Native Plant Coverage Is Increasing in Spring Lake (June 5, 2017)

Aquatic Plant Surveys and Curlyleaf Pondweed Evaluation for Spring Lake, Scott County, Minnesota in 2017

Curlyleaf Pondweed Delineation & Spring Aquatic Plant Survey: April 14, 2017
Curlyleaf Pondweed Treatment: May 2, 2017 (3.7 acres)
Curlyleaf Pondweed Assessment & Summer Aquatic Plant Survey: June 5, 2017

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Summary

Curlyleaf pondweed distribution and abundance were delineated in Spring Lake on April 14, 2017 to determine if curlyleaf control was needed. Curlyleaf growth was observed at 16 out of 82 samples sites (Figure S1). Growth was light to heavy and curlyleaf treatment was delineated for 3.7 acres. A follow-up late season survey was conducted on June 5, 2017 to check the status of curlyleaf pondweed and native plant community in Spring Lake.

The June plant survey found curlyleaf was controlled in the treatment areas with several untreated sites showing light growth (Figure S2). No curlyleaf treatment was conducted in Spring Lake from 2007 through 2015. In 2016, 20.4 acres of curlyleaf pondweed were treat with Aquathol K and in 2017 3.7 acres of curlyleaf pondweed were treated with Aquathol K.

The June plant survey found native plants at 94% of the sample sites (47 out of 50 sites). Stringy pondweed was the most common native plant that was found with mostly light growth at 86% of the sample sites.
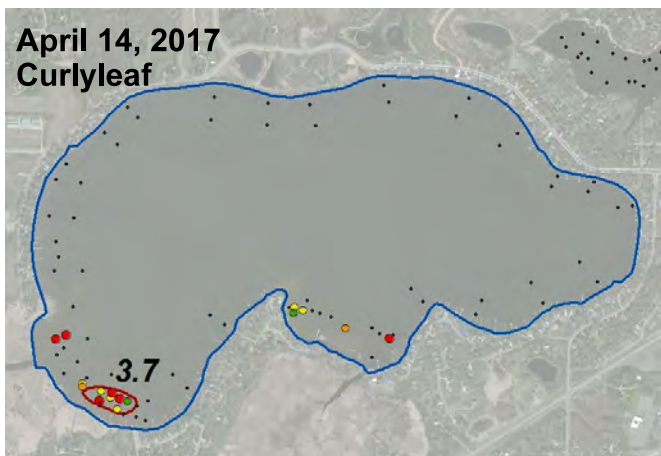
Figure S1. CURLYLEAF PONDWEED DELINEATION: Map of curlyleaf pondweed for April 14, 2017. Colored sample areas indicate the growth for curlyleaf pondweed. 3.7 acres were delineated for treatment.
Key: Green = light growth, yellow = moderate growth, and red = heavy growth.

**HERBICIDE APPLICATION:** Aquathol K was applied on 3.7 acres on May 2, 2017.
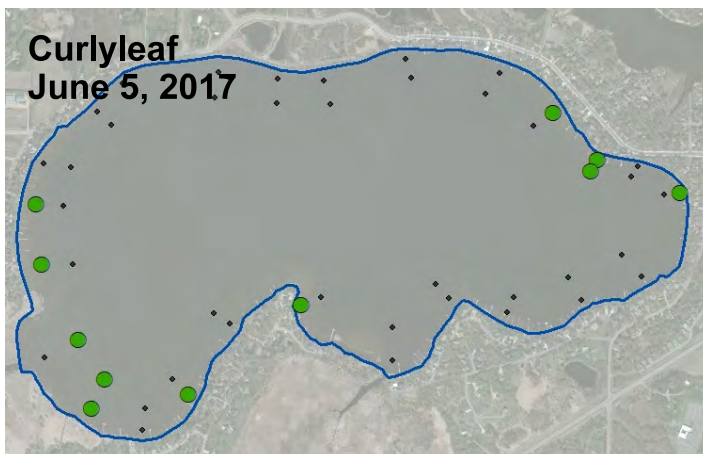
Figure S2. CURLYLEAF PONDWEED ASSESSMENT: Map of curlyleaf pondweed sample points from a June 5, 2017 point-intercept survey. Colored sample points indicate the growth in early June, 2017 for curlyleaf pondweed. Curlyleaf control was successful.
Key: Green = light growth and black = no curlyleaf pondweed.

What's Next? Treating heavy growth of curlyleaf pondweed based on early season curlyleaf distribution was conducted in Spring Lake from 2002 through 2006 and 2016 and 2017. However, there was no treatment necessary due to light growth from 2007-2015. Stem density assessments have supported the treatment or no treatment decisions (Figure S3).

In 2017 there was 1 area measuring a total area of 3.7 acres that was treated based on the early season survey. 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 for delineation has been to use past treatment history combined with early season scouting. Then the sites are rechecked to evaluate treatment effects and see if curlyleaf any areas were missed. Using this approach, 1 area from the April survey were predicted to produce heavy CLP growth in June. The subsequent summer plant survey found curlyleaf pondweed had grown to low densities with some moderate growth.

In 2018, curlyleaf delineation and assessment surveys are recommended to keep track and monitor the curlyleaf growth. Previous sediment survey results indicate where light, moderate, and heavy curlyleaf growth are likely to occur based on sediment characteristics. These results combined with data from 2017 and then early season curlyleaf scouting in May will give confidence in areas to treat, if needed in the future. Areas to be treated with herbicides can be limited to areas of heavy growth. Areas where light growth is expected based on lake sediment characteristics could be left untreated.

2014 - 2017 Spring Lake Curlyleaf Pondweed Hot Spot Areas
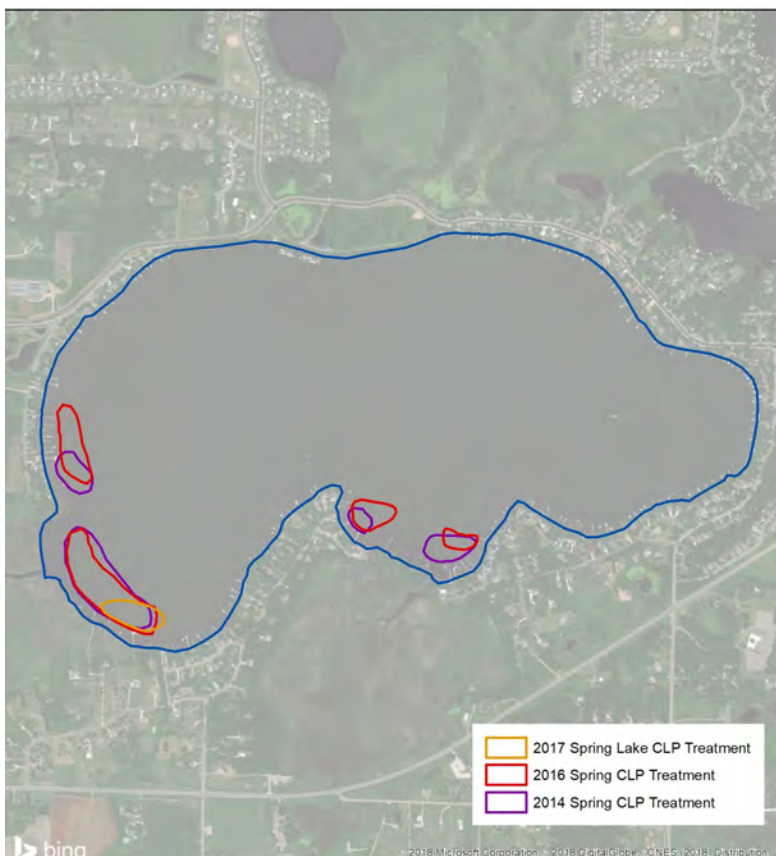
Figure S3. 2014-2017 curlyleaf pondweed hot spot areas.

Aquatic Plant Surveys and Curlyleaf Pondweed Evaluation for Spring Lake, Scott County, Minnesota in 2017

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 April 14, 2017. The delineation consisted of 82 sample locations in the littoral zone around Spring Lake. The sample locations are shown in Figure 1.

