					
140	4						2									1			
141	5								2										
142	4						1		2										
143	3										1			1		1			
144	7																		1
145	9																		1
146	9																		1
147	8																		1
148	4															1			
149	2							1			1		1						
150	1										1		2				1		
151	2												1	1		1	1		
152	4								1		1						1	1	
153	4										1		1				1	1	
154	1	3																	
155	2								1		1			1					
156	5								1		1								
157	8																		1
170	3												1	1		3			
171	2							1	1		1								
172	3								3										
173	5																		1
174	7																		1
175	8																		1
176	9																		1
182	2												1			3		1	
183	2								1				1			1			
184	4								1										
185	5								2		1								
186	5												1	1			1		
187	7																		1
188	8																		1
189	9																		1
190	6								1		1								
191	4										1						1	1	
192	1	2																	
193	2								1							1			
194	4							1	1					1		1			
195	4								1										

Individual sample site data for sites sample in Spring Lake point intercept survey on August 20, 2018.

Site	Depth (ft)	Cat-tails	Duck-weed	White lilies	Bladder wort	Chara	Chara-2	Clasp-ingleaf	Coon-tail	CLP	Elodea	Moss	Naiads	Sago	Stringy	Water celery	Water star-grass	Fila. algae	No plants
209	3										1		1			3	1		
211	1							1	1							2	1	1	
212	3							2	1										
214	10																		1
218	8																		1
222	4												1	1	1	1		1	
223	3							2					1				1		
224	4								1				1			1			
232	10																		1
233	8																		1
234	5															1			
235	4										1				1	1	1		
236	2								1									1	
237	3								1									1	
238	4								1										
239	2													2	1				
255	2							3			1				1		1		
256	2							2					1	1		2	1		
257	2							1					1			2	1		
267	6											1	1						
268	6																		1
269	8																		1
281	4							1								1	1		
282	3							2								2		1	
283	3								1		1							1	
284	3								1		1								
285	5								1										
286	3							2											
302	4												1				1		
303	2							1				1	1	1		2	1		
321	2								1										
330	5												1			1		1	
332	3								1				1						
333	5								1									1	
334	7																		1
351	8																		1
380	4								1		1		1			1	1	1	
381	2								1		1								
382	3								1		1								
383	5								1									1	
431	3										1							1	
432	4									1	1							1	
433	6										1		1						
434	8																		1
480	8											1							1
481	2								1	1			1						
482	3								1				1						
483	5													1					
489	8																		1
533	8																		1
580	3								1		1								
581	3								1		1							1	
582	9																		1
627	5																	2	
628	3												1	1		1			
629	2								1		1								
630	4								1		1								
632	10																		1
641	7																		1
674	11																		1
676	3							1					1			2		1	
677	2							1	1		1		1			1		1	
678	5																		1
679	9																		1
717	4															1			
718	2												1			2		1	

