



White Waterlilies in Spring Lake on August 20, 2018

Aquatic Plant Surveys and Curlyleaf Pondweed Evaluation for Spring Lake, Scott County, Minnesota in 2018

No Open Lake Herbicide Application in 2018

Curlyleaf Pondweed Meandering and Transect Surveys: May 14, 2018
Curlyleaf Pondweed Post Treatment Meandering and Transect Survey: June 18, 2018
Summer Point Intercept Plant Survey: August 20, 2018

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Summary

Early Season Delineation and Assessment: Curlyleaf pondweed distribution and abundance were delineated in Spring Lake on May 14, 2018 to determine if curlyleaf control was needed. Curlyleaf growth was observed at 22 out of 87 samples sites (Figure S1). Growth ranged from light to heavy. An area of 8.56 acres on the southwest side of Spring Lake was projected to produce significant growth in the peak growing timeframe in June. However, open water curlyleaf pondweed was not treated in 2018.

A follow-up survey was conducted on June 18, 2018 to check the status of curlyleaf pondweed and native plant community in Spring Lake. Moderate to heavy growth was observed in patches the SW side of Spring Lake. Curlyleaf growth was mostly light in other areas of Spring Lake (Figure S2).

Except for 2016 and 2017, there has been no open water curlyleaf treatment in Spring Lake from 2007 through 2018.

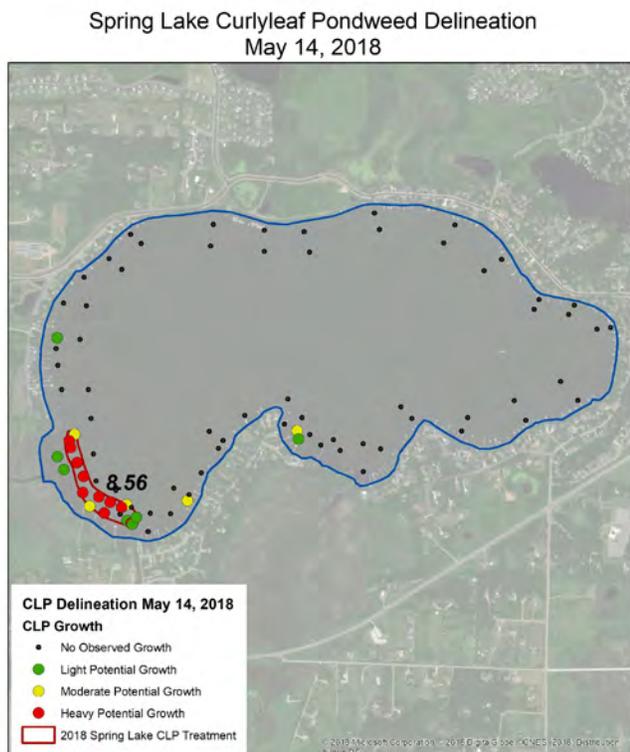


Figure S1. Map of curlyleaf pondweed for May 14, 2018. Red outlined areas indicates curlyleaf pondweed treatment area.

Key: green = light growth, yellow = moderate growth, red = heavy growth, and black = no growth.

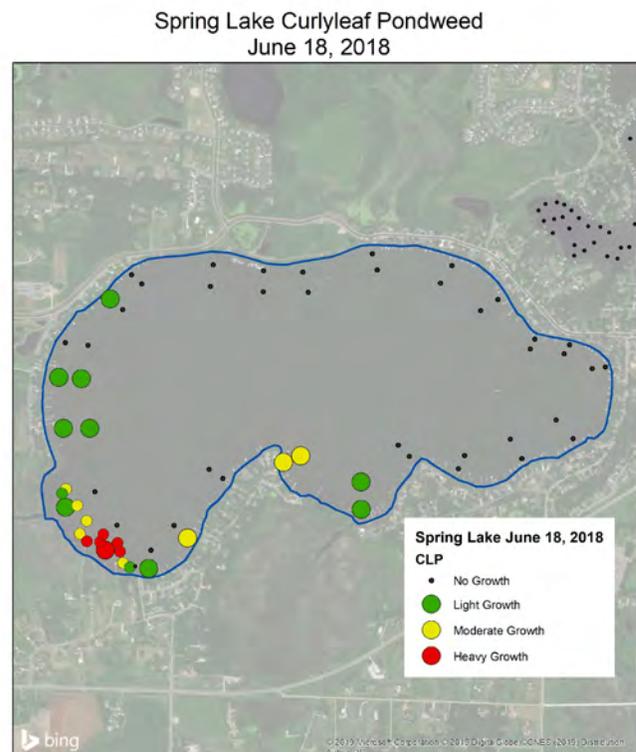


Figure S2. Map of curlyleaf pondweed for June 18, 2018. Key: green = light growth, yellow = moderate growth, red = heavy growth, and black = no growth.

Point Intercept Survey: A total of 248 points spaced 50 meters apart, were sampled on August 20, 2018. Results of the summer aquatic plant point intercept survey conducted on August 20, 2018 found 13 submerged aquatic plant species with 12 native plant species and 1 non-native plant species present. Plant growth was restricted to water depths of 8 feet or less in Spring Lake. Native plants were found around the perimeter of the basin of Spring Lake.

Native aquatic plants were estimated to cover 21% of the lake bottom (124 acres)(Figure S3). Coontail was the dominant aquatic plant. The 13 aquatic plant species found in this survey are the highest plant diversity since the first plant survey was conducted in 1948.

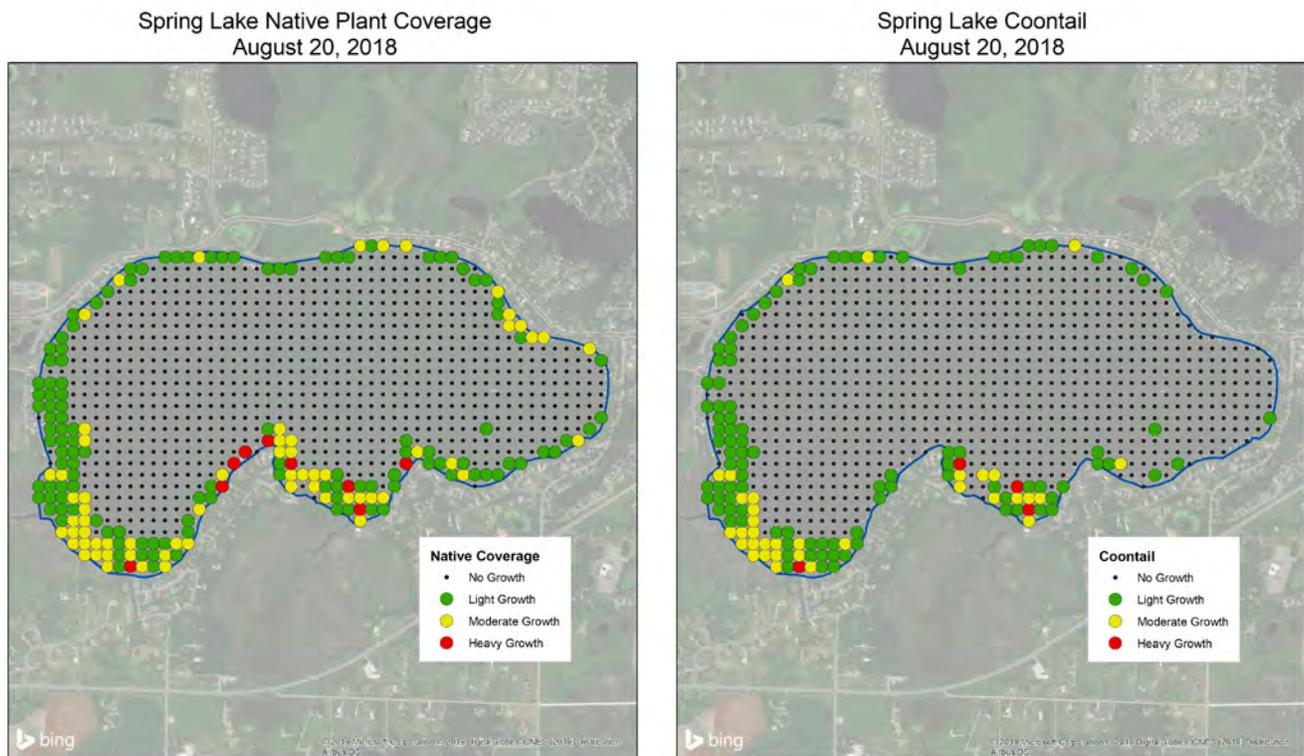


Figure S3. [left] Native plant distribution and abundance for the August 20, 2018 point intercept survey. [right] Coontail distribution and abundance for the August 20, 2018 point intercept survey. Key: green = light growth, yellow = moderate growth, red = heavy growth, and black dot = no growth.