A summer aquatic plant point-intercept survey was conducted June 5, 2017 to assess both curlyleaf growth as well as the native plant community in Spring Lake.
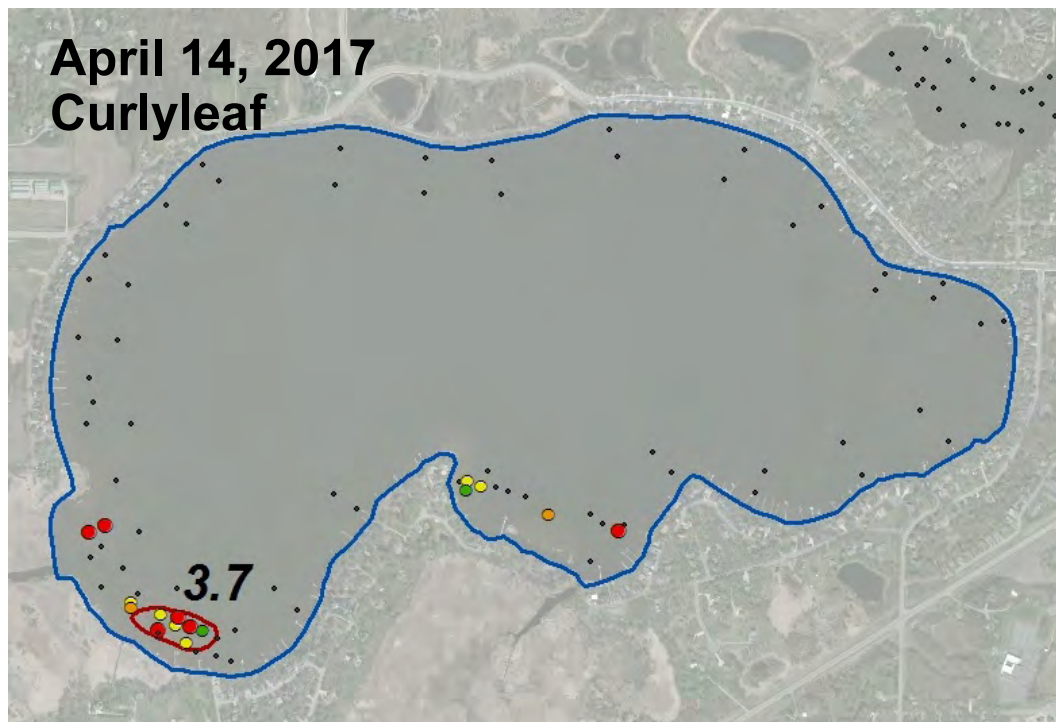
Figure 1. The sample sites for the April 14, 2017 delineation curlyleaf pondweed survey.
Key: black dot = no curlyleaf; green dot = light potential growth, yellow dot = moderate potential growth, and red dot = heavy potential growth.

Curlyleaf Pondweed Delineation, April 14, 2017: A curlyleaf delineation was conducted on April 14, 2017 and curlyleaf was found at 16 out of 82 sites (Table 1 and Figure 2). One area was delineated for an herbicide application which was treated on May 2, 2017.

Table 1. Aquatic plant densities based on rake sampling for April 14, 2017. Densities are based on a scale from 1 to 4 with 4 being the densest. Curlyleaf stems per rake sample were also noted. Those points are shown in Figure 2.

| Way Point	Site	Depth (ft)	Chara	Coon-tail	CLP-stems	Elodea	Moss	No plants
	1	4		1		1		1
	2	6						1
	3	4						1
	4	6						1
	5	4			1			
	6	6						1
	7	3	1					
	8	7						1
	9	3						1
	10	7						1
	11	4				1		
	12	7						1
	13	4						1
	14	6						1
	15	4						1
	16	6						1
	17	4						1
	18	6						1
	19	4						1
	20	7						1
	21	4						1
	22	6						1
	23	4					1	
	24	6						1
	25	4						1
	26	6						1
	27	4						1
	28	6						1
	29	4						1
	30	6						1
	31	4						1
	32	6	1			1		
	33	4						1
	34	6						1
	35	4						1
	36	6						1
	37	4						1
	38	6						1
	39	4				1		
	40	6						1
	41	4	1					
	42	6						1
	43	4		1		1		
	44	6						1
	45	4		1				
	46	6						1
	47	4		1				
	48	6						1
	49	4			10			
	50	6						1
259		4			2			
260		3			1			
261		4			2			
262		5						1
263		6						1

Way Point	Site	Depth (ft)	Chara	Coon-tail	CLP-stems	Elodea	Moss	No plants
264		6						1
265		6			3			
266		6		1		1		
267		6						1
268		6		1	4			
269		3						1
270		5						1
271		5						1
272		5		1		1		
273		5			6			
274		5			7			
275		5						1
276		3		1		1		
277		6		1				
278		5						1
279		5		1	2			
280		5			3			
281		5			2			
282		4						1
283		5			2			
284		5			5			
285		5		1	10			
286		4			2			
287		4						1
288		5			1			
289		5						1
290		4						1
Occurrence (82 sites)			3	11	16	9	1	52
% occur			4	13	20	11	1	
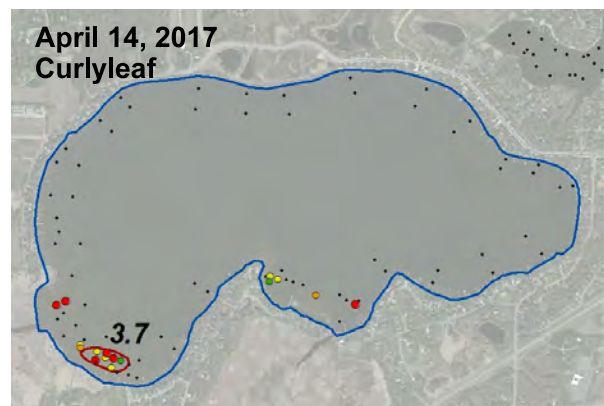
Figure 2. Map of curlyleaf pondweed for April 14, 2017. Key: black dot = no curlyleaf, green dot = light growth, yellow dot = moderate growth, and red dot = heavy growth.

Curlyleaf Comparison of May 21, 2014, May 28, 2015, April 20, 2016, and April 14, 2017:
Full aquatic plant surveys using transects were combined with additional sampling to delineate areas of predicted heavy growth of curlyleaf in 2014, 2015, 2016, and 2017 (Figure 3). Based on the curlyleaf plant survey 4 areas of potential heavy curlyleaf growth were delineated in 2014 and are shown in Figure 3. Similar areas were found with the potential for heavy curlyleaf growth in 2015 and 2016. However in 2017 only 1 area was delineated for treatment.

