Spring Lake on June 24, 2013

Aquatic Plant Surveys and Curlyleaf Pondweed Evaluation for Spring Lake, Scott County, Minnesota in 2013

No Open Lake Herbicide Application from 2007- 2013

Spring Plant Survey and Stem Density Assessment: May 29, 2013 (water temp: 61°F)
Early Summer Plant Survey and Stem Density Assessment: June 24, 2013

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Summary

Curlyleaf pondweed distribution and abundance were evaluated May 29, 2013 to determine if curlyleaf control was needed. In 2013, curlyleaf control was not necessary. A follow-up curlyleaf survey was conducted on June 24, 2013 to determine the status of curlyleaf pondweed.

Curlyleaf was found at 3 out of 66 sites in May (Figure A) and the density of the curlyleaf growth was light. Then the June curlyleaf assessment found curlyleaf growth had expanded since the May 29 assessment but growth was still light (Figure B). There has been no open water curlyleaf treatment in Spring Lake from 2007 through 2013.

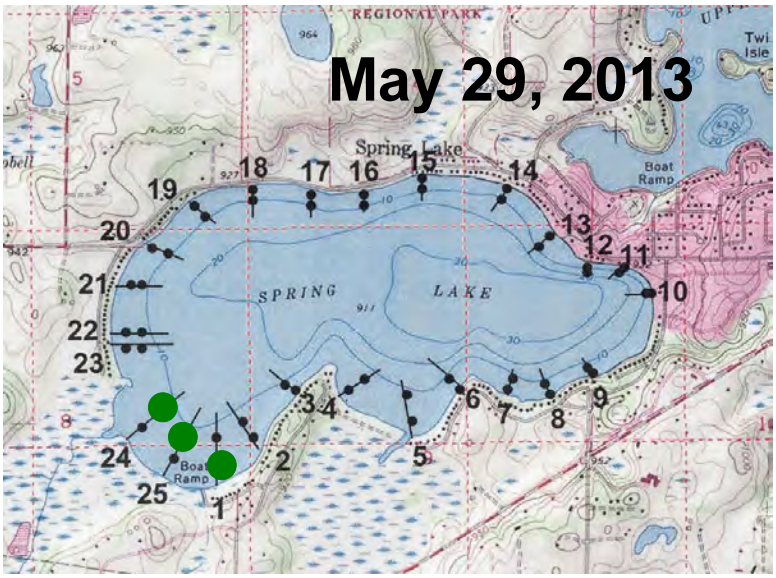


Figure A. Map of curlyleaf pondweed sample points on 25 transects for May 29, 2013. Colored sample areas indicate the growth in May of 2013 for curlyleaf pondweed. Green = light growth of curlyleaf pondweed.

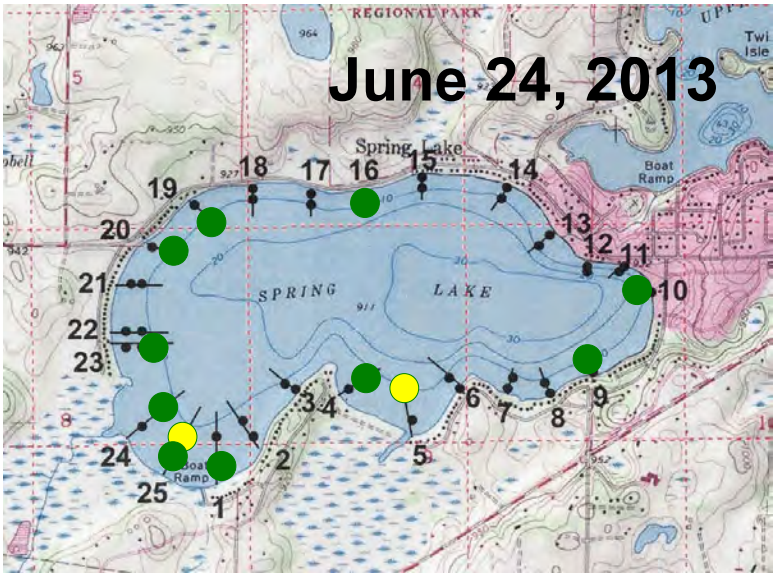


Figure B. Map of curlyleaf pondweed sample points on 25 transects for June 24, 2013. Colored sample areas indicate the growth in late June, 2013 for curlyleaf pondweed. Green = light growth of curlyleaf pondweed.

What's Next? Treating heavy growth of curlyleaf pondweed based on early season curlyleaf distribution was conducted in Spring Lake from 2002 through 2006. However, there has been no treatment necessary due to light growth from 2007-2013. Stem density assessments have supported the treatment or no treatment decisions (Figure C). 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. Using this approach, it was determined that no areas needed treatment in 2013 and the subsequent recheck found no heavy growth of curlyleaf pondweed.

In 2014, to continue to make concise delineations for future possible treatments, a lake sediment survey should be conducted. Results indicate where light, moderate, and heavy curlyleaf growth are likely to occur based on sediment characteristics. These results combined with data from 2013 and then early season curlyleaf scouting in April or May will give confidence in areas to treat, if needed, in 2014. 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.