Aquatic Plant Surveys and Curlyleaf Pondweed Evaluation for Spring Lake, Scott County, Minnesota in 2018

Introduction

Spring Lake has an area of 592 acres with a littoral area of 290 acres (source: MnDNR). A curlyleaf pondweed delineation survey was conducted on May 14, 2018. Fifty sample locations on 25 transects are shown in Figure 1 as well as areas where curlyleaf has been found in the past.

A curlyleaf pondweed assessment was conducted on June 18, 2018.

A summer aquatic plant point-intercept survey was conducted July 30, 2015 to assess both curlyleaf growth as well as the native plant community 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.

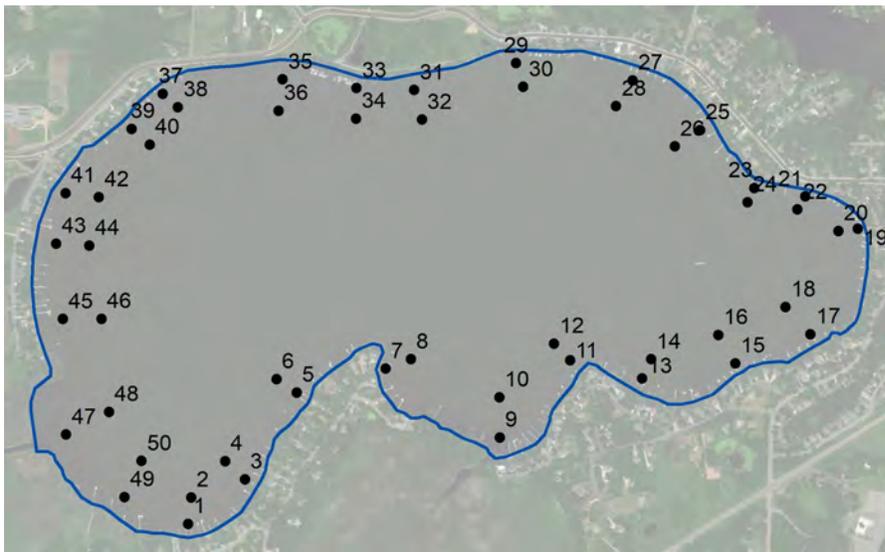


Figure 1. Sample sites for whole lake plant surveys are shown with black numbers.

Survey Methods for the Point Intercept Survey: An aquatic plant point-intercept survey of Spring Lake was conducted by Blue Water Science on August 20, 2018. A total 248 points in the littoral zone out to 15 feet were sampled. Sample points were spaced 50 meters apart on a grid that covered the lake (Figure 2). 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, a plant distribution map was constructed.

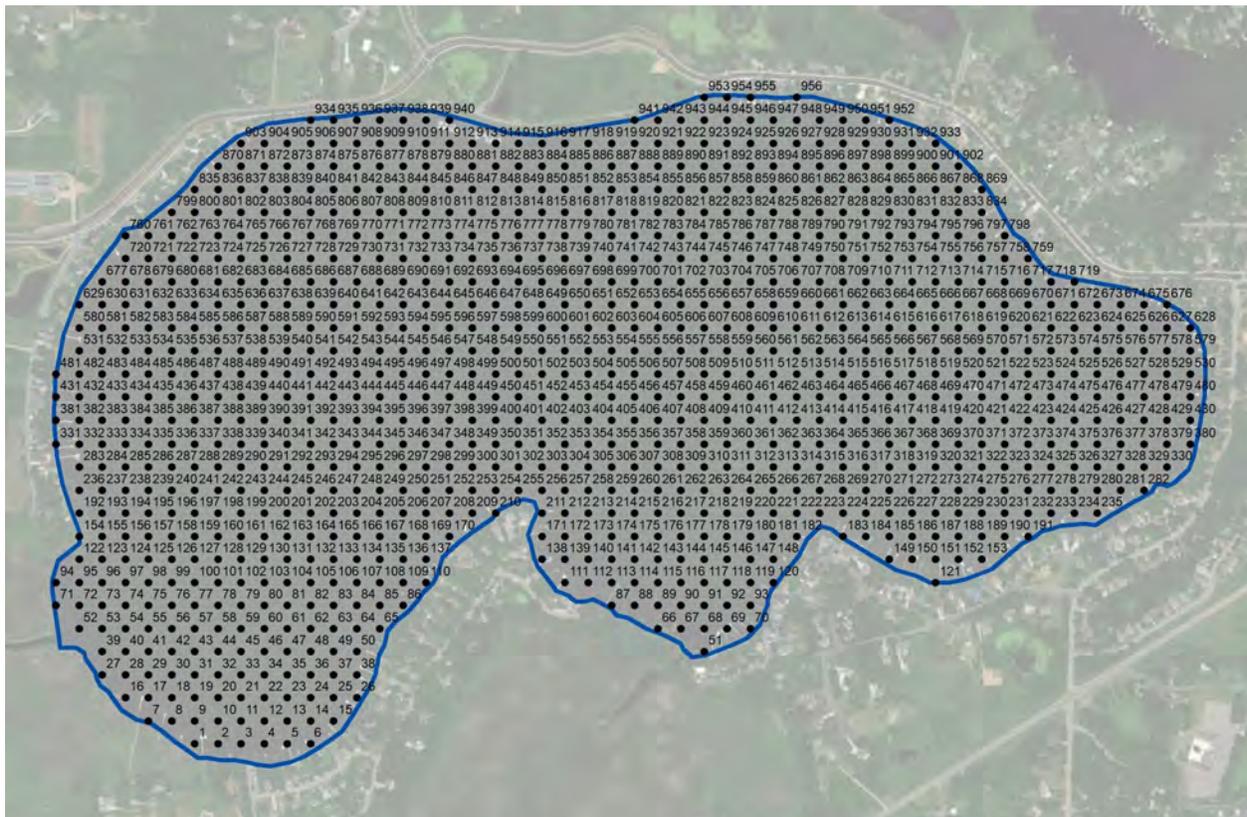


Figure 2. Point-intercept sample sites for Spring Lake in 2018. Sample sites were spaced 50 meters apart.

Results of Curlyleaf Pondweed Delineation Combined with an Early Season Aquatic Plant Survey, May 14, 2018: A curlyleaf survey using a meandered survey and an aquatic plant line-transect survey was conducted on May 14, 2018. Curlyleaf was found at 22 out of 87 sites (Table 1 and Figure 3). Several sites were found with moderate to heavy growth potential.