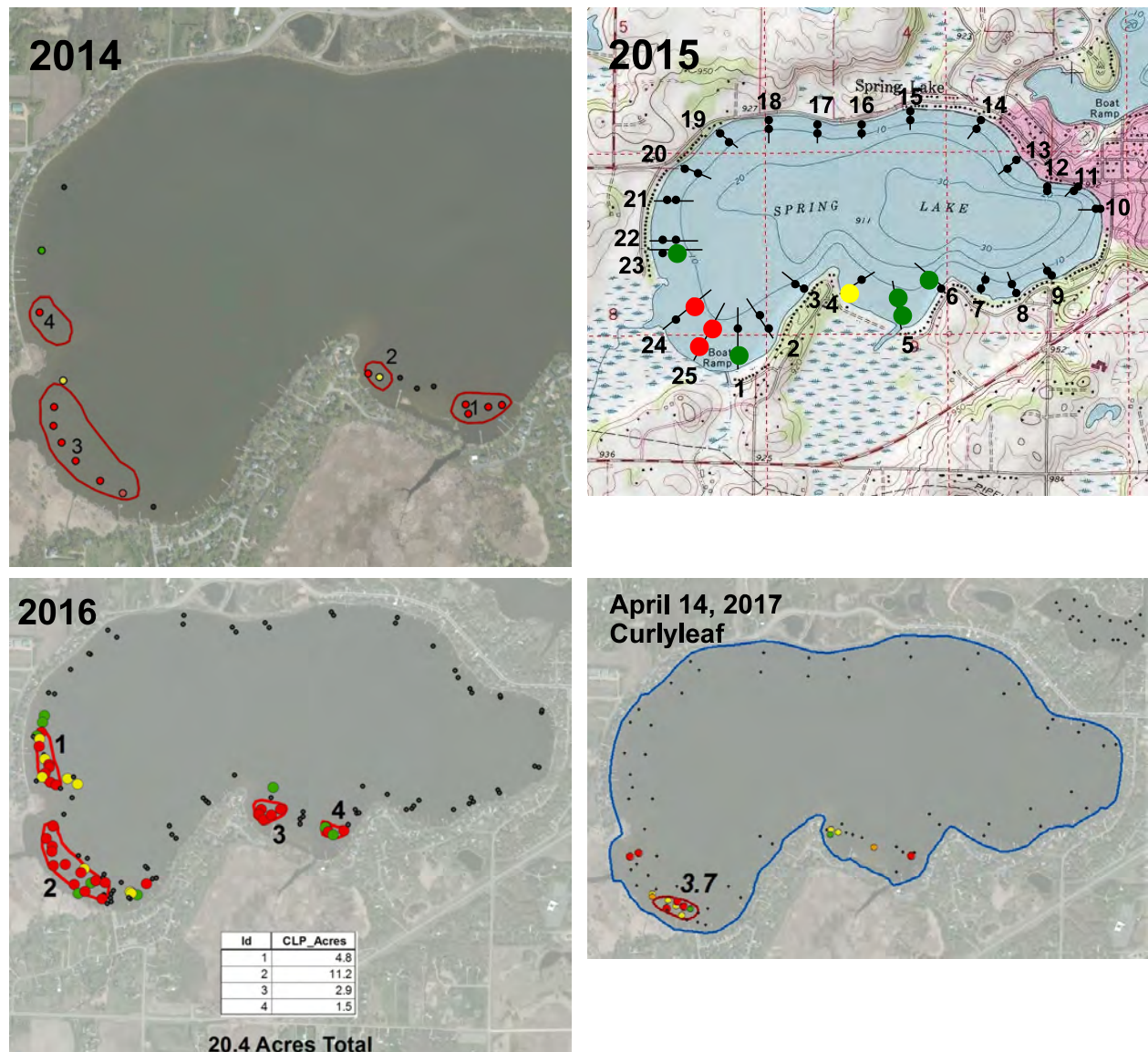**Figure 3. [top-left] Curlyleaf delineation in Spring Lake on May 21, 2014. [top-right] Curlyleaf delineation in Spring Lake on May 28, 2015. [bottom-left] Curlyleaf delineation in Spring Lake on April 20, 2016. [bottom-right] Curlyleaf delineation in Spring Lake on April 14, 2017.**
**Key: black dot = no curlyleaf, green dot = light curlyleaf growth, yellow dot = moderate growth, red dot = heavy growth, and red outline = treatment area.**

Curlyleaf Pondweed Assessment, June 5, 2017: A curlyleaf assessment was conducted on June 5, 2017 and curlyleaf was found at 13 out of 50 transect sites (Table 2).

Table 2. Aquatic plant densities based on rake sampling for June 5, 2017. Densities are based on a scale from 1 to 4 with 4 being the densest.

Site	Depth (ft)	Chara	Clasping-leaf	Coontail	CLP	Elodea	Stringy	Water celery	Water stargrass	Filament algae	No plants
1	4						2			3	
2	5			1		1	3			1	
3	4			1	1	1	3			3	
4	6			1			1			1	
5	4						2			3	
6	5			1		1	2			3	
7	4		2	1	1		2				
8	6			1			1			2	
9	4			3						1	
10	7						1				
11	4						2	1			
12	7						1				
13	3					1	1			3	
14	5			1		1	3				
15	4						2	1		2	
16	6	1				1	3			2	
17	4						2			3	
18	6						1				
19	4			1	1		1			1	
20	6									1	1
21	4								1		
22	6									1	1
23	4				1						
24	6				2		2				
25	4	1			1				1		
26	5						2			1	
27	4			1			1			2	
28	7						2			2	
29	4			1			1			1	
30	6						2				
31	4						2			1	
32	6						3				
33	4			2			2				
34	6						2			1	
35	4			1		1	1			1	
36	6			1			3			1	
37	4			1			1			2	
38	7						1			2	
39	4			1			1			1	
40	6						1				
41	4						3			1	
42	6						1			1	
43	4				1		1				
44	7						1			1	
45	4			1	1						
46	6						1				
47	5			3		1					
48	6			1	1						
49	4			2	2		3				
50	6			1	2					1	
Average		1.0	2.0	1.3	1.2	1.0	1.8	1.0	1.0	1.6	
Occur (50 sites)		2	1	23	13	8	43	2	2	31	2
% Occurrence		4	2	46	26	16	86	4	4	62	

Spring Lake Curlyleaf Pondweed Distribution
June 5, 2017

Spring Lake June 5, 2017
CLP
- No Growth
- Light Growth

UTM NAD 1983
Blue Water Science
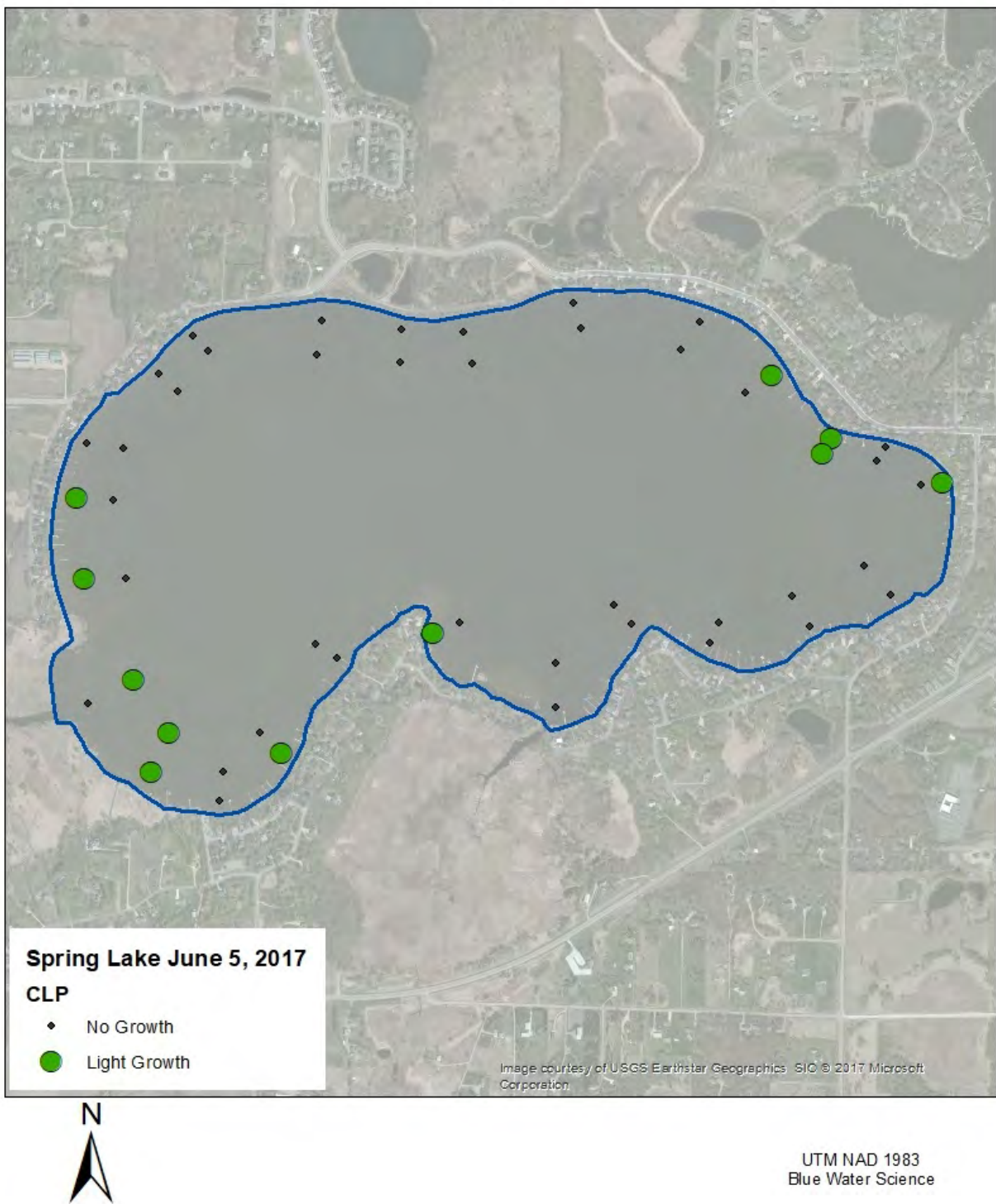
Figure 4. Curlyleaf pondweed assessment on June 5, 2017.
Key: Black = no growth and green = light growth.