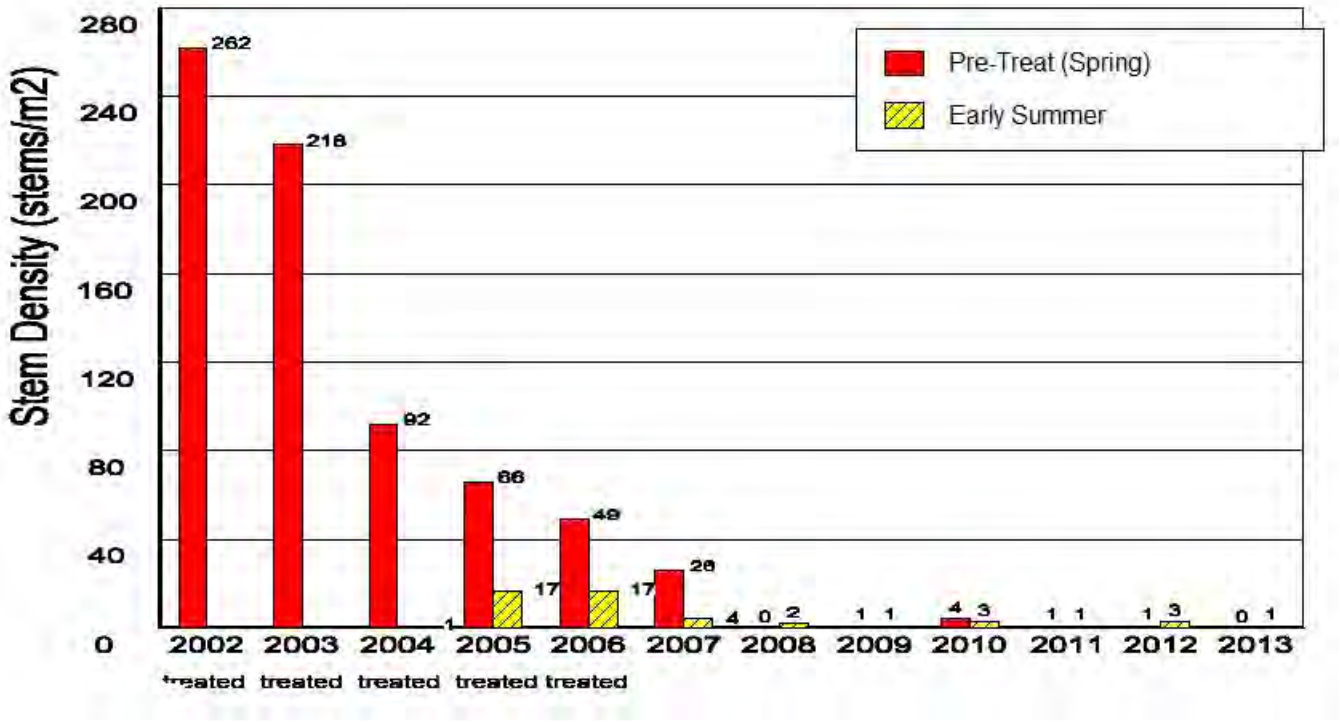


Figure C. Curlyleaf stem densities for early season monitoring for 2002-2013 for two sites in Spring Lake. Curlyleaf stem densities have been low since 2007 and no treatment has occurred.

Aquatic Plant Surveys and Curlyleaf Pondweed Evaluation for Spring Lake, Scott County, Minnesota in 2013

Introduction and Methods

Spring Lake has an area of 592 acres with a littoral area of 290 acres (source: MnDNR). An initial curlyleaf pondweed assessment was conducted on May 29, 2013. A follow-up curlyleaf pondweed assessment was conducted on June 24, 2013 to characterize the status of curlyleaf pondweed at it's peak growing period. Fifty sample locations on 25 transects are shown in Figure 1 and were selected based on areas where curlyleaf had been found in the past. A chart showing examples of curlyleaf growth conditions are shown on the next page.