Spring Lake Curlyleaf Pondweed Delineation May 14, 2018

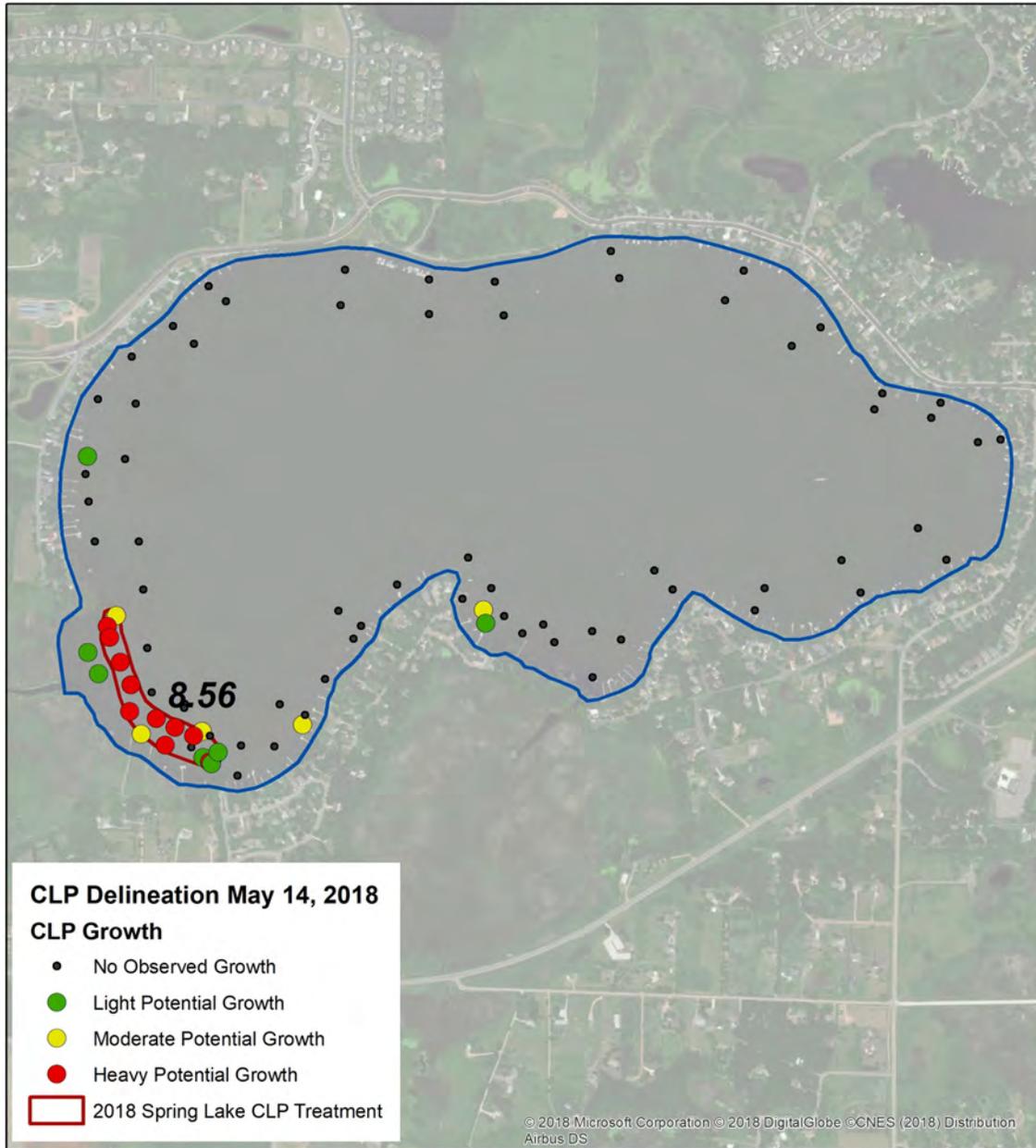


Figure 3. Map of curlyleaf pondweed for May 14, 2018. Colored sample areas indicate the growth in May of 2018 for curlyleaf pondweed. Key: green = light potential growth, yellow = moderate potential growth, red = heavy potential growth, and black dot = no curlyleaf.

Table 1. Aquatic plant densities based on rake sampling for May 14, 2018. Densities are based on a scale from 1 to 3 with 3 being the densest. Curlyleaf stems per rake sample were also noted. Gray shading indicates additional sites that were sampled. .

Way points	Site	Depth (ft)	CLP-stems	Chara	Coon-tail	Elodea	No plants
	1	5					1
	2	7					1
	3	4	3			1	
	4	7					1
	5	4					1
	6	8					1
	7	4					1
	8	6					1
	9	3					1
	10	6			1	1	
	11	5					1
	12	7					1
	13	5			1	1	
	14	7					1
	15	5					1
	16	10					1
	17	5					1
	18	8					1
	19	5					1
	20	8					1
	21	4		1			
	22	9					1
	23	5					1
	24	8					1
	25	4					1
	26	8					1
	27	5					1
	28	7					1
	29	5			1	1	
	30	8					1
	31	5					1
	32	8					1
	33	4					1
	34	7					1
	35	5				1	
	36	9					1
	37	5					1
	38	7					1
	39	4					1
	40	7					1
	41	3					1
	42	8					1
	43	4	1				
	44	7					1
	45	5			1		
	46	7					1
	47	4	2				
	48	9					1
	49	4	10				
	50	8					1

Way points	Site	Depth (ft)	CLP-stems	Chara	Coon-tail	Elodea	No plants
1		6			1		
2		6					1
3		5					1
4		6				1	
5		6					1
6		3					1
7		5	3		1		
8		5	2				
9		6			1		
10		4					1
11		5		2	1		
12		4		1			
13		8					1
14		4					1
15		6			1	1	
16		6					1
17		9					1
18		6	3				
19		5	5				
20		6	9				
21		5	1		1		
22		6	4			1	
23		7					1
24		5	5				
25		4	3		1		
26		6	6				
27		8					1
28		6	3		1		
29		1	1		1		
30		5	4				
31					1	1	
32		6	10				
33		6	6			1	
34		6	6				
35		4	1		1	1	
36		6	2		1	1	
37		7					1
Average			4.1	1.3	1.0	1.0	
Occurrence (87 sites)			22	3	16	12	52

Curlyleaf Delineations for May 21, 2014, May 28, 2015, April 20, 2016, April 14, 2017, and May 14, 2018: Full aquatic plant surveys using transects were combined with additional sampling to delineate areas of predicted heavy growth of curlyleaf in 2014, 2015, 2016, 2017, and 2018 (Figure 4). Based on the curlyleaf plant survey 4 areas of potential heavy curlyleaf growth were delineated in 2014 and are shown in Figure 4. Similar areas were found with the potential for heavy curlyleaf growth in 2015 and 2016. However in 2017 and 2018 only 1 area was delineated for treatment.

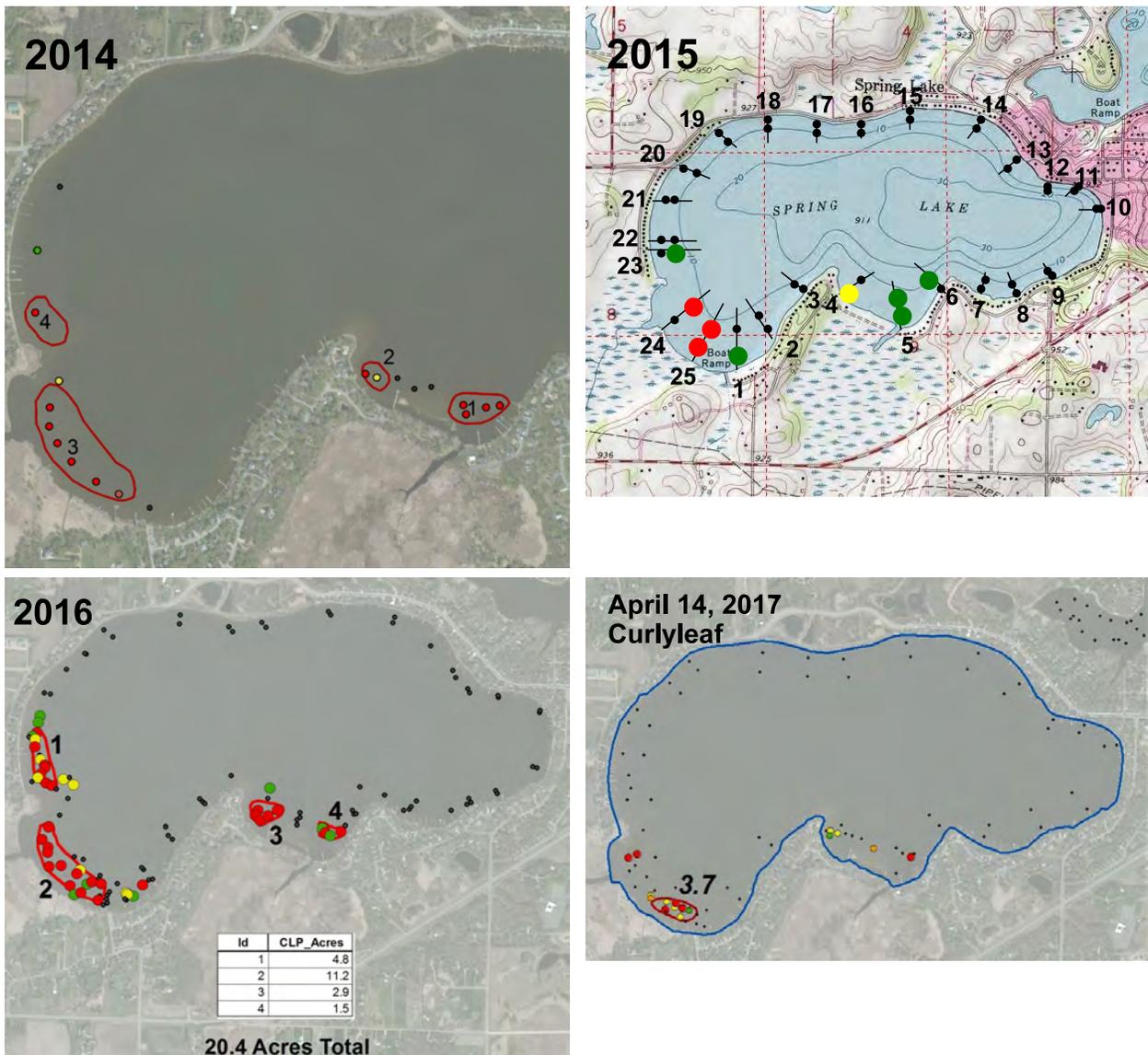


Figure 4. [top-left] Curlyleaf delineation in Spring Lake on May 21, 2014. [top-right] Curlyleaf delineation in Spring Lake on May 28, 2015. [bottom-left] Curlyleaf delineation in Spring Lake on April 20, 2016. [bottom-right] Curlyleaf delineation in Spring Lake on April 14, 2017. Key: black dot = no 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