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 in Figure 5. Curlyleaf stem densities have been very low since 2007.
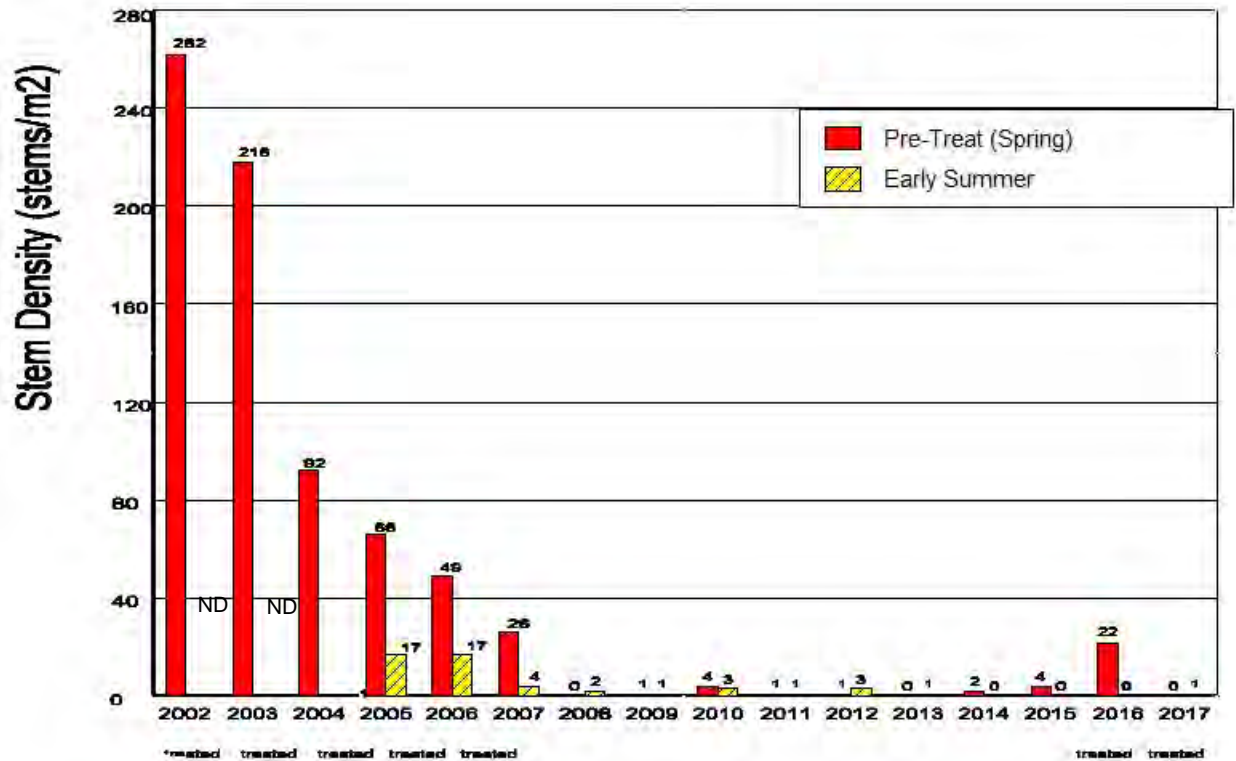
Figure 5. Curlyleaf stem densities (stems/m^2) for early season and late season monitoring (using scuba diving) for 2002-2017 (ND = no data).

Figure 6. [left] Curlyleaf pondweed conditions in April, 2017.
[right] Curlyleaf stems conditions in June, 2017.

Summary of Curlyleaf Pondweed 2000 to 2017

Curlyleaf pondweed growth has been variable from 2000 through 2017 but there has been less curlyleaf from 2007 through 2017 compared to the time frame of 2000 through 2006.

Table 3. Curlyleaf pondweed occurrence and acres either harvested or treated with herbicides from 2000 to 2017.

	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

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

Details of Whole Lake Curlyleaf Pondweed Surveys from 2000-2017: Curlyleaf growth was light in 2017 (Table 4). From 2007 through 2015 there were no open water herbicide applications but treatment occurred in 2016 and 2017.

Table 4. Summary of Curlyleaf Pondweed Distribution and Abundance from 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. 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 (blue shading for years of treatment). There has been no treatment from 2007-2015.

Transect	Depth	2000 Jun 3	2002 Jun 7	2003 May 15	2004 May 2	2004 Jun 14	2005 Apr 20	2005 Jun 1	2006 Apr 26	2006 Jun 2	2007 Apr 15	2007 Jun 5	2008 Apr 29	2008 Jun 13	2009 Apr 23	2009 Jun 10	2010 Apr 27	2010 Jun 2	Predicted growth based on lake soils
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	0.7	1	1	0	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	0.5	0	0	1	0	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	1	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 May 12	2011 Jun 10	2012 Apr 17	2012 Jun 5	2013 May 29	2013 Jun 24	2014 May 21	2014 June 19	2015 May 28	2015 Jul 30	2016 Apr 20	2016 June 1	2017 Apr 14	2017 Jun 1	Predicted growth based on lake soils
1	S	0	0	0	0	1	1	0	1	2	0	1	1	0	0	
1	M	0	0.5	0	0	0	0	0	0	0	1	2	1	0	0	Heavy
2	S	0.5	0	0	0	0	0	0	0	0	0	0	0	0	1	
2	M	0	0	0.5	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	Light
3	M	0	0	0	0	0	0	0	1	0	0	0	0	0	0	Light
4	S	0	0.5	0	0	0	0	2	1	3	0	4	0	0	1	Moderate
4	M	0	0.5	0	0	0	1	0	0	0	1	1	0	0	0	
5	S	0	2.5	0	0	0	0	2	2	2	0	0	0	0	0	
5	M	0	0.3	0	1	0	3	2	0	2	1	0	0	0	0	Light
6	S	0	1	0	0	0	0	0	0	0	0	0	1	0	0	
6	M	0	0	0.5	0	0	0	0	0	1	1	0	0	0	0	Moderate
7	S	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	
7	M	0	0	0	0.5	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	
8	M	1	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	0	1	0	0	Moderate
9	M	0	0	1	0	0	0	0	1	0	0	0	0	0	0	
10	S	0	1	0	1	0	0	0	0	0	0	0	1	0	1	
10	M	0	0	0	0	0	1	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	
11	M	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	0	1	
12	M	0	0	0	0	0	0	0	1	0	0	0	0	0	2	
13	S	0	0	1	0	0	0	0	0	0	0	0	0	0	1	
13	M	0	1	0	0	0	0	0	0	0	0	0	1	0	0	Moderate
14	S	0.5	1	0	0	0	0	0	0	0	0	0	0	0	0	
14	M	0	1	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	
15	M	0.5	0.5	0	0	0	0	0	1	0	1	0	0	0	0	Moderate
16	S	0	0.8	0	0	0	1	0	1	0	0	0	0	0	0	
16	M	0	0.5	0	0.5	0	0	0	0	0	1	0	0	0	0	Moderate
17	S	0	0.5	0	0	0	0	0	1	0	0	0	1	0	0	Light
17	M	0	0	0	0	0	0	0	1	0	0	0	0	0	0	
18	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
18	M	0.5	0.5	0.3	0.5	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	
19	M	0	0	0.5	0	0	1	0	0	0	1	0	0	0	0	Moderate
20	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Moderate
20	M	0	0	0	0	0	1	0	0	0	1	0	0	0	0	
21	S	0.5	0	0	0	0	0	0	0	0	0	0	1	0	0	Moderate
21	M	0	0	0	1	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	
22	M	0	0	0	0	0	0	1	1	0	0	3	1	0	0	Moderate
23	S	0.5	0	0	0	0	0	2	1	0	0	1	0	0	1	
23	M	0	0	0	0	0	1	1	0	1	1	1	0	0	0	Moderate
24	S	0	0	0	0	0	0	2	1	4	0	3	0	0	0	
24	M	0	0	0	0	1	1	3	1	4	1	3	0	0	1	Moderate
25	S	0.5	1	0	0	0	2	1	1	5	1	2	0	1	2	
25	M	0	0.8	0	0	1	3	1	3	5	1	0	0	0	2	Moderate
Number of Reds		0	0	0	0	0	0	0	0	4	0	1	0	0	0	
Number of Sites		10	18	6	8	3	12	10	18	10	12	11	9	1	11	