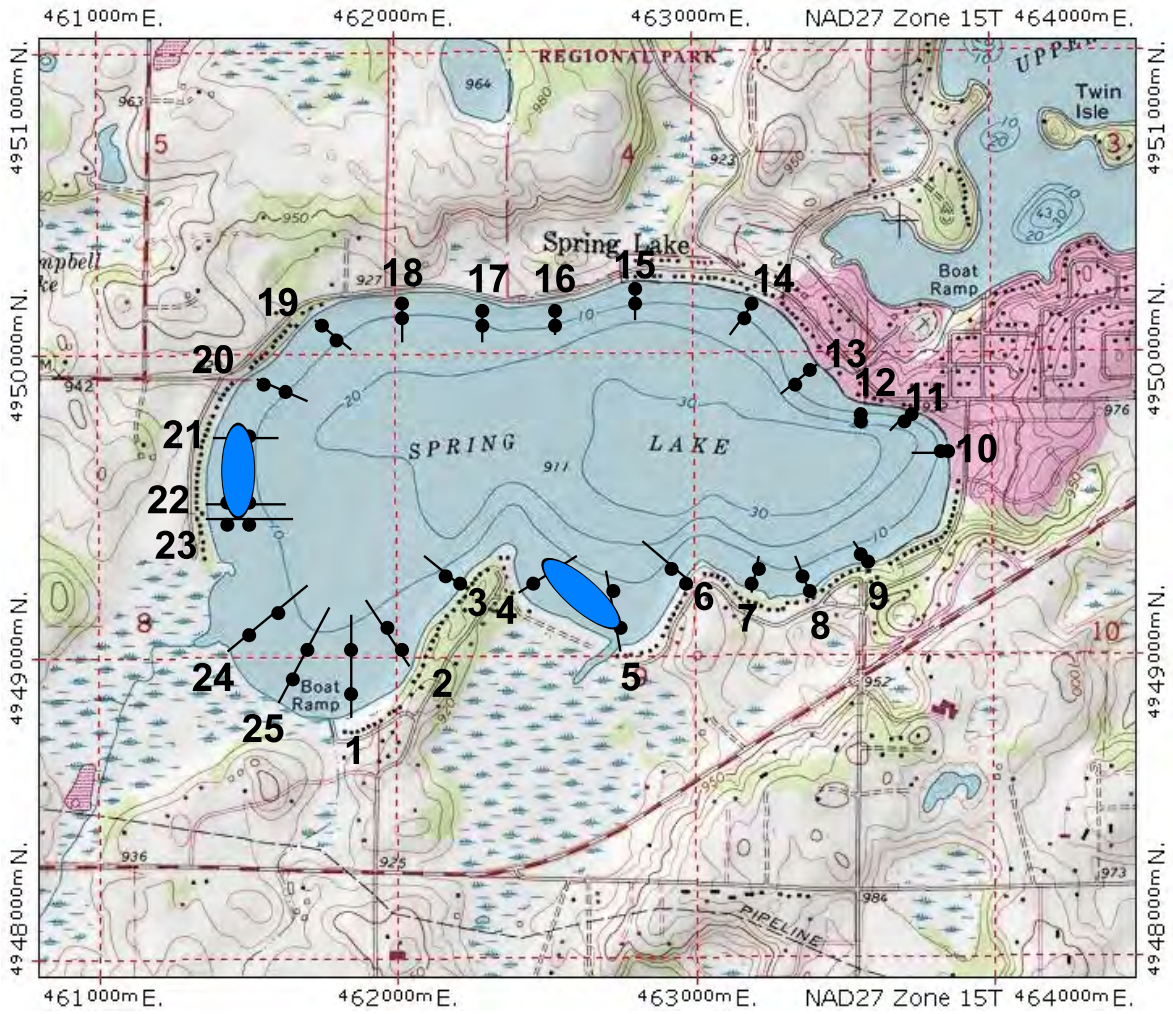
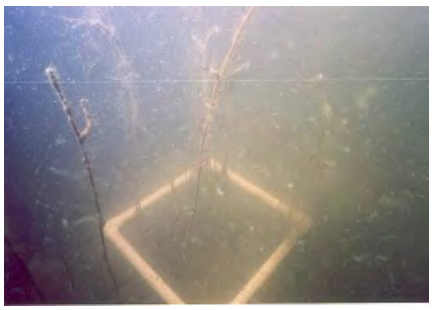


Figure 1. Sample sites for whole lake plant surveys are shown with black numbers. There are 50 aquatic plant survey sites and, in addition, there are two underwater evaluation sites located in the dark blue shaded areas. Map of treatment areas form 2002-2006 (5 years) are shown in dark blue shading.

Methods: Curlyleaf pondweed densities are represented on a scale of 1 to 5 with 5 being densest.

Light Growth Conditions



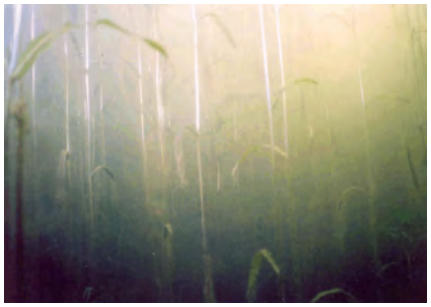
Plants rarely reach the surface.

Navigation and recreational activities are not generally hindered.

Stem density: 0 - 160 stems/m^2
Biomass: 0 - 50 g-dry wt/m^2
Estimated TP loading: <1.7 lbs/ac

MnDNR rake sample density equivalent for light growth conditions: 1, 2, or 3.

Moderate Growth Conditions



Broken surface canopy conditions.

Navigation and recreational activities may be hindered.

Lake users may opt for control.

Stem density: 100 - 280 stems/m^2
Biomass: 50 - 85 g-dry wt/m^2
Estimated TP loading: 2.2 - 3.8 lbs/ac

MnDNR rake sample density equivalent for moderate growth conditions: 2, 3 or sometimes, 4.

Heavy Growth Conditions

Solid or near solid surface canopy conditions.

Navigation and recreational activities are severely limited.

Control is necessary for navigation and/or recreation.

Stem density: 400+ stems/m^2
Biomass: >300 g-dry wt/m^2
Estimated TP loading: >6.7 lbs/ac

MnDNR rake sample density has a scale from 1 to 4. For certain growth conditions where plants top out at the surface, the scale has been extended: 4.5 is equivalent to a near solid surface canopy and a 5 is equivalent to a solid surface canopy. Heavy growth conditions have rake densities of a 4 (early to mid-season with the potential to reach the surface), 4.5, or 5.

Curlyleaf Pondweed Assessment on May 29, 2013 in Spring Lake

A curlyleaf assessment was conducted using rake sampling on May 29, 2013 and curlyleaf was found at low densities at 3 out of 66 sites (Table 1 and Figure 2). No curlyleaf pondweed treatments were proposed for offshore curlyleaf control in 2013. A total of four submerged plant species were observed.

Table 1. Aquatic plant densities based on rake sampling for May 29, 2013. Densities are based on a scale from 1 to 5 with 5 being the densest. Curlyleaf stems per rake sample were also noted. Areas with green shading are predicted to have light to moderate growth at the peak of the curlyleaf growth cycle. Areas with yellow shading are predicted to have moderate to heavy curlyleaf growth.