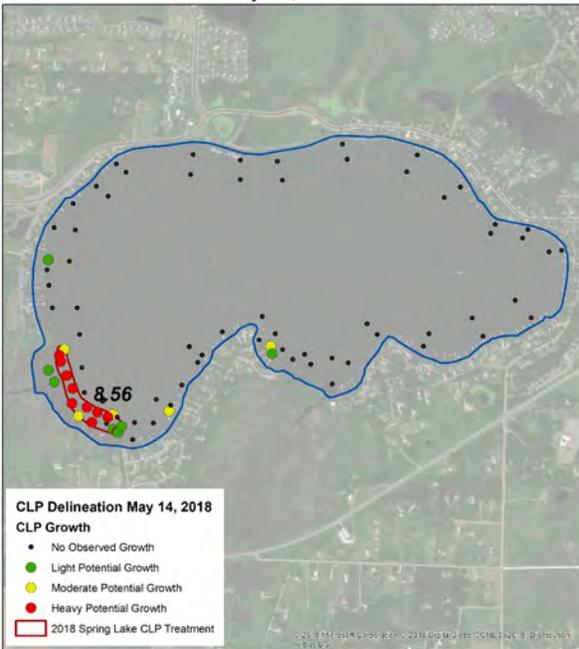


Figure 4. Concluded. Curlyleaf delineation in Spring Lake on May 14, 2018.

Key: Green dots = light curlyleaf growth, yellow dots = moderate growth, and red dots = heavy growth. Black dots = no curlyleaf.

Curlyleaf Pondweed Assessment, June 18, 2018: A curlyleaf assessment was conducted on June 18, 2018 and curlyleaf was found at 13 out of 50 transect sample sites and at a number of meander points (Figure 5). Curlyleaf did not expand significantly compared to the May 14, 2018 delineation. A table of results for individual sample sites is found in Table 2.

Spring Lake Curlyleaf Pondweed June 18, 2018

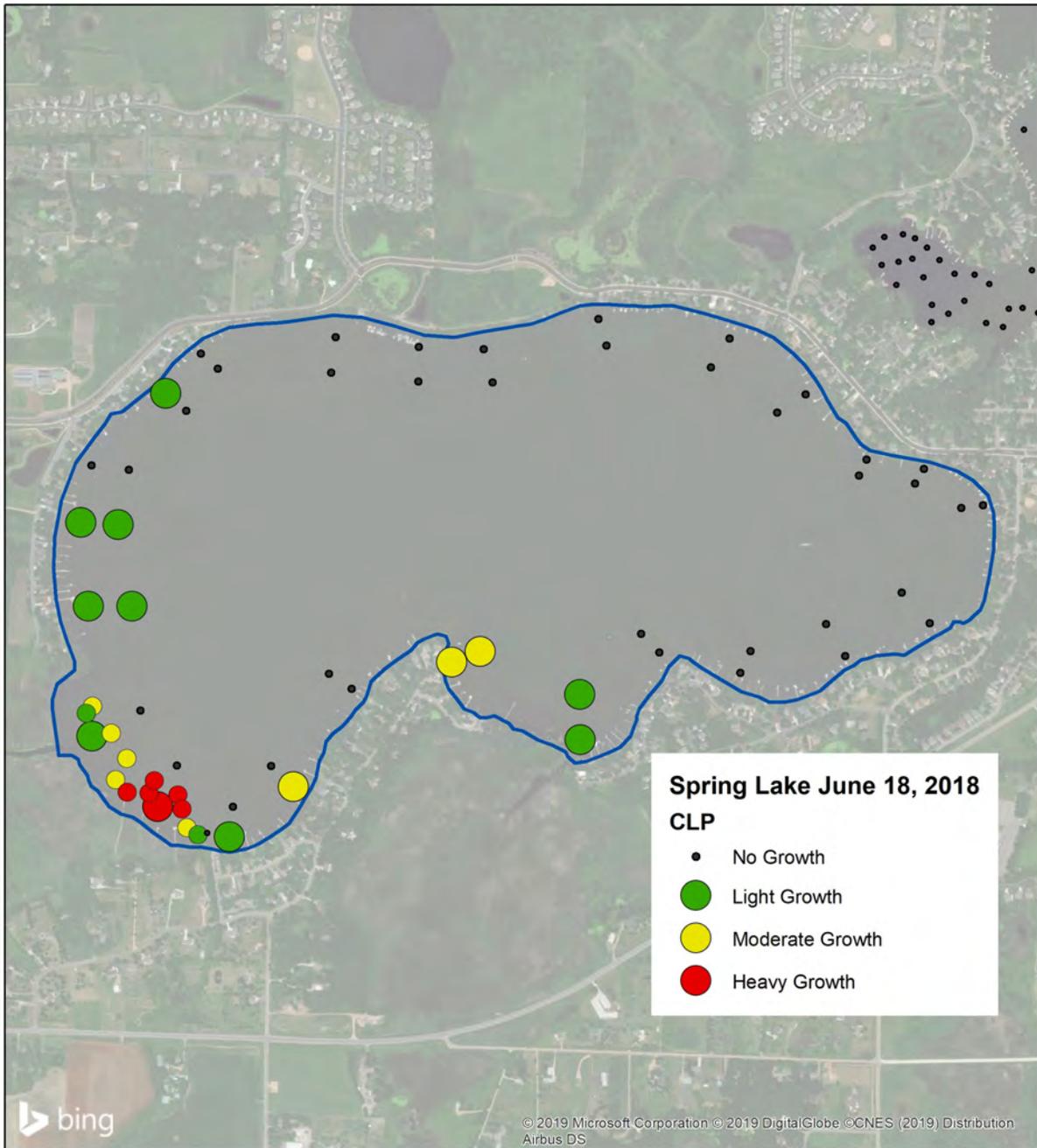


Figure 5. Curlyleaf pondweed assessment on June 18, 2018.
Key: green = light growth, yellow = moderate growth, red = heavy growth, and black = no curlyleaf.

Table 2. Aquatic plant densities based on rake sampling for June 18, 2018. Densities are based on a scale from 1 to 3 with 3 being the densest.

Way Point	Site	Depth (ft)	Duck-weed	Chara	Coontail	CLP	Elodea	Star duckweed	Stringy	Water celery	Water stargrass	FA	No plants
	1	5			1	1			1			1	
	2	7										1	1
	3	4				2			2			1	
	4	8											1
	5								2	1			
	6	8							1				
	7	4				2			1			1	
	8	7			1	2			2			1	
	9	4			3	1							
	10	7			1	1			2				
	11	4			1					1			
	12	7			2		2						
	13	4							1	1	1		
	14	7			1		1		2				
	15	4							1			1	
	16	7					1					2	
	17	4									1	1	
	18	7										1	1
	19	4							1			1	
	20	7										1	1
	21	4							2	1			
	22	7							1				
	23	4								1	1	1	
	24	7									1	1	
	25	4								1		1	
	26	7										1	1
	27	4			1		1		1			1	
	28	7										1	1
	29	5			1				2				
	30	7							1			1	
	31	4			1				1			2	
	32	7			1				3		1	1	
	33	4					1		1			1	
	34	7					1					1	
	35	4			1				2			1	
	36	7			1				2				
	37	4			1				3			1	
	38	7			1				1				
	39	4				1			1			1	
	40	7					1		2				
	41	4							3				
	42	7							1			1	
	43	4				1			2			2	
	44	7				1							
	45	4			1	1			3			2	
	46	7		1	1	1							
	47	4	1		3	1	1	1					
	48	8											1
	49	5			2	3	1		1				
	50	7							1				
1		5	1		1	2	3						
2		5	1		3	1							
3		6			2	2	2						
4		6			2	2							
5		4	2		3	2	1	1				1	
6		4	1		2	3			1				
7		5			2	3							
8		5			2	3							
9		6			1	3							
10		5				3							
11		4			1	2						2	
12		4	1			1	2					2	
13		4			1		1					1	
Average			1.2	1.0	1.5	1.8	1.4	1.0	1.6	1.0	1.0	1.2	
Occurrence (63 sites)			6	1	30	25	14	2	32	6	5	32	7

Summary of Curlyleaf Pondweed 2000 to 2018

Curlyleaf pondweed growth has been variable from 2000 through 2018 but there has been less curlyleaf from 2007 through 2018 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 6, 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			



Figure 6. Curlyleaf pondweed growth was very heavy in 2000.