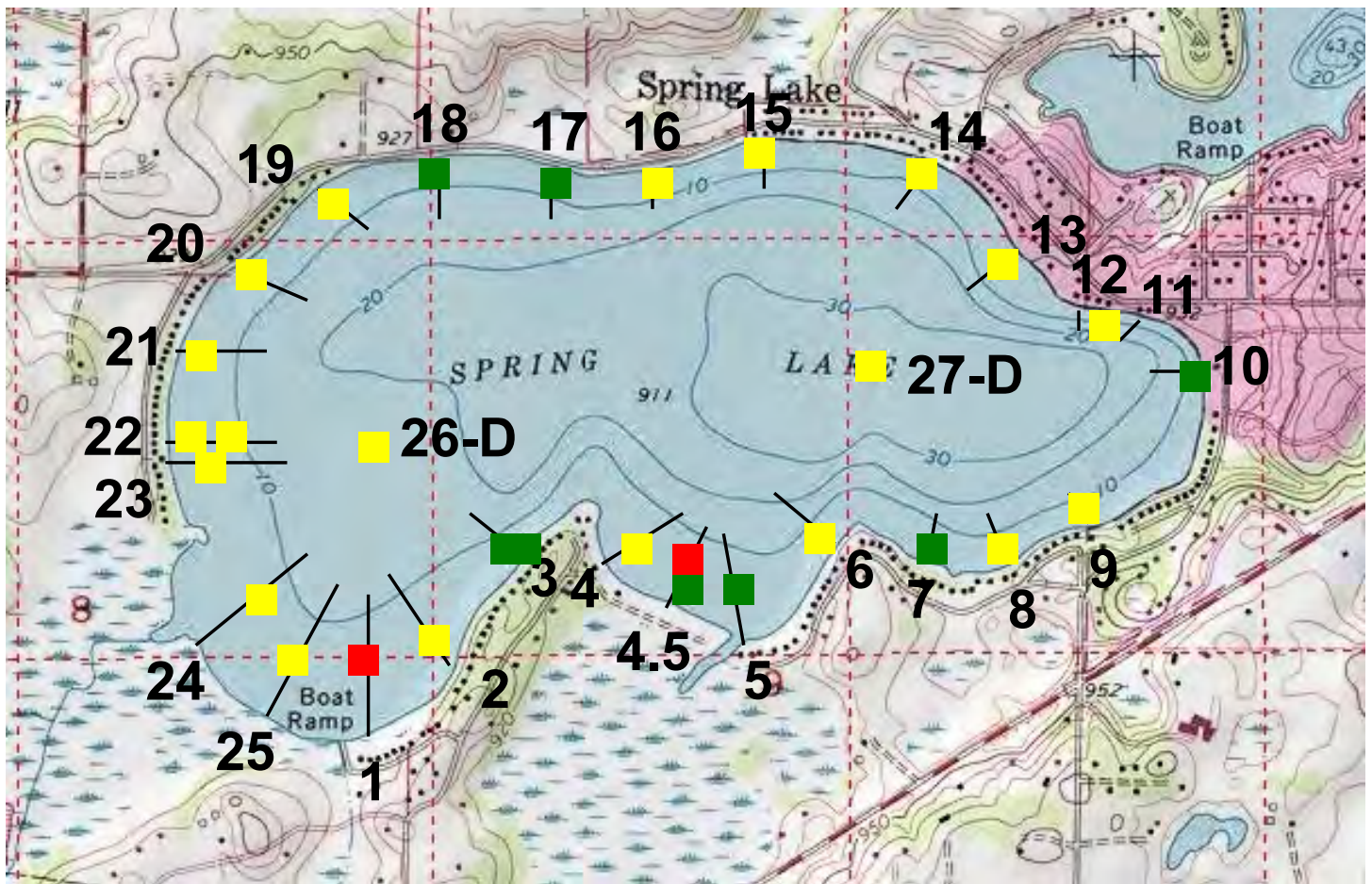
Individual sample site data for sites sample in Spring Lake point intercept survey on August 20, 2018.

Site	Depth (ft)	Cat-tails	Duck-weed	White lilies	Bladder wort	Chara	Chara-2	Clasp-ingleaf	Coon-tail	CLP	Elodea	Moss	Naiads	Sago	Stringy	Water celery	Water star-grass	Fila. algae	No plants
719	3												1			2	1		
720	3								1		1			1		1			
721	7																		1
758	3													1		2			
759	2															2			
760	2										1		1		1	1			
761	3								1		1		2						
762	8																		1
797	4												1	1					
798	3							2						1		1			
799	3								1		1							1	
800	7																		1
833	6																		1
834	3												1				1		
835	3								1		1		1					1	
836	7																		1
868	4																	1	
869	3								1				2						
870	5								2		1								
871	6								1										
872	9																		1
901	5							1	1		1		1					2	
902	3												1			1			
903	4								1										
904	4								1									1	
905	6																		1
913	8																		1
914	8																		1
915	4					1							1			1			
916	4					1					1							1	
917	4					1			1										
932	5								1		1		1						
934	3								1		1		1			1			
935	3								1		1			1		1			
936	4								1		1		1		1				
937	4								2		1								
938	4								1		1								
939	4												1			1	1	1	
940	4								1		1		1			1	1		
941	3								1		1			1		1			
942	4					1			1		1		1					1	
943	7								1						1		1		
945	9																		1
950	5								1								1	1	
951	4												1						
952	3												1			1			
953	3					1			1		1		1		1	2			
954	3								1		1					1			
955	3					2			1		1								
956	4								2		1		1						
Average		2.7	1.7	1.3	1.0	1.2	1.3	1.4	1.3	1.0	1.1	1.0	1.1	1.0	1.0	1.4	1.0	1.0	
Occur (248 site)		3	3	3	1	6	3	25	138	16	89	3	56	28	17	49	29	41	50
% occur		1	1	1	0	2	1	10	56	6	36	1	23	11	7	20	12	17	