Site	Depth (ft)	Claspingleaf	Coontail	Curlyleaf	Stringy	FA	No Plants
T 1	4			1			
T 1	7						1
T 1	8						1
T 2	4					1	
T 2	6						1
T 3	4					1	
T 3	5						1
T 3	6						1
T 4	4						1
T 4	5						1
T 5	4				1		
T 5	6						1
T 6	4					1	1
T 6	7						1
T 7	4					1	1
T 7	5						1
T 7	6						1
T 8	4					1	1
T 8	5					1	1
T 8	6						1
T 9	4						1
T 9	6						1
T 9	7						1
T10	4						1
T10	7						1
T10	8						1
T11	4					1	1
T11	5					1	
T11	6						1
T11	7						1
T12	4	1					
T12	5						1
T13	4					1	1
T13	6					1	1
T14	4						1
T14	6						1
T15	3						1
T15	4						1
T15	5						1
T15	6						1
T16	4						1
T16	6						1
T17	4						1
T17	5						1
T17	7						1
T18	4						1
T18	6						1
T18	8						1
T19	4						1
T19	6						1

Table 1. Aquatic plant densities based on rake sampling for May 29, 2013. Densities are based on a scale from 1 to 5 with 5 being the densest. Curlyleaf stems per rake sample were also noted. Areas with green shading are predicted to have light to moderate growth at the peak of the curlyleaf growth cycle. Areas with yellow shading are predicted to have moderate to heavy curlyleaf growth.

Site	Depth (ft)	Claspingleaf	Coontail	Curlyleaf	Stringy	FA	No Plants
T20	4				1		
T20	6						1
T21	4						1
T21	5						1
T22	4						1
T22	5						1
T22	6						1
T23	4						1
T23	5						1
T24	4						1
T24	6		1	1			
T25	4						1
T25	6						1
T25	6				1		
T25	7		1	1			
T25	7						1
Average		**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**
occurrence (66 sites)		1	2	3	3	10	56
% occurrence		2	3	5	5	15	85

Curlyleaf Distribution and Abundance in Spring Lake, May 29, 2013

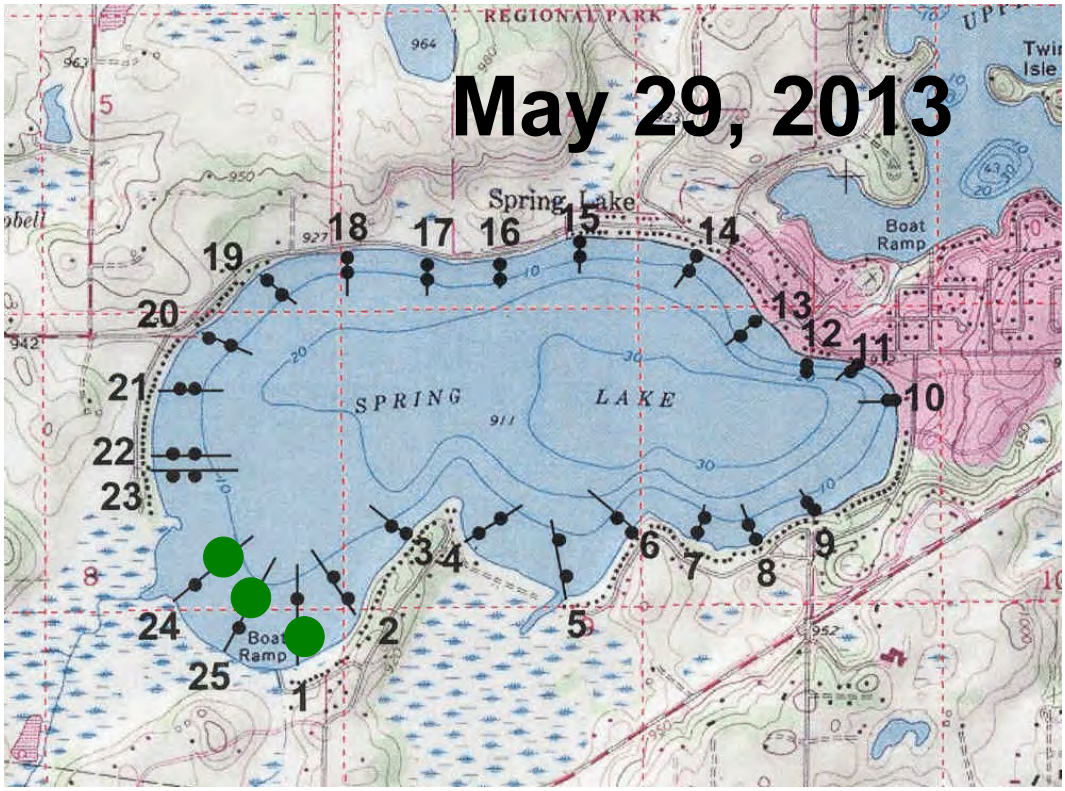


Figure 2. Curlyleaf delineation in Spring Lake on May 29, 2013. Curlyleaf was growing at light densities and was found at 3 sites. Green dots represent light curlyleaf growth.