Curlyleaf Pondweed Density at Individual Sites from 2000-2018: Curlyleaf growth was light 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	1	0	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	1	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		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	
1	S	0	0	0	0	1	1	0	1	2	0	1	1	0	0	0	1	
	M	0	0.5	0	0	0	0	0	0	0	1	2	1	0	0	0	0	Heavy
2	S	0.5	0	0	0	0	0	0	0	0	0	0	0	1	2	2		
	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		
	M	0	0.5	0	0	0	1	0	0	0	1	1	0	0	0	0	2	
5	S	0	2.5	0	0	0	0	2	2	2	0	0	0	0	0	0	1	
	M	0	0.3	0	1	0	3	2	0	2	1	0	0	0	0	0	1	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	
	M	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	Moderate
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	0	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	0	2	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	
	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	
	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	
	M	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	Moderate
21	S	0.5	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	
	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	0	1	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	0	1	1
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 2018

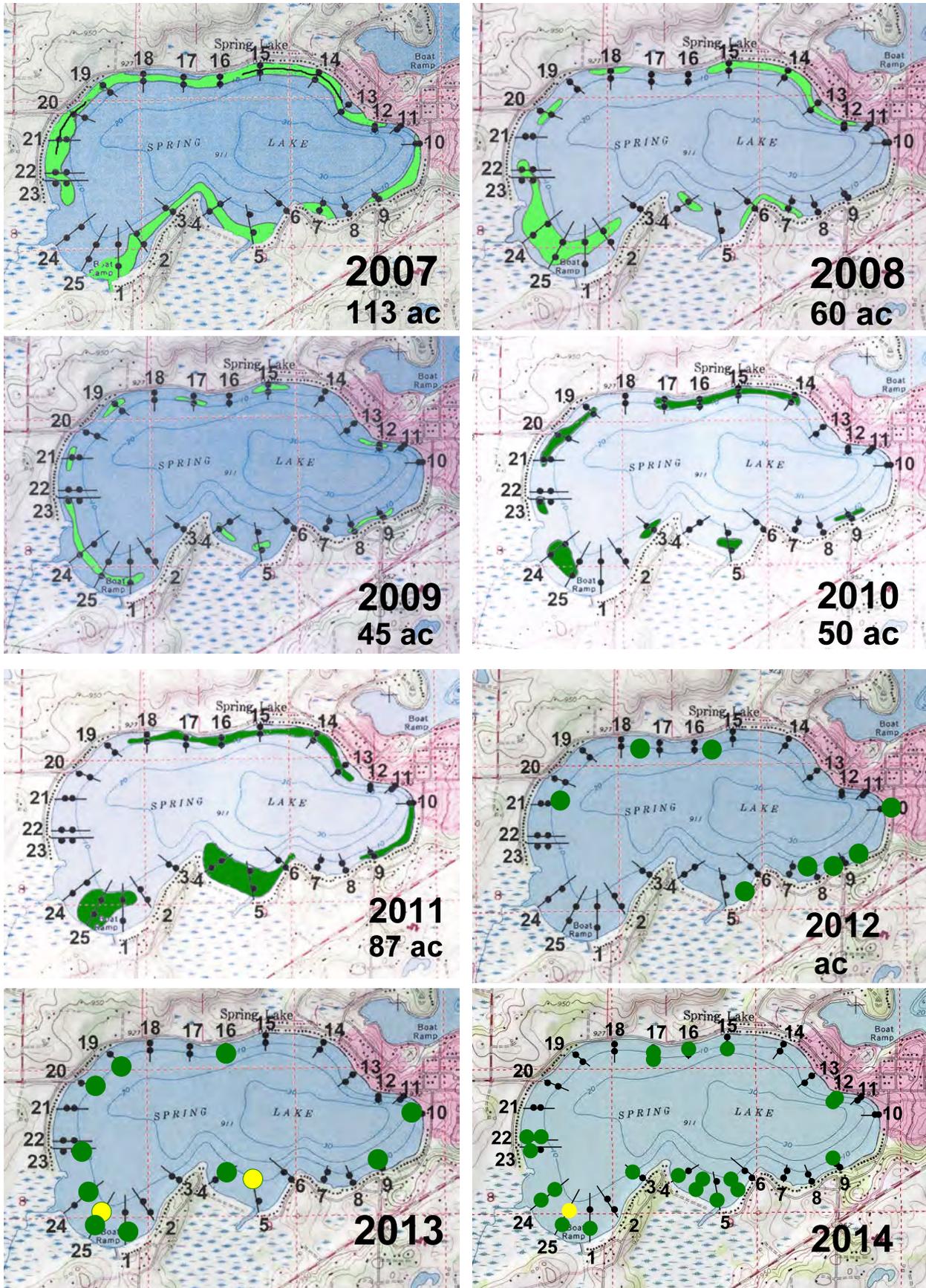


Figure 7. Curlyleaf pondweed distribution during the peak growing season from 2007 through 2017.

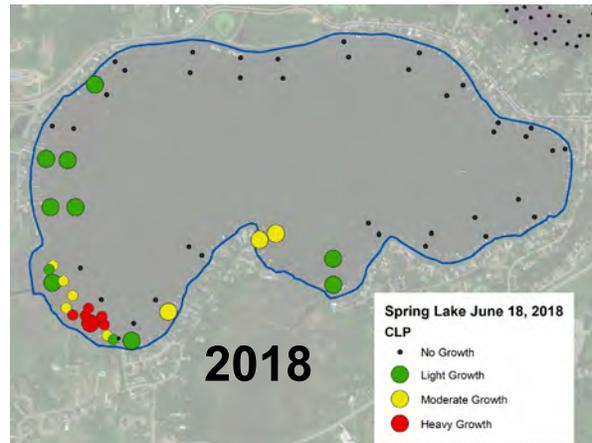
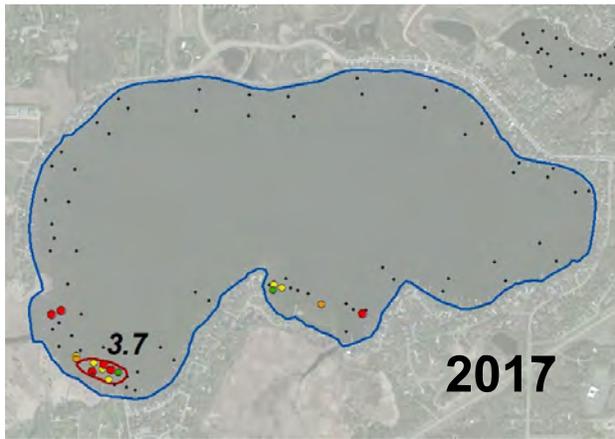
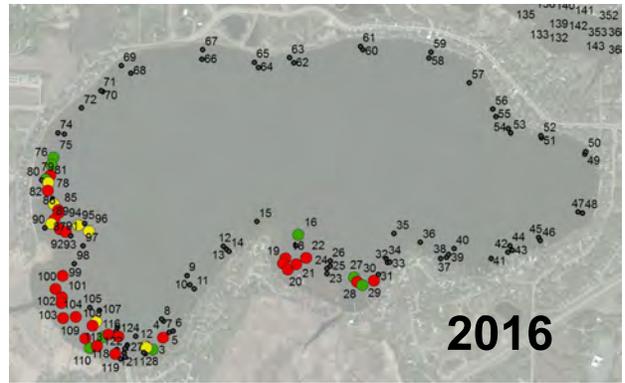
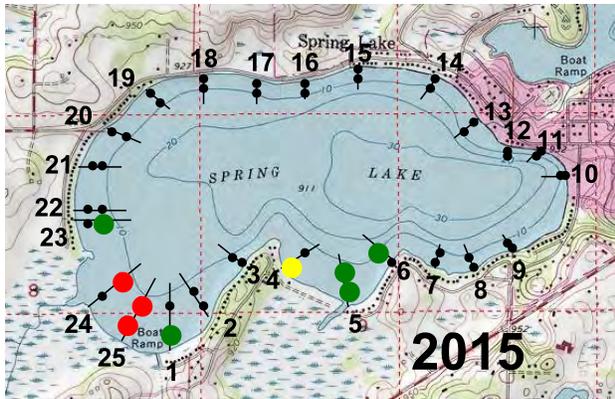


Figure 7. Curlyleaf pondweed distribution during the peak growing season from 2007 through 2018.