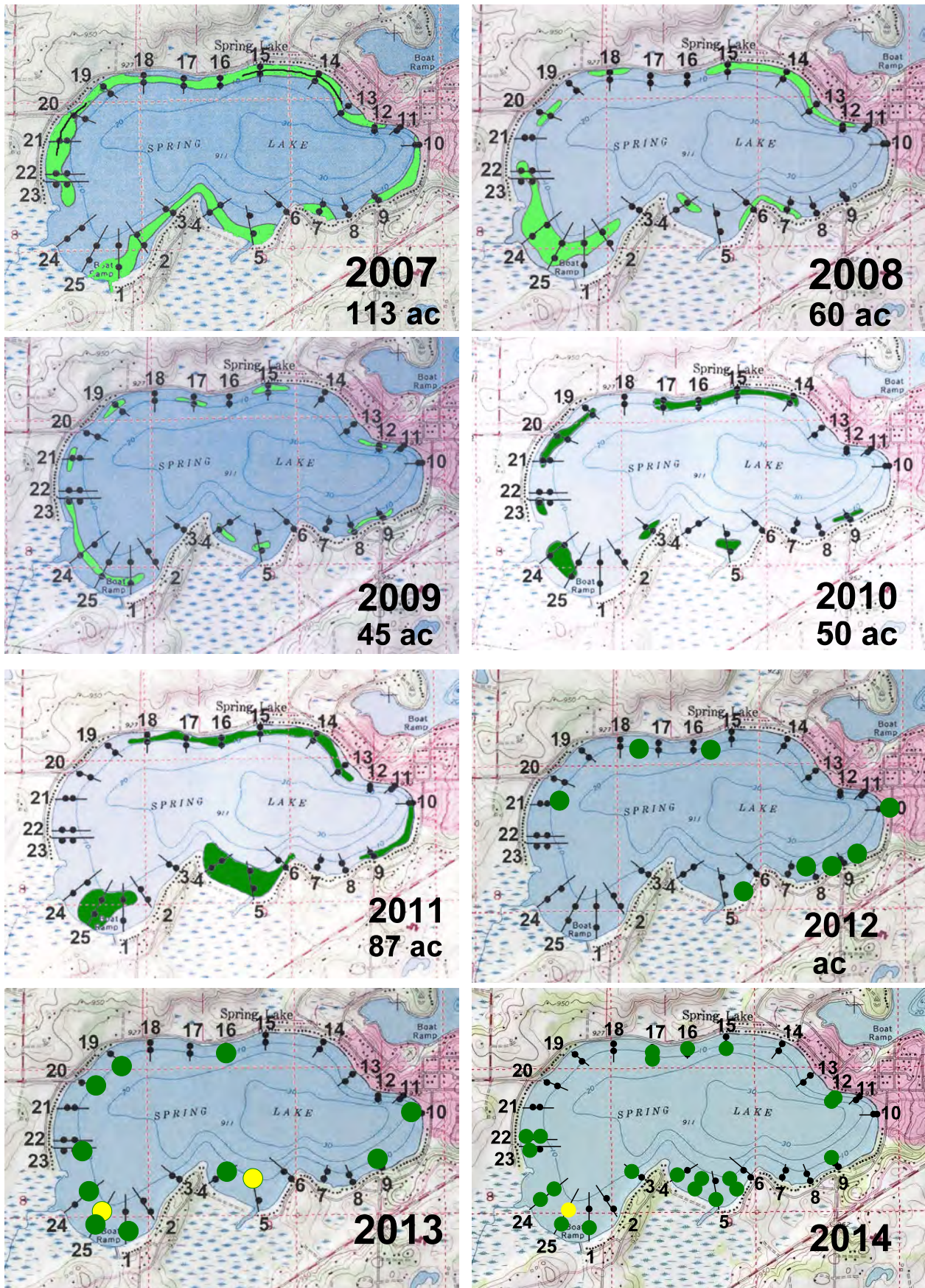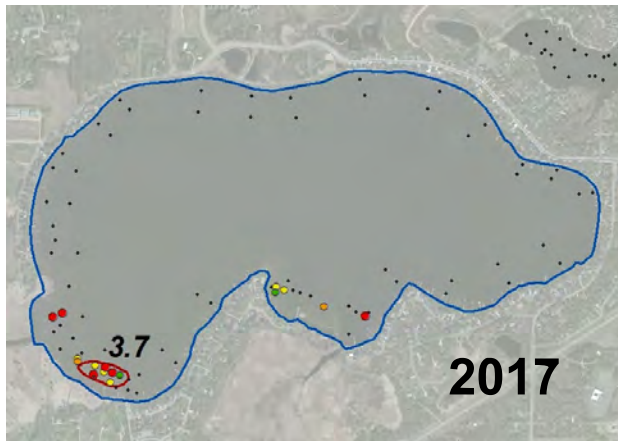Depth Zones: S = 0 - 4 feet; M = 5 - 8 feet

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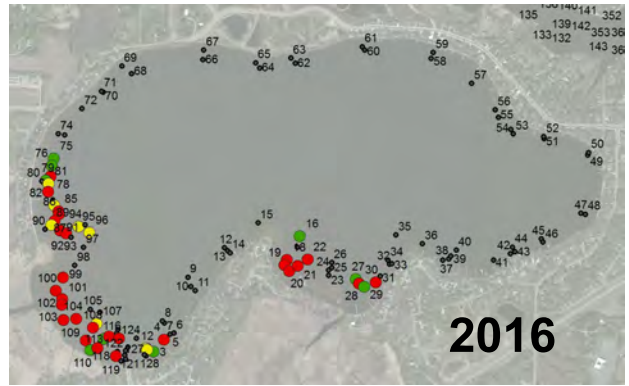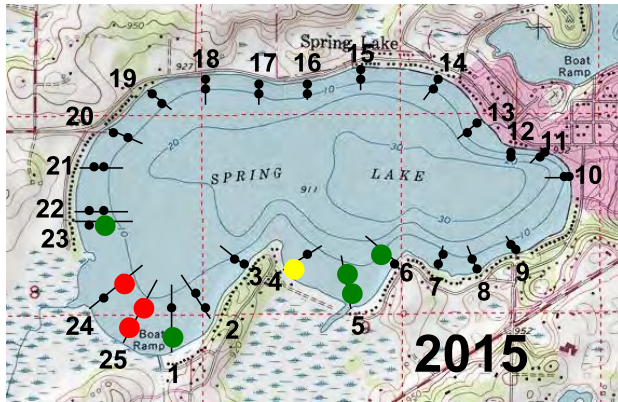
**Figure 8. Curlyleaf pondweed distribution during the peak growing season from 2007 through 2017.**

Native Plants in 2017

Native plant coverage in 2017 was estimated at 96% occurrence at the 50 sample sites (Table 6 and Figure 9). Stringy pondweed (*Potamogeton sp*) was the dominant plant species and coontail was second. The plant coverage was mostly light growth, but widely distributed with plant growth out to 7 feet of water depth (shown in Table 2).

Table 6. Aquatic plant densities based on rake sampling for June 5, 2017 for 50 sites on 25 transects with 2 depth zones per transect.

	Occurrence (50 sites)	% Occurrence	Average
Chara	2	4	1.0
Claspingleaf	1	2	2.0
Coontail	23	46	1.3
Curlyleaf	13	26	1.2
Elodea	8	16	1.0
Stringy	43	86	1.8
Water celery	2	4	1.0
Water stargrass	2	4	1.0
Filamentous algae	31	62	1.6
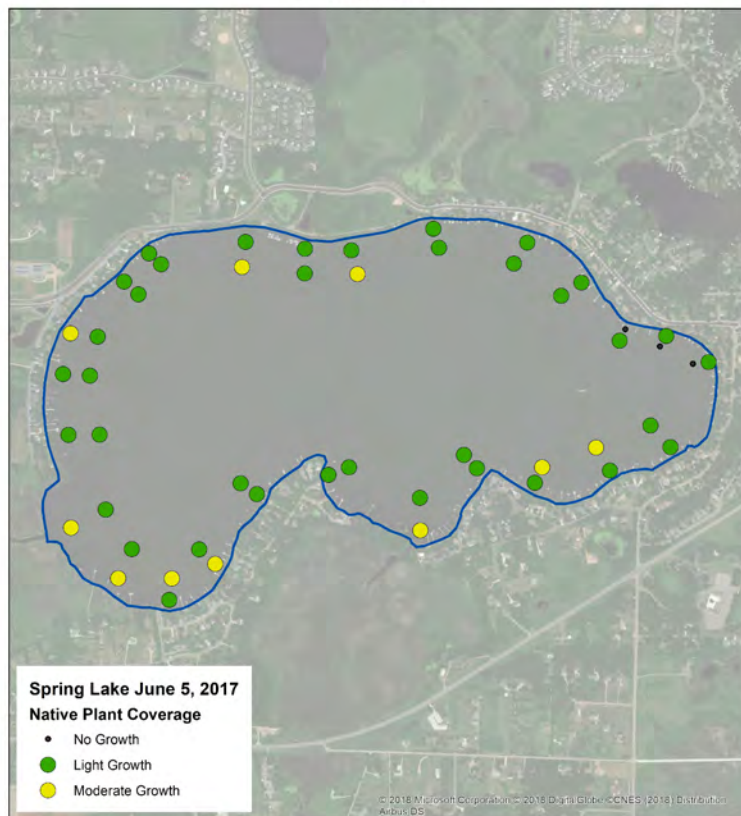
Figure 9. Native plant coverage on June 5, 2017.