Curlyleaf Pondweed Assessment on June 24, 2013 in Spring Lake

Curlyleaf growth was rechecked on June 24, 2013, which was the peak growing period for curlyleaf in lakes in the area. A total of 62 sites were monitored with rake sampling on June 24, 2013. Curlyleaf was found at 14 sample sites out of the 62 that were monitored (Table 2). Curlyleaf growth was mostly light. Curlyleaf abundance did not increase significantly from May to June.

Curlyleaf pondweed was the most abundant plant in the June assessment.

Table 2. Aquatic plant densities based on rake sampling for June 24, 2013. Densities are based on a scale from 1 to 3 with 3 being the densest. Curlyleaf stems per rake sample were also noted. Areas with green shading are predicted to have light to moderate growth at the peak of the curlyleaf growth cycle.

Site	Depth (ft)	Coontail	Curlyleaf	CLP-stems	Elodea	Sago	Stringy	No Plants
T 1	3		1			2		
T 1	7							1
T 2	4						2	
T 2	6							1
T 3	3						1	
T 3	6							1
T 4	3						2	
T 4	5		1	3				
T 4.5	4						4	
T 5	4					2		
T 5	6		3	16				
T 5	6		3	14				
T 5	6		3	12				
T 5	7							1
T 6	3					2		
T 6	5					1		
T 6	7							1
T 7	3					1		
T 7	6							1
T 8	4							1
T 8	5							1
T 9	4		1	1				
T 9	6							1
T10	4					1		
T10	6		1	1				
T11	4							1
T11	6							1
T12	4						1	
T12	6							1
T13	4					1		
T13	5							1
T14	4							1
T14	6							1
T15	4							1
T15	6							1
T16	4		1	2		1		
T16	7							1
T17	4							1
T17	7							1
T18	4						1	
T18	5						1	
T18	7							1
T19	4							1
T19	5	1	1	2				
T20	4						1	
T20	6		1	2				
T21	4							1
T21	5							1

Table 2. Aquatic plant densities based on rake sampling for June 24, 2013. Densities are based on a scale from 1 to 3 with 3 being the densest. Curlyleaf stems per rake sample were also noted. Areas with green shading are predicted to have light to moderate growth at the peak of the curlyleaf growth cycle.

Site	Depth (ft)	Coontail	Curlyleaf	CLP-stems	Elodea	Sago	Stringy	No Plants
T22	4							1
T22	5							1
T22	6							1
T22	7							1
T23	3	1						
T23	6							1
T23	6		1	2				
T23	7	1						
T24	4	1				1	1	
T24	5							1
T24	6		1	2	1			
T24	8							1
T25	4		2	10		1	1	
T25	6		3	20				
Average		**1.0**	**1.6**		**1.0**	**1.3**	**1.5**	**1.0**
occurrence (62 sites)		4	14		1	10	10	31
% occurrence		6	23		2	16	16	50

Curlyleaf Conditions in Spring Lake, June 24, 2013

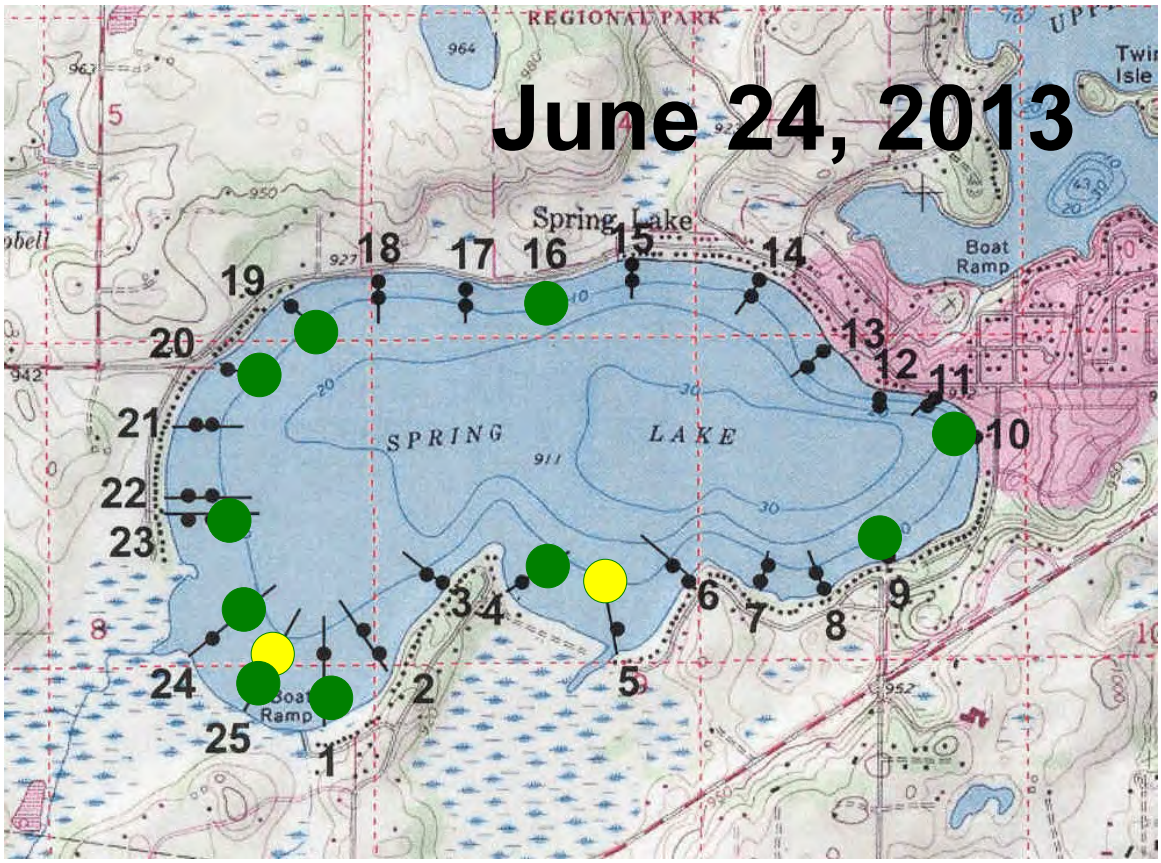


Figure 3. Map of curlyleaf distribution in Spring Lake on June 24, 2013. Green circles = curly leaf density of a "1" or "2". Yellow circle = curlyleaf density of a "3".