Results - Point Intercept Aquatic Plant Survey on August 20, 2018:

Results of the summer aquatic plant survey conducted on August 20, 2018 found 13 submerged aquatic plant species with 12 native plant species and 1 non-native plant species present. 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 20, 2018 survey based on 248 sites. Density ratings are 1-3 with 1 being low and 3 being most dense.

Spring Lake	All Stations (n=248)		
	Occur	% Occur	Average Density
Cattails (<i>Typha sp</i>)	3	1	2.7
Duckweed (<i>Lemna sp</i>)	3	1	1.7
White water lilies (<i>Nymphaea ordata</i>)	3	1	1.3
Coontail (<i>Ceratophyllum demersum</i>)	138	56	1.3
Chara (<i>Chara sp</i>)	6	2	1.2
Chara - 2 (<i>Chara sp</i>)	3	1	1.3
Moss (<i>Drepanocladus sp</i>)	3	1	1.0
Elodea (<i>Elodea canadensis</i>)	89	36	1.1
Naiads (<i>Najas flexilis</i>)	56	23	1.1
Curlyleaf pondweed (<i>Potamogeton crispus</i>)	16	6	1.0
Claspingleaf pondweed (<i>P. Richardsonii</i>)	25	10	1.4
Stringy pondweed (<i>P. sp</i>)	17	7	1.0
Sago pondweed (<i>Stuckenia pectinata</i>)	28	11	1.0
Bladderwort (<i>Utricularia vulgaris</i>)	1	1	1.0
Water celery (<i>Vallisneria americana</i>)	49	20	1.4
Water stargrass (<i>Zosterella dubia</i>)	29	12	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 8. A total of 248 points were sampled. Plant occurrence and abundance for individual sites are shown in the Appendix.

Table 6. MnDNR Template Statistics

Total # Points Sampled	248
Depth Range of Rooted Veg	1-8 feet
Maximum Depth of Growth (95%) in feet	6.0
# Points in Max Depth Range	203
Max Depth of *SSW in feet	0.0
# Points in Littoral Zone (0-15 feet)	248
% Points w/ Submersed Native Taxa	78
Mean Submersed Native Taxa/Point	1.8
Mean Density of Submersed Native Taxa	1.2
# Submersed Native Taxa	12
% Frequency of *SSW	0

Table 7. Aquatic plants sampled by depth.

Depth Bin (Feet)	# points sampled	% Sampling points with submersed species observed
0	0	0
1	10	70
2	40	100
3	59	100
4	48	98
5	30	83
6	16	81
7	14	7
8	18	6
9	9	0
10	3	0
11	1	0

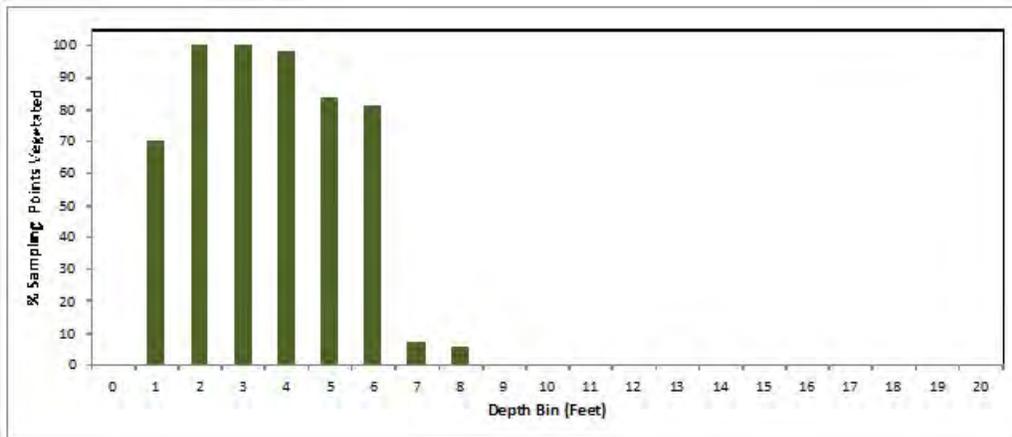


Figure 8. Depth of plant colonization (in feet).

Aquatic Plant Maps: Coverage of the select native plants species found in the August survey are shown in Figures 9 and 10. Native plant coverage was estimated at 21% of the lake area in 2018 (Figure 9).

Spring Lake Native Plant Coverage August 20, 2018

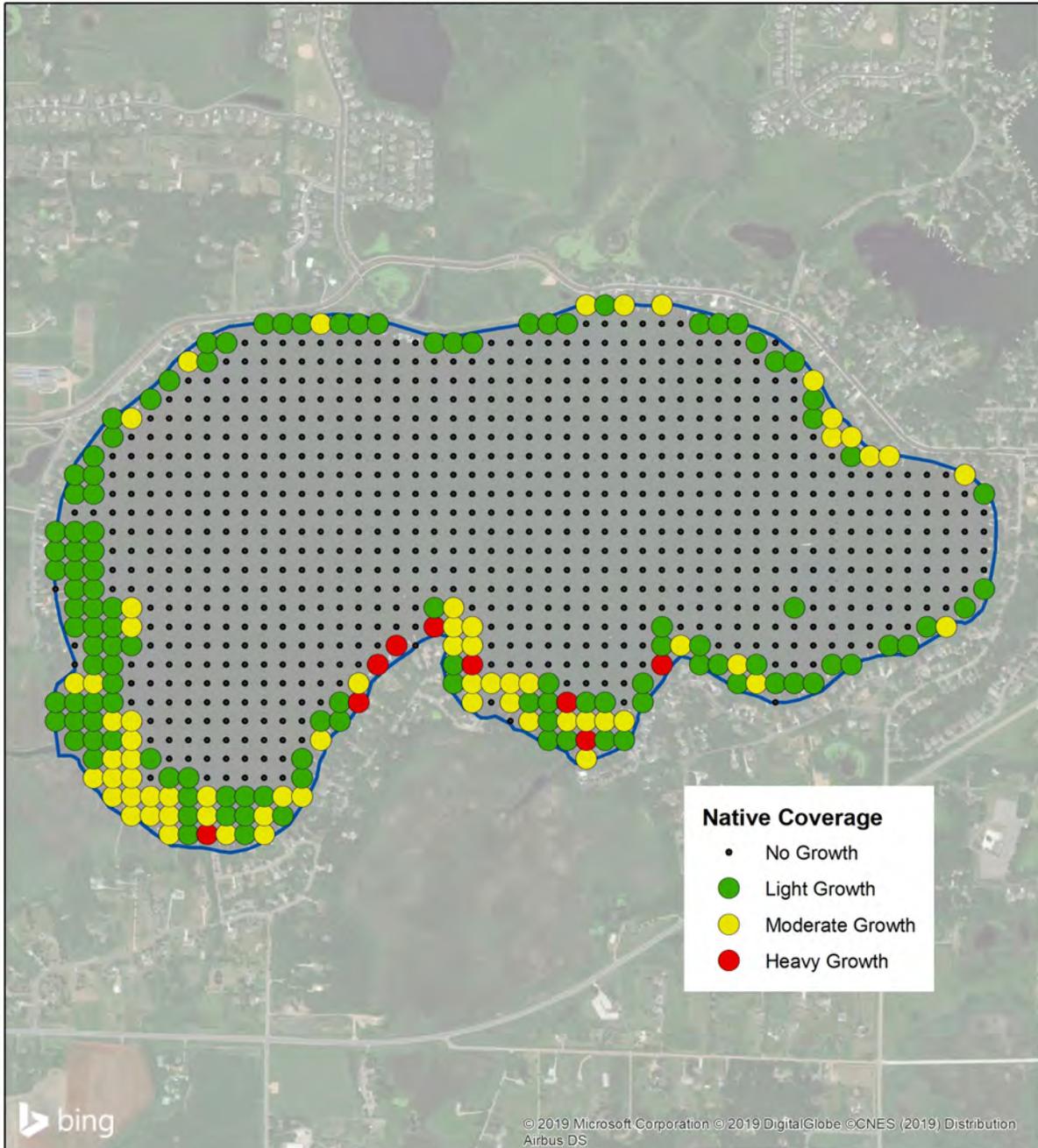


Figure 9. Distribution and abundance maps for native submerged aquatic plant species. Key: green = light growth, yellow = moderate growth, and red = heavy growth.