Summary of Aquatic Plant Surveys from 1948 - 2017

Since 1948, a number of plant species within the aquatic plant community have appeared and others have disappeared (Table 8). The percent occurrence of the native plants elodea and water stargrass have decreased since 2000. Curlyleaf distribution and curlyleaf density are lower in 2015 compared to 2000. Curlyleaf changes observed in the lake may be due to the curlyleaf management program.

Overall, the native aquatic plant community has been fairly stable for a number of years but stringy pondweed, a native plant, may be increasing which is an encouraging sign that native plants are starting to increase. In 2017, native plant coverage was 94% which is one of the highest plant coverages on record.

Table 7. Aquatic plant status for 1948 to 2017.

	Plant Status (% occurrence)	Dominant Species	Number of 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	Elodea	10
2016	38	Elodea	6
2017	86	Stringy	8

Table 8. List of aquatic plants found in past surveys. Surveys from 1948 to 1988 were conducted by MnDNR. Surveys in 2000 and 2002 through 2017 were conducted by Blue Water Science. Numbers for plant species in 2000 and 2002 through 2014 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 (*Lemna minor*)				X	R														
Duckweed (*Lemna sp*)			O													6			
White waterlilies (*Nymphaea tuberosa*)																			
Greater duckweed (*Spirodela polyrhiza*)				X									2						
Coontail (*Ceratophyllum demersum*)	R	O	A	X	O	29		4	22		13	28	40	8	14	58	16	26	50
Chara (*Chara sp*)						4			2			4							
Elodea (*Elodea canadensis*)			O		O	25		8	18	6	25	48	68	22	54	76	64	68	48
Moss (*Drepanocladus sp*)																			
Naiads (*Najas flexilis*)																			
Berchtold's pondweed (*Potamogeton berchtoldi*)	R	O																	
Curlyleaf pondweed (*P. crispus*)			R	X		98	40	86	4	72	78	6	10	58	72	12	64	64	2
Variable pondweed (*P. gramineus*)	R	C	O																
Floatingleaf (*P. natans*)	R	C			P														
Stringy pondweed (*P. pusillus*)						2		6	8	2			4		6	8		20	
Claspingleaf (*P. Richardsonii*)	R	C			O				10				6		2	4		2	4
Stringy pondweed (*P. strictifolius*)																			2
Narrowleaf pondweed (*P. sp*)			O	X															
Sago* (*Stuckenia pectinata*)	R	C			C	40	15		36	2		24	6		6	14			6
Star duckweed (*Lemna trisulca*)		C																	
Wild celery (*Vallisneria americana*)			O		P	6			16			2	22		2	32		2	18
Mud plantain* (*Zosterella dubia*)	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 8. Concluded.

Year	2007			2008			2009			2010		2011		2012		2013		2014		2015		2016		2017	
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	5.28	7.30	4.20	6.1	4.14	6.5
Secchi disc (ft)				2.3	3.9		3.5	6.2	2.9		2.2		5.6					15.5			4.5				
Lesser duckweed (*Lemna minor*)			2																						
Duckweed (*Lemna sp*)																									
White waterlilies (*Nymphaea tuberosa*)																									
Greater duckweed (*Spirodela polyrhiza*)																									
Coontail (*Ceratophyllum demersum*)	22	28	30	8	30	16	4	8	24	18	26	16	22	4	30	3	6		16		15		32	8	46
Chara (*Chara sp*)		2				8		2		12											4		2	6	4
Elodea (*Elodea canadensis*)	20	6	2			4			4	2	2	2	4	2			2			6	42		38	12	16
Moss (*Drepanocladus sp*)				1																				2	
Naiads (*Najas flexilis*)									6												21				
Berchtold's pondweed (*Potamogeton berchtoldi*)																									
Curlyleaf pondweed (*P. crispus*)	44	58		5	38	8	10	28	18	50	42	20	36	14	16	5	23	20	36	22	12	50	18	2	26
Variable pondweed (*P. gramineus*)																									
Floatingleaf (*P. natans*)																									
Stringy pondweed (*P. pusillus*)		26																							
Claspingleaf (*P. Richardsonii*)		2	2		2	2		2	6		4		2			2					5				2
Stringy pondweed (*P. sp*)	2		2			24		14	66	52	34		64	36	92	5	16		48	12	29		38		86
Narrowleaf pondweed (*P. sp*)								2																	
Sago* (*Stuckenia pectinata*)		8	2	1	24	8		24	20		26						16		6		17				
Star duckweed (*Lemna trisulca*)																									
Wild celery (*Vallisneria americana*)		6	12			18		2	18		4		2		6				10		9				4
Mud plantain* (*Zosterella dubia*)						8			24												5		4		4
Number of submerged species	4	8	6	4	4	9	2	8	9	5	7	3	6	4	4	4	5	1	5	3	10		6	5	8

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

APPENDIX A

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 Figure 14.

Except for two sites, curlyleaf pondweed growth is predicted to produce mostly light to moderate growth around the lake based on lake sediment characteristics.
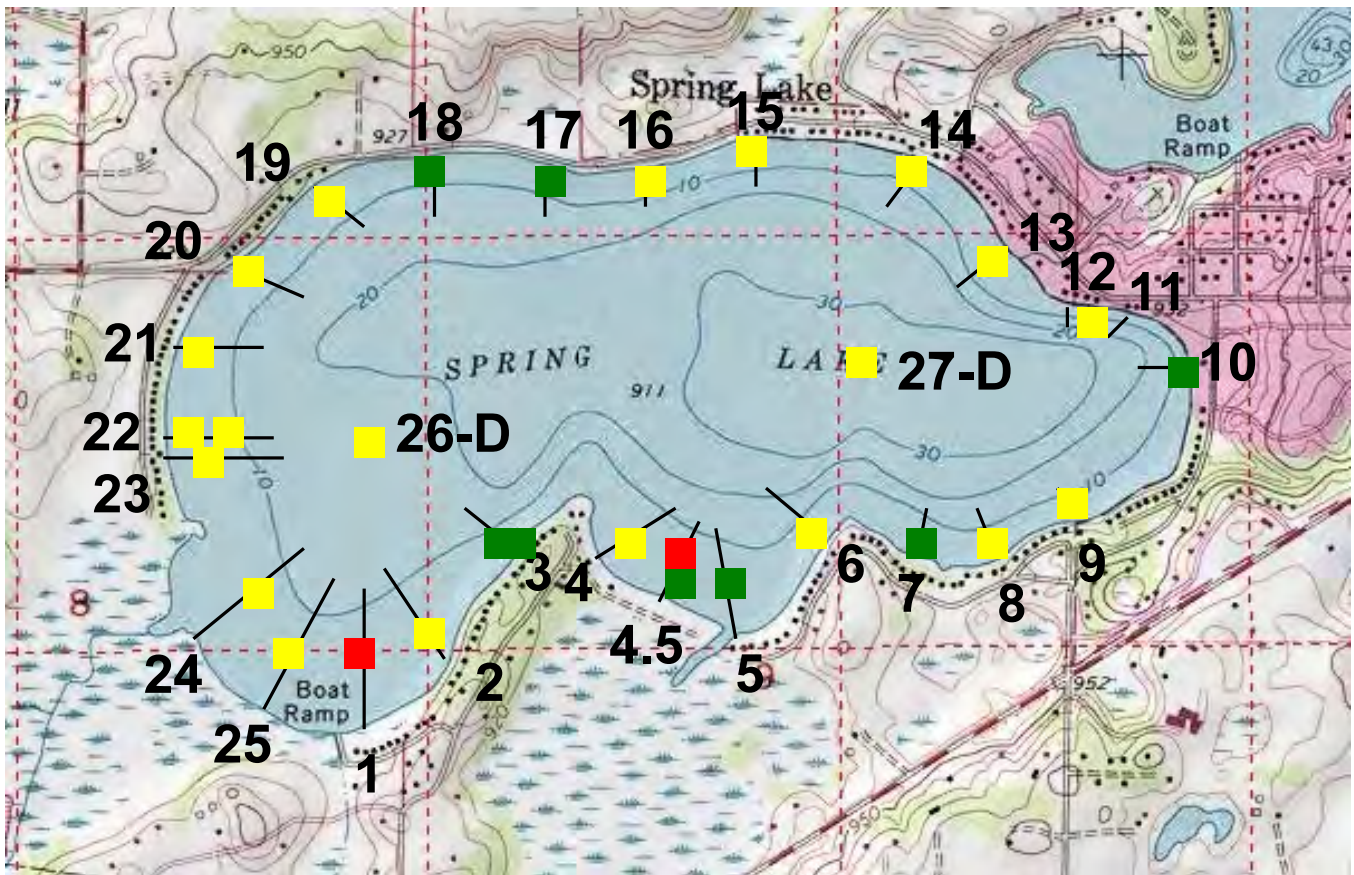
Sediment sample locations are shown with a square. The square color indicates the potential for curlyleaf pondweed growth to occur at that site. Key: green = light; yellow = moderate; red = heavy. A key that illustrates the three types of growth is shown on the next page.