Comparison of Early Season to Late Season Curlyleaf Growth

Light growth of curlyleaf pondweed was found in the May 29, 2013 assessment (Table 3). There were no open water herbicide treatments in 2013. A curlyleaf reassessment on June 24, 2013 found curlyleaf to be growing at mostly light densities (Table 3 and Figure 4).

Table 3. Comparison of curlyleaf pondweed stem densities based on rake sampling for May 29 and June 24, 2013. Densities are based on a scale from 1 to 5 with 5 being the densest.

site	depth (ft)	May 29	June 24
T1	4	1	1
	6		
	7		
T2	4		
	6		
T3	4		
	5		
	6		
T4	4		
	5		1
T5	4		
	6		3
T6	4		
	7		
T7	4		
	5		
	6		
T8	4		
	5		
	6		
T9	4		1
	6		
	7		
T10	4		
	6		1
	7		
	8		
T11	4		
	5		
	6		
	7		
T12	4		
	5		
T13	4		
	6		
T14	4		
	6		
T15	3		
	4		
	5		
	6		
T16	4		1
	6		
T17	4		
	5		
	7		

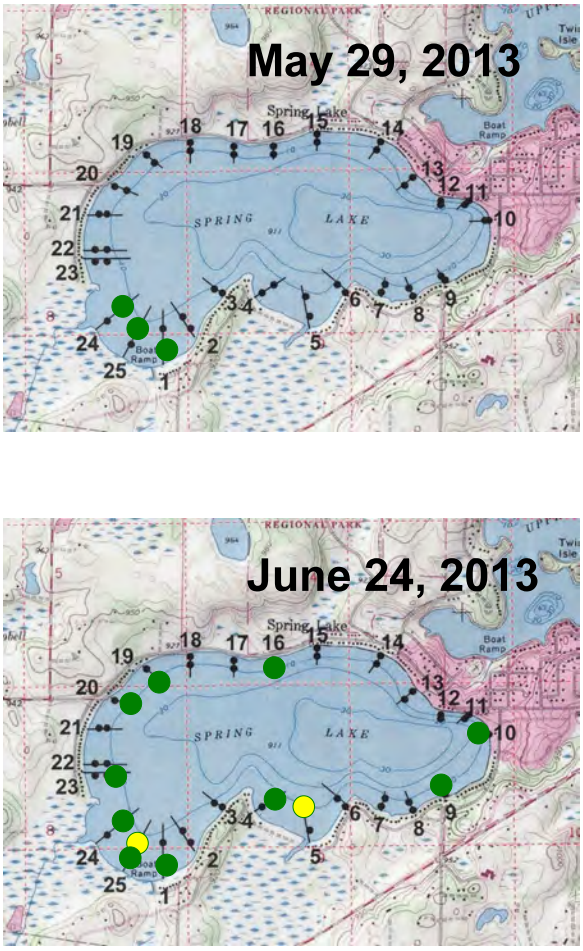


Figure 4. Maps of curlyleaf pondweed distribution are shown on the top (early season - May) and bottom (late season - June) maps.

Table 3. Concluded.

site	depth (ft)	May 29	June 24
T18	4		
	6		
	8		
T19	4		
	5		1
	6		
T20	4		
	6		1
T21	4		
	5		
T22	4		
	5		
	6		
T23	4		
	5		
	6		1
T24	4		
	6	1	1
T25	4		2
	6		3
	7	1	

Curlyleaf Stem Densities Collected by Scuba Diving at Two Treatment Locations on May 29 and June 24, 2013

Curlyleaf stem densities were determined by scuba diving at two depths for sample locations at Transect 4.5 and Transect 22 that were treated from 2002-2006. Ten quadrat samples were taken at two depths at each location. A total of 40 quadrat samples were taken on each date. The results for 2013 show curlyleaf was sparse and was found at low stem densities for spring and early summer (Table 4). These stem densities were similar to densities found from 2008 through 2013 and are low compared to pre-treatment stem densities from 2002 where there were over 250 stems/m^2 (Figure 5).

Table 4. Curlyleaf pondweed stem densities (stems/m^2) for 2013.

Quadrat	May 29, 2013 (stems/m^2)				June 24, 2013 (stems/m^2)			
	T4.5		T22		T4.5		T22	
	4 ft	5 - 6 ft	4 ft	5 - 6 ft	4 ft	5 - 6 ft	4 ft	5 - 6 ft
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	10	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
AVE	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**

Curlyleaf Plant Density Based on Scuba Diving from 2002 - 2013: Scuba diving was used to collect curlyleaf stem densities at 4 feet and 5 feet for 10 sites at each depth at two 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.