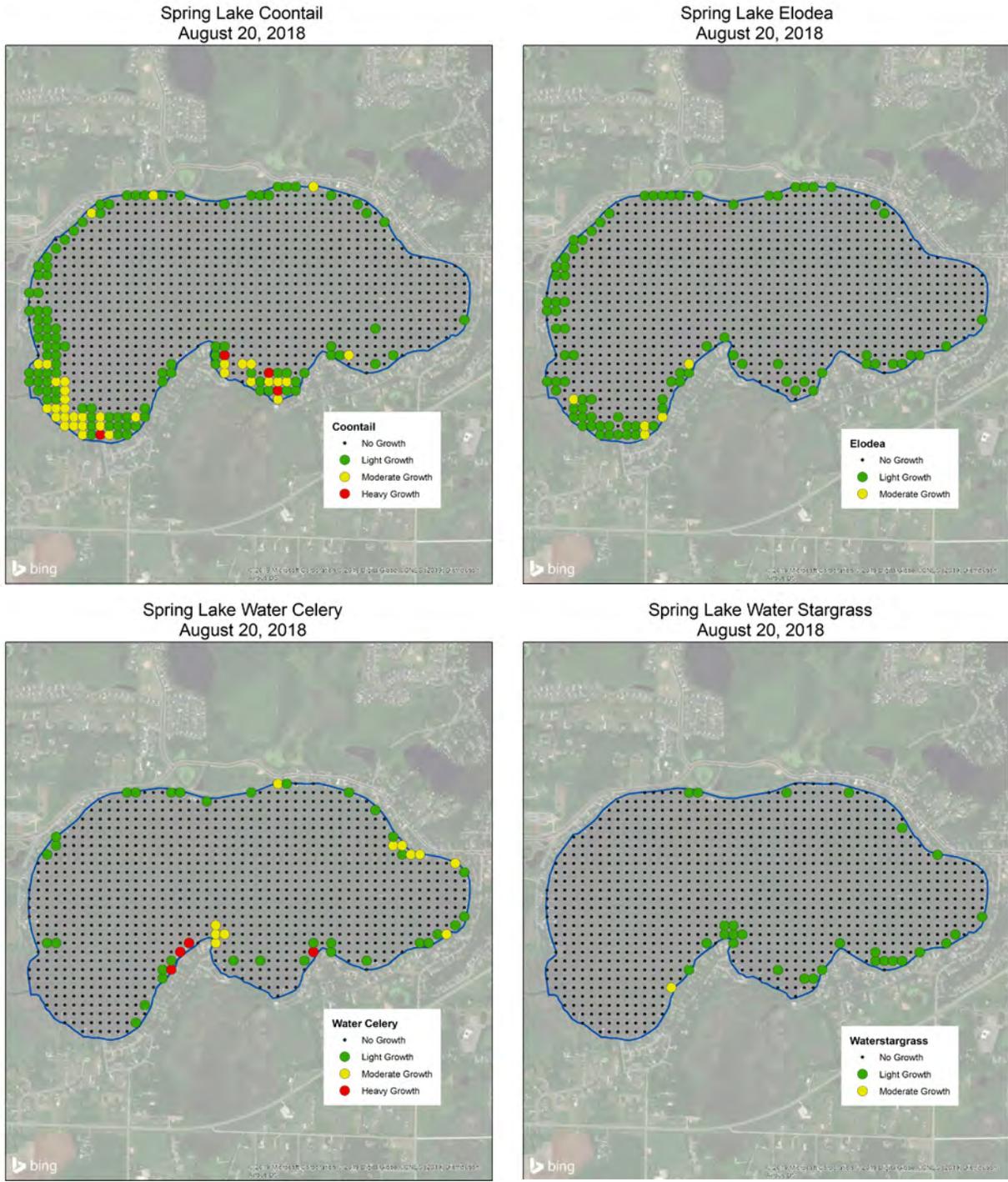


Figure 10. Distribution and abundance maps for select submerged aquatic plant species. Key: green = light growth, yellow = moderate growth, and red = heavy growth.

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

Native Plant Coverage: Native aquatic plant distribution may have decreased slightly from 2015 to 2018 based on point intercept survey results (Figure 11). 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 (21%).

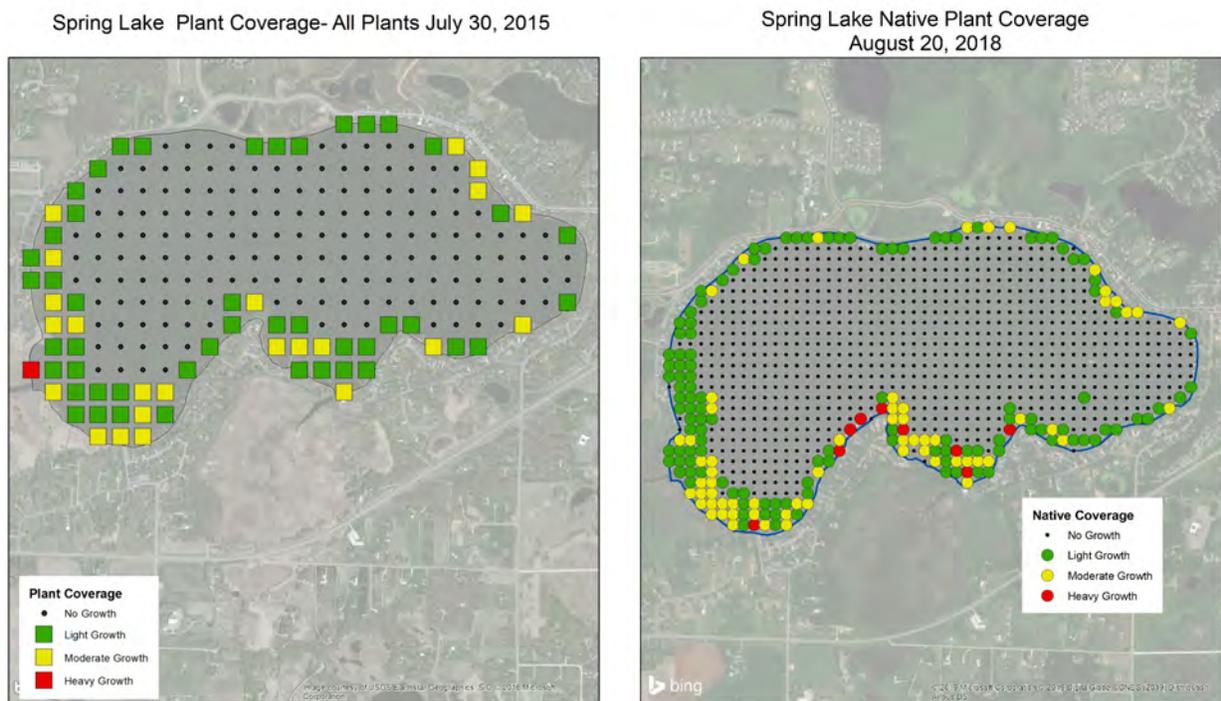


Figure 11. [left] All plants distribution and abundance for the August 20, 2018 point intercept survey. [right] Native plant distribution and abundance for the August 20, 2018 point intercept survey. Key: green = light growth, yellow = moderate growth, red = heavy growth, and black dot = no growth.