Appendix B - 2015 Point Intercept Survey

Introduction: An aquatic plant point-intercept survey was conducted on 592 acre Spring Lake, located in Scott County on July 30, 2015. The objective of the survey was to characterize the aquatic plant community.

Methods: An aquatic plant point-intercept survey of Spring Lake was conducted by Blue Water Science. A total 113 points in the littoral zone were sampled. Sample points were spaced 50 meters apart on a grid that covered the lake (Figure B1). 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 5 with 1 being sparse and 5 being heavy growth. Based on these sample sites, a plant distribution map was constructed.
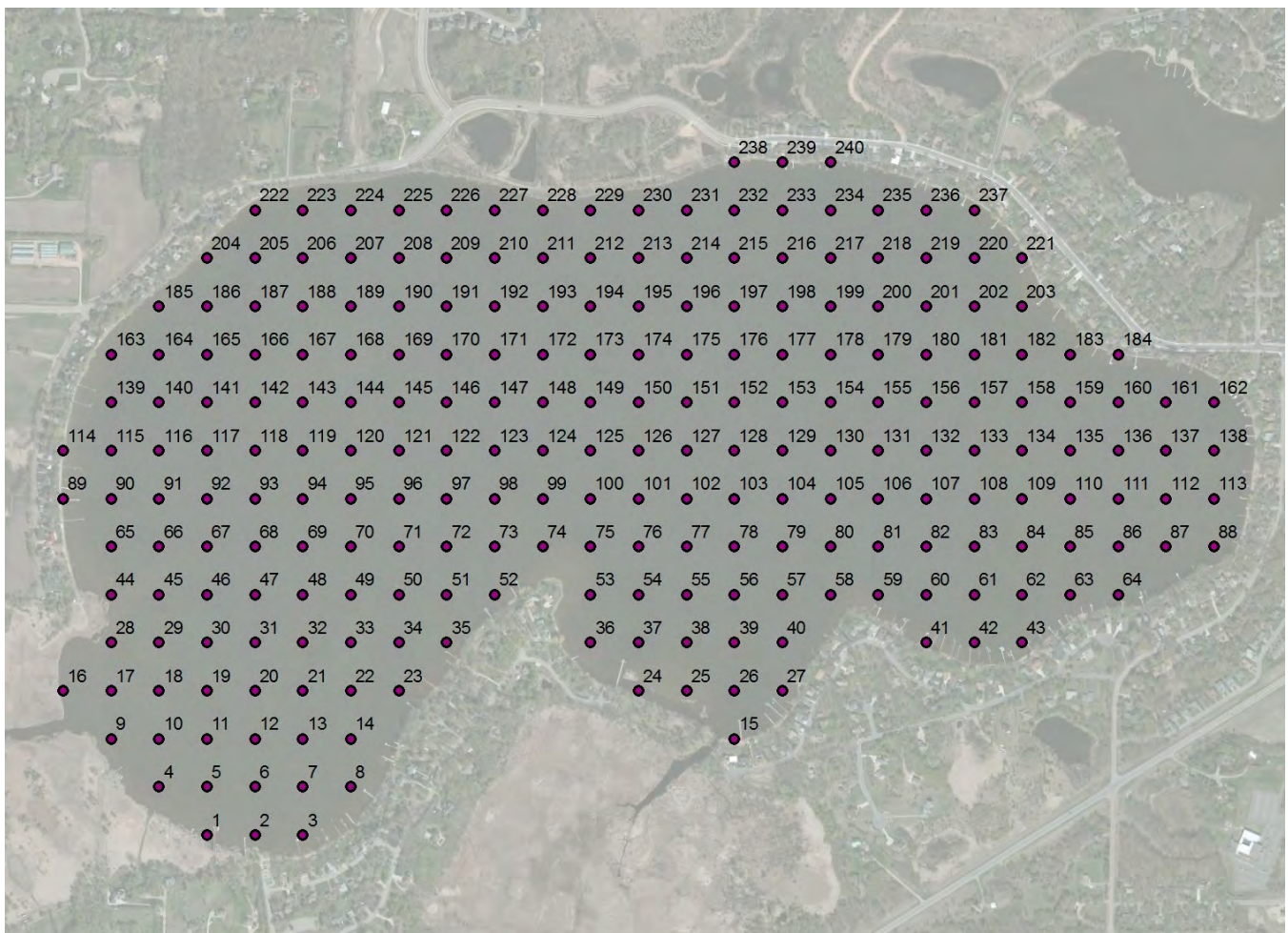

Figure B1. Point-intercept sample sites for Spring Lake in 2015. Sample sites were spaced 50 meters apart.

Results - Point Intercept Aquatic Plant Survey on August 24, 2015: Results of
the summer aquatic plant survey conducted on July 30, 2015 found nine native submerged plant species and one non-native plant species present and restricted to water depths of 7 feet or less in Spring Lake (Table B1). Coverage of the native plants species found in the July survey are shown in Figure B2. Native plants were found around the perimeter of the basin of Spring Lake. Plant distribution and abundance are shown in Table B1.

Table B1. Spring Lake aquatic plant occurrence and density for the July 30, 2015 survey based on 74 sites. Density ratings are 1-5 with 1 being low and 5 being most dense.