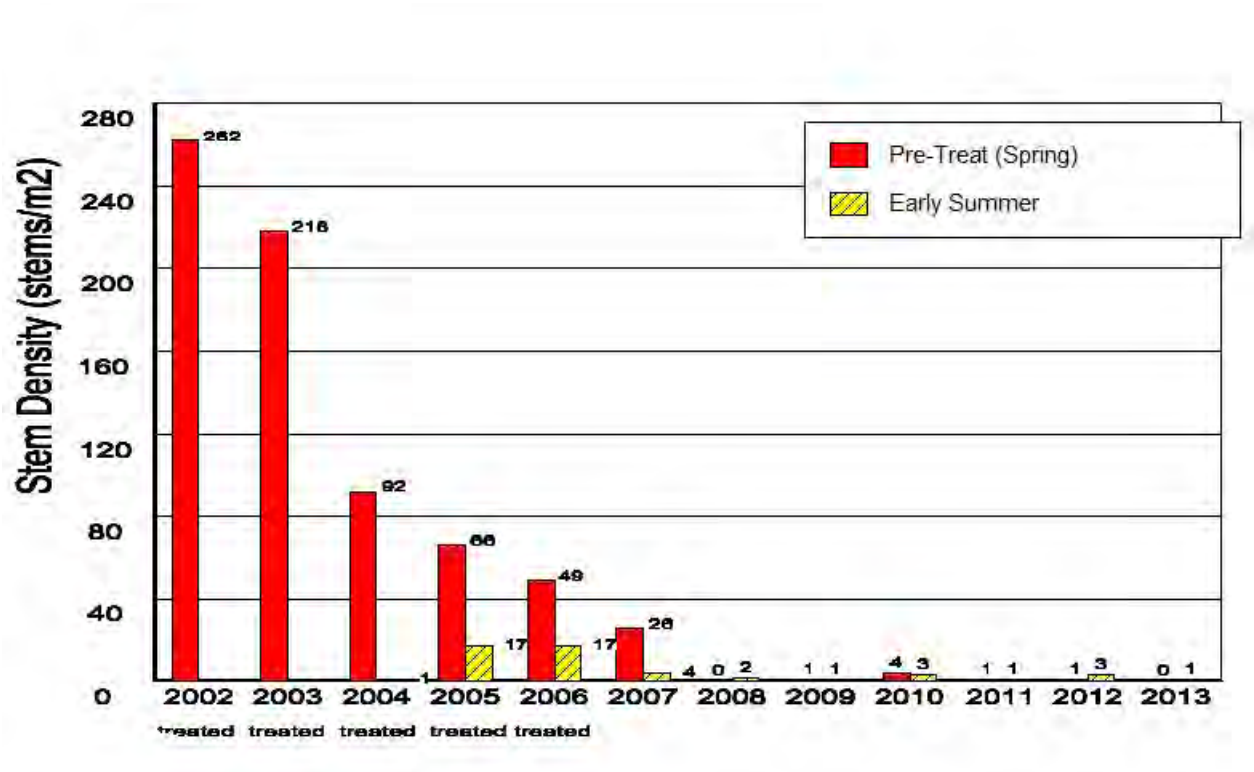


Figure 5. Curlyleaf stem densities (stems/m^2) for early season and late season monitoring (using scuba diving) for 2002-2013 (ND = no data).

Figure 6. Curlyleaf pondweed conditions in May (left) and June (right).

Review of Spring Lake Aquatic Plants Over the Years

Summary of Whole Lake Curlyleaf Pondweed Surveys for 2007-2013

Curlyleaf pondweed was found at 3 locations out of the 66 that were monitored on May 29, 2013 in the course of an aquatic plant survey that sampled two depths on 25 line transects. Curlyleaf growth was sparse in 2013 and has been sparse since 2007. From 2007 through 2013 there have been no open water herbicide applications (Table 5). (Transect and sample locations are shown in Figure 1.)

Table 5. Density of curlyleaf, at two depths, shallow (S) which is 0-4 feet, and deep (D) which is 5-8 feet, for each transect, for the early season plant surveys from 2007-2013. The density rating is on a scale from 0.5 to 5 with 5 being the highest density. For 2010 through 2013, the numbers in parentheses indicate the number of CLP stems found in the rakehead sampler.