Spring Lake Curlyleaf Growth Potential Based on Lake Sediment Characteristics

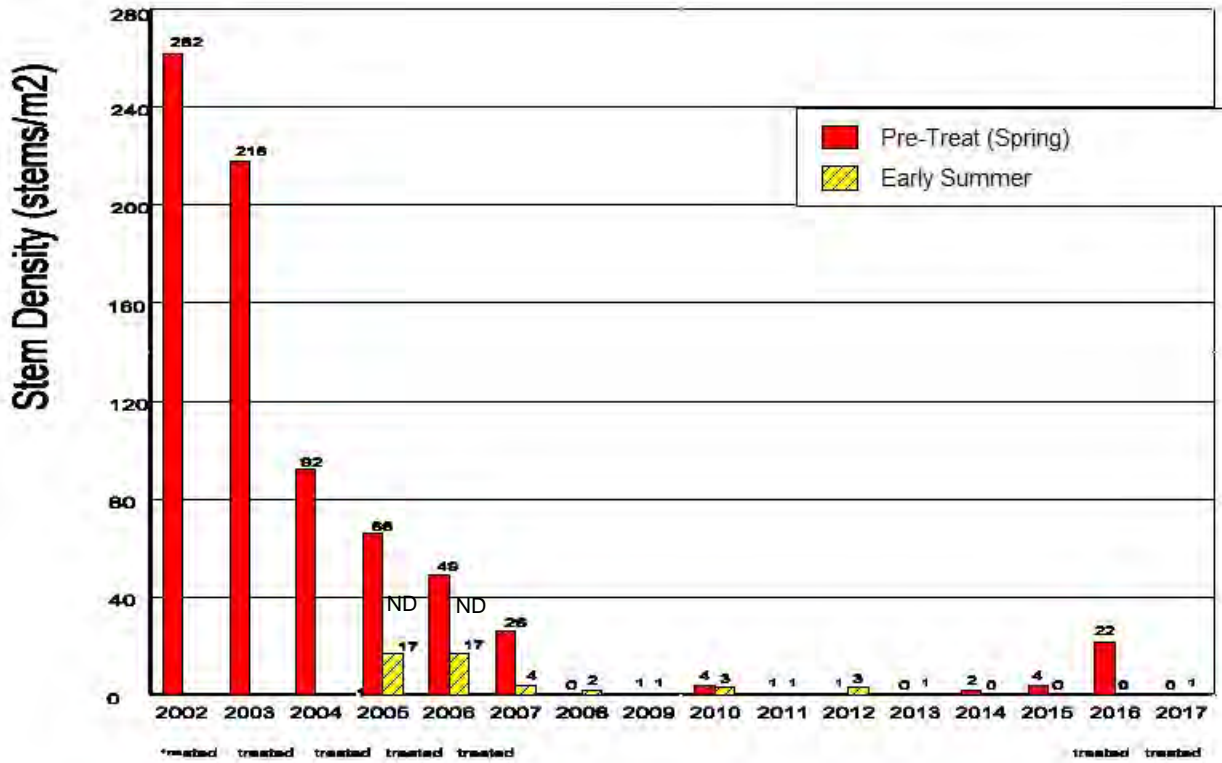
A Spring Lake sediment survey was conducted on August 13, 2008. Lake sediment sampling results from 2008 have been used to predict lake bottom areas that have the potential to support heavy curlyleaf pondweed plant growth. Based on the key sediment parameters of pH, sediment bulk density, organic matter, and the Fe:Mn ratio (McComas, unpublished), the predicted growth characteristics of curlyleaf pondweed are shown in below.

Except for two sites, curlyleaf pondweed growth is predicted to produce mostly light to moderate growth around the lake based on lake sediment characteristics.



Sediment sample locations are shown with a square. The square color indicates the potential for curlyleaf pondweed growth to occur at that site. Key: green = light; yellow = moderate; red = heavy. A key that illustrates the three types of growth is shown on the next page.

Curlyleaf Plant Density from 2002 - 2017: The 2 established sites (Transects 4.5 and 22) were sampled again in 2017. Rake sampling was used to collect curlyleaf stem densities at 4 feet and 5 feet for 10 sites at each depth at 2 locations in early and late season dates. Data from the two sites (n=40) for each date are shown below. Curlyleaf stem densities have been very low since 2007.



Curlyleaf stem densities (stems/m²) for early season and late season monitoring (using scuba diving) for 2002-2017 (ND = no data).