Spring Lake	All Stations (n=113)		
	Occur	% Occur	Average Density
Coontail (*Ceratophyllum demersum*)	17	15	1.6
Chara (*Chara sp*)	5	4	1.0
Elodea (*Elodea canadensis*)	47	42	1.6
Naiads (*Najas flexilis*)	24	21	1.8
Curlyleaf pondweed (*Potamogeton crispus*)	13	12	1.1
Claspingleaf pondweed (*P. Richardsonii*)	4	4	1.5
Stringy pondweed (*P. sp*)	33	29	1.2
Sago pondweed (*Stuckenia pectinata*)	19	17	1.6
Water celery (*Vallisneria americana*)	10	9	2.1
Water stargrass (*Zosterella dubia*)	6	5	1.0
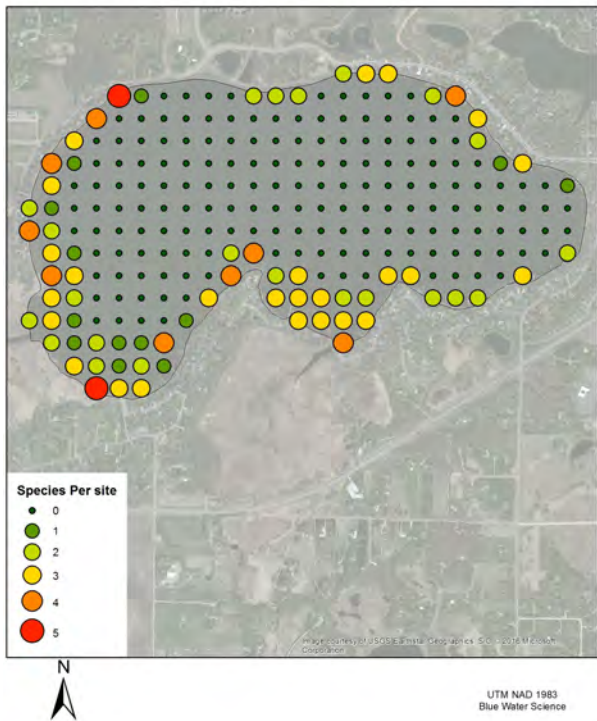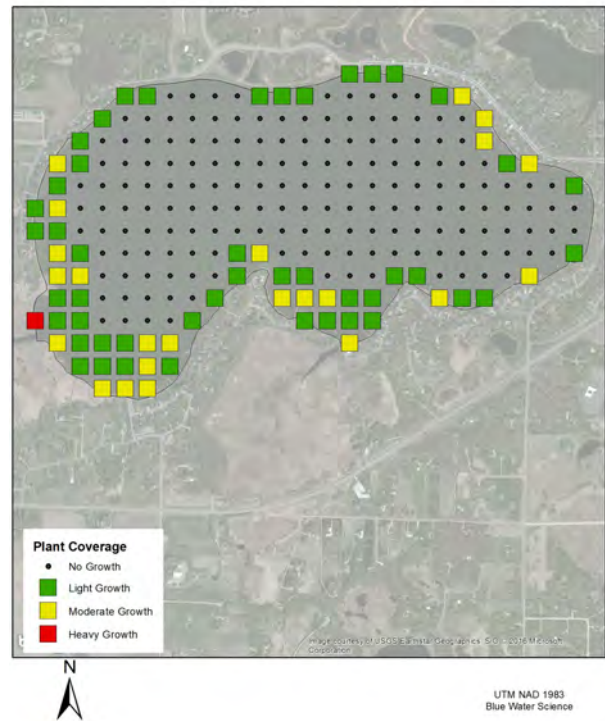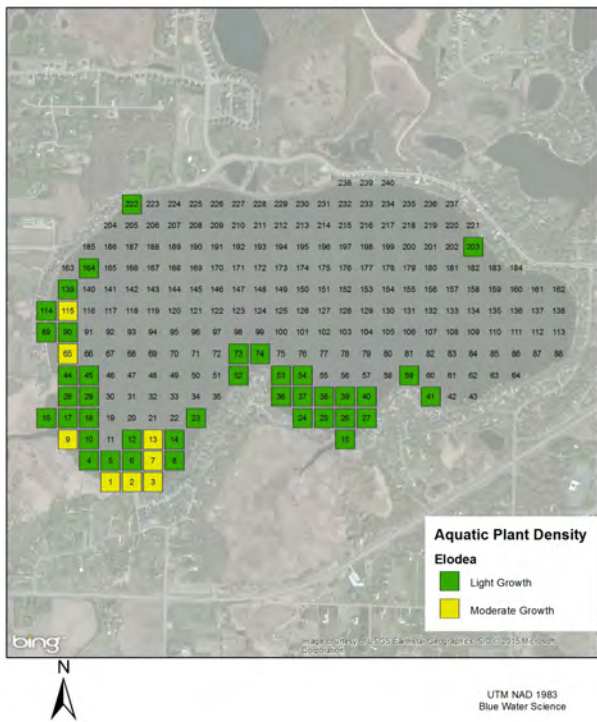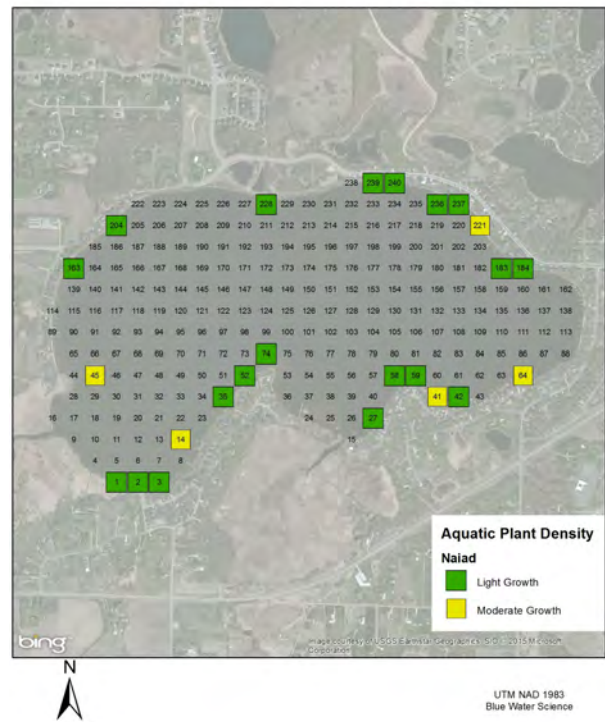
Figure B2. Distribution and abundance maps for select submerged aquatic plant species.
Key: green = light growth, yellow = moderate growth, and red = heavy growth.

Table B2. Individual sample site data for sites sample in Spring Lake on July 30, 2015.

Site	Depth (ft)	Chara	Clasping-leaf	Coontail	Curlyleaf	Elodea	Naiad	Sago	Stringy	Water celery	Water stargrass	Fila algae	No plants
1	3			1		3	1	1			1		
2	4			1		3	1						
3	4			1		3	2						
4	5			1	1	1						2	
5	6				1	1						1	
6	6					1						1	
7	6				1	3							
8	5					2							
9	4			3		3							
10	6					2						1	
11	7			1					1				
12	9					2							
13	9					3							
14	8			1		2	3		2				
15	2			2		1		3	1				
16	3			4		2						4	
17	5			1	1	1						1	
18	7					2							
19													1
20													1
21													1
22													1
23	6					1							
24	2			1		1		1					
25	2	1				1		1					
26	5			2	1	1							
27	4					2	2	1					
28	2			2		1		1					
29	8					1			1				
30													1
31													1
32													1
33													1
34													1
35	5						1		1	2			
36	5			3		1		1					
37	5					1		3	1				
38	4					2		1		3			
39	4					1			1				
40	8				1	1							
41	2					1	3						
42	4						2			1		1	
43	4									1	1		
44	3		1	2		2				3			
45	5					1	3		1				
46													1
47													1
48													1
49													1
50													1
51	13												
52	4					1	1	1		2			
53	4	1				1							
54	9				1	1			1				
55	13												
57													1
58	6				1		1		2				
59	7					1	2		1				
60	11												
63	8												
64	5						3		1			1	
65	5			1	1	3							

Appendix B - iv

Table B2. Individual sample site data for sites sample in Spring Lake on July 30, 2015.

Site	Depth (ft)	Chara	Clasping-leaf	Coontail	Curlyleaf	Elodea	Naiad	Sago	Stringy	Water celery	Water stargrass	Fila algae	No plants
66	6			1								2	
67													1
68													1
69													1
72													1
73	8					2			1				
74	5					1	2		1	3			
75	10												
87	16												
88	5							2	1				
89	2		1			2			1		1	1	
90	6					1			1			1	
91													1
114	2					2		1					
115	6					3						1	
116													1
138													1
139	6					2		1	1				
140													1
162	7								1				
163	3		1				2		2	3			
164	9					1							
183	6						1						
184	3		3				1			1			
185	4							1	2	2			
186													1
202													1
203	5					1		3					
204	4	1			1		2		2				
205													1
220													1
221	3	1					3				1		
222	3			2	1			1	2		1		
223	7								2				
224													1
225													1
226													1
227	9												
228	5						2		1			2	
229	5							2	1				
230	8				1				1				
231													1
232													1
233													1
234													1
235													1
236	7						1		1				
237	4						1	3	2	1			
238	4							2	1				
239	3	1					1		1				
240	4				1		1		1				
Average		1.0	1.5	1.6	1.1	1.6	1.8	1.6	1.2	2.1	1.0	1.5	1.0
Occurrence (113 sites)		5	4	17	13	47	24	19	33	10	6	12	35
% occurrence		4	4	15	12	42	21	17	29	9	5	11	31