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

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 2018 were conducted by Blue Water Science. Numbers for plant species in 2000 and 2002 through 2018 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										
Berchtold's pondweed (<i>Potamogeton berchtoldi</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		
Date (month.day)	5.28	7.30	4.20	6.1	4.14	6.5	5.14	6.18	8.20
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
Greater duckweed (<i>Spirodela polyrhiza</i>)									
Coontail (<i>Ceratophyllum demersum</i>)		15		32	8	46	8	38	56
Chara (<i>Chara sp</i>)		4		2	6	4	2		2
Chara - 2 (<i>Chara sp</i>)	6	42		38					1
Elodea (<i>Elodea canadensis</i>)					12	16	10	18	36
Moss (<i>Drepanocladus sp</i>)					2				1
Star duckweed (<i>Lemna trisulca</i>)		21						2	
Naiads (<i>Najas flexilis</i>)									23
Berchtold's pondweed (<i>Potamogeton berchtoldi</i>)	22	12	50	18					
Curlyleaf pondweed (<i>P. crispus</i>)					2	26	8	26	6
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
Stringy pondweed (<i>P. sp</i>)						86		62	7
Narrowleaf pondweed (<i>P. sp</i>)		17							
Sago* (<i>Stuckenia pectinata</i>)									11
Bladderwort (<i>Utricularia sp</i>)		9							1
Wild celery (<i>Vallisneria americana</i>)		5		4		4		12	20
Mud plantain* (<i>Zosterella dubia</i>)	3	10		6		4		10	12
Number of submerged species	4	11	1	7	5	8	4	8	13

* *Stuckenia pectinata* = *Potamogeton pectinatus*

Mud plantain = water stargrass

Zosterella dubia = *Heteranthera dubia*

APPENDIX

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						

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
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										
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

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
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										
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

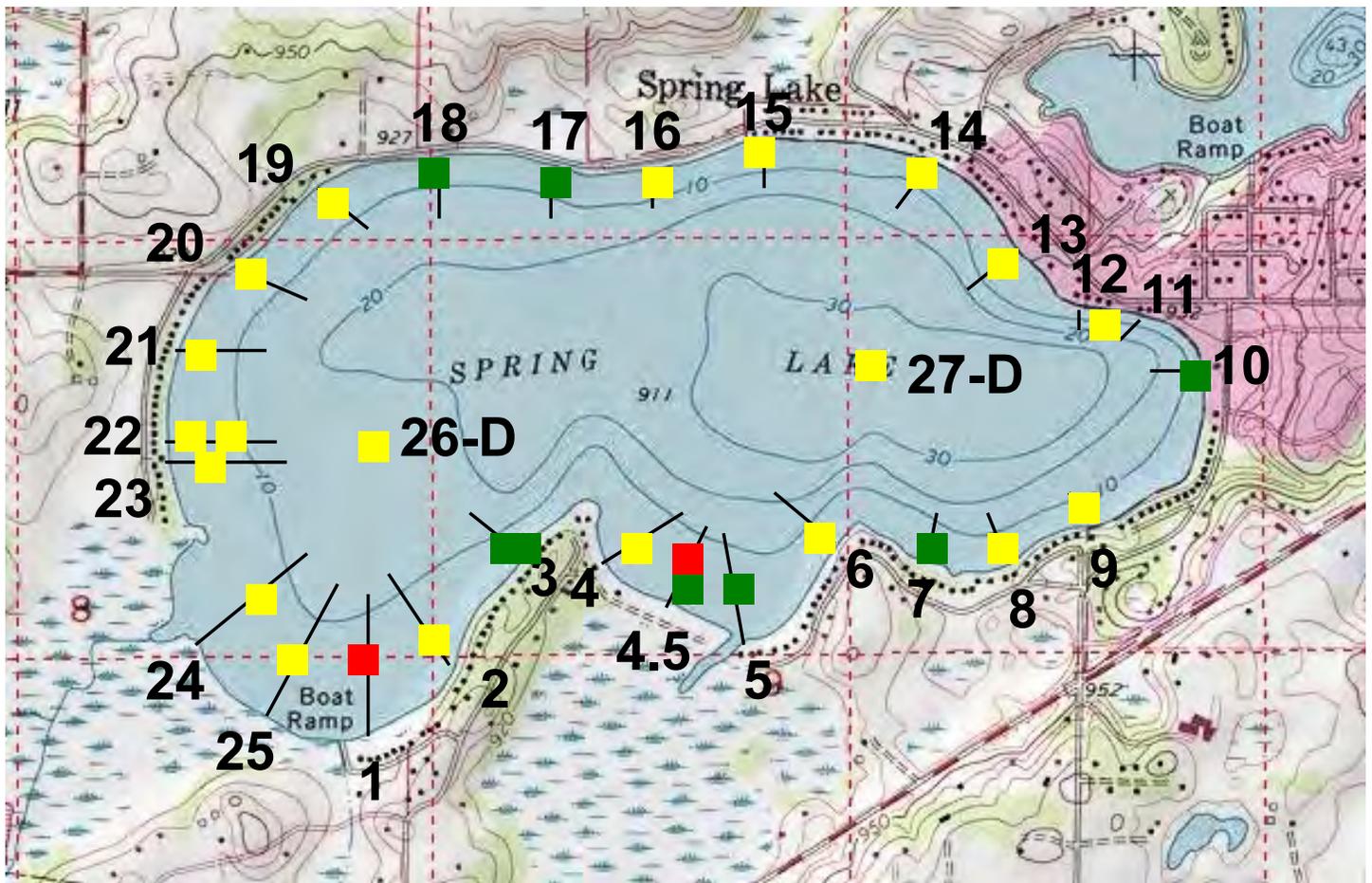
Individual sample site data for sites sample in Spring Lake point intercept survey on August 20, 2018.

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
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	
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

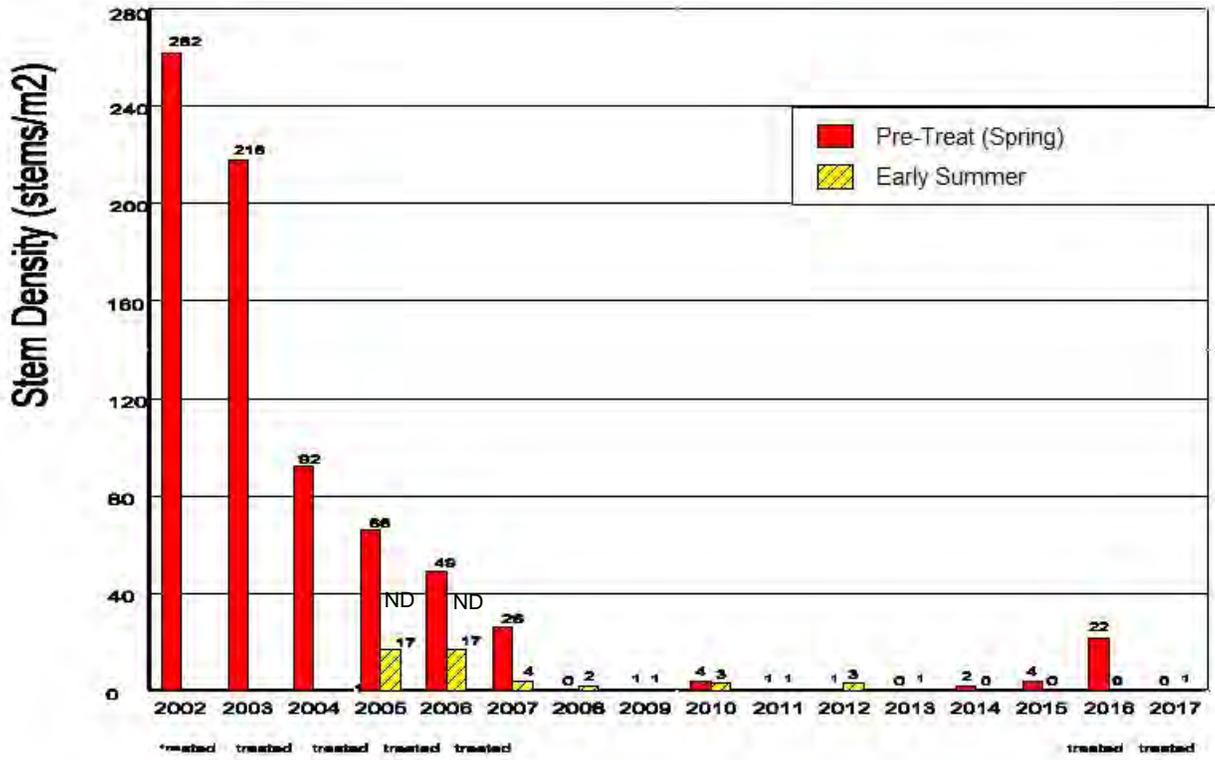
A Spring Lake sediment survey was conducted on August 13, 2008. Lake sediment sampling results from 2008 have been used to predict lake bottom areas that have the potential to support heavy curlyleaf pondweed plant growth. Based on the key sediment parameters of pH, sediment bulk density, organic matter, 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).