		2007		2008		2009		2010		2011		2012		2013	
Transect		Curlyleaf Plant Density		Curlyleaf Plant Density		Curlyleaf Plant Density		Curlyleaf Plant Density		Curlyleaf Plant Density		Curlyleaf Plant Density		Curlyleaf Plant Density	
		Apr 15	Jun 5	Apr 29	Jun 13	Apr 23	Jun 10	Apr 27	Jun 20	May 12	Jun 10	Apr 17	Jun 5	May 29	Jun 24
1	S		2			0.5	2							1 (1)	1
	D			0.7	1	1					0.5 (1)				
2	S									0.5 (1)					
	D		1.8		1							0.5 (1)			
3	S								1 (3)						
	D		1.5					0.5 (1)							
4	S			0.5			1				0.5 (1)				
	D		1		0.5						0.5 (1)				1 (3)
5	S		0.7				0.5	1 (1)	1 (3)		2.5 (9)				
	D							1 (1)	1.3 (3)		0.3 (1)		1 (3)		3 (12, 14, 16)
6	S				1						1 (1)				
	D	1						0.5 (1)				0.5 (3)			
7	S	1	1		1					0.5 (1)					
	D	0.5	0.5										0.5 (2)		
8	S							0.5 (1)		0.5 (1)			1 (2)		
	D						0.5			1 (2)					
9	S		1					1 (1)	0.5 (2)		2 (8)		1 (1)		
	D	0.5	1.8				0.5		0.5 (1)			1 (5)			1 (1)
10	S		0.5								1 (2)		1(1)		
	D		1												1 (1)
11	S														
	D														
12	S		1				1	1 (1)							
	D		1		0.3										
13	S											1 (3)			
	D	0.8	3.5		3						1 (2)				
14	S	1	1		1			1 (1)	1 (1)	0.5 (1)	1 (4)				
	D	1	2.8		1.5			0.3 (1)	1 (1)		1 (2)				
15	S		3.5		1		2	1 (2)	1 (3)						
	D	1.3	2.8		2		0.3	1 (3)	1 (1)	0.5 (1)	0.5 (1)				
16	S		1					1 (1.5)	1 (1)		0.8 (2)				1 (2)
	D	0.5	1.8					1 (1)	1 (2)		0.5 (2)		0.5 (1)		
17	S	0.5						1 (4)			0.5 (1)				
	D	0.3	2	0.3			0.3	1 (3)	1 (2)						
18	S	0.5			1			1 (3)							
	D	0.5	1	0.3				1 (4)		0.5 (1)	0.5 (1)	0.3 (3)	0.5 (1)		
19	S		1				0.5	1 (2)	1 (1)						
	D								1 (3)			0.5 (1)			1 (2)
20	S	0.5	2.8					0.5 (1)	1 (3)						
	D	0.5			1	0.3		0.5 (1)	0.5 (1)						
21	S		1.5				1	1 (1)	0.5 (1)	0.5 (1)					
	D		4										1 (1)		
22	S	1	1		1			1 (1)							
	D	1						0.3 (0.5)							
23	S	1					1		1 (4)	0.5 (1)					
	D	0.5	1		0.5										1 (2)
24	S	1			1	1	2		1 (2)						
	D	0.5			1			1 (1.5)	1 (2)					1	1 (2)
25	S	1	0.5		1	1	1		2 (6)	0.5 (1)	1 (3)				2 (10)
	D				1			1 (3)			0.8 (2)			1	3 (20)
Sites Where Curlyleaf Was Found		**22**	**29**	**4**	**19**	**5**	**14**	**25**	**21**	**10**	**18**	**6**	**8**	**3**	**12**

Summary of Curlyleaf Pondweed Distribution and Abundance from 2000 - 2012

Transect	Depth	2000	2002	2003	2004		2005		2006		2007		2008		2009		2010		2011		2012		2013		Avg	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	May 12	Jun 10	Apr 17	Jun 5	May 29	Jun 24		
1	S	5	0.5	0	0	0	0	0	0	0	0	2	0	0	0.5	2	0	0	0	0	0	0	1	1	0.5	
	M	4	2	2	1	0	1	1	0.5	0	0	0	0.7	1	1	0	0	0	0	0.5	0	0			0.7	Heavy
2	S	4	0.5	0	0.5	0	0	2	1	0	0	0	0	0	0	0	0	0	0.5	0	0	0			0.4	
	M	5	2	4	0.5	0	0	0.3	0.7	0	0	1.8	0	1	0	0	0	0	0	0	0.5	0			0.8	Moderate
3	S	2	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0.5	1	0	0	0	0			0.3	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	0	0	0	0			0.5	Light
4	S	4	2	0.5	1	0	1	0	0	0	0	0	0.5	0	0	1	0	0	0	0.5	0	0			0.5	Moderate
	M	5	2.5	4	1	0	2	0.8	1.3	0.7	0	1	0	0.5	0	0	0	0	0	0.5	0	0		1	0.9	
5	S	2	2	0.5	1	0	2	1	1	0.5	0	0.7	0	0	0	0.5	1	1	0	2.5	0	0			0.7	
	M	5	3	2	2.5	0	0.5	0	2	1	0	0	0	0	0	0	1	1.3	0	0.3	0	1		3	1.0	Light
6	S	1.8	0	0	0.5	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0			0.3	
	M	2	2	1	1	0	0.5	0.5	2	0.3	1	0	0	0	0	0	0.5	0	0	0	0.5	0			0.5	Moderate
7	S	1	0.5	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0.5	0	0	0			0.3	
	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	0	0	0	0.5			0.7	Light
8	S	1	1	0	0.5	0	0.3	1	0	0	0	0	0	0	0	0	0.5	0	0.5	0	0	1			0.3	
	M	3	1	1	0	0	0.5	1	0	0.3	0	0	0	0	0	0.5	0	0	1	0	0	0			0.4	Moderate
9	S	4	0.5	0	0	0	0	1	0	1	0	1	0	0	0	0	1	0.5	0	2	0	1		1	0.6	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	0	0	1	0			0.6	
10	S	2	0	0	0	0	0	0	0	0	0	0.5	0	0	0	0	0	0	0	1	0	1			0.2	
	M	4	0	0	0.5	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0		1	0.3	Light
11	S	1	0	0	0	0	0	0	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	0	0	0	0			0.2	Moderate
12	S	3	0.5	0	0.5	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0			0.3	
	M	3	0.5	0	0.5	0	0	0	0	0	0	1	0	0.3	0	0	0	0	0	0	0	0			0.3	
13	S	0	0.5	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0			0.1	
	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	0	1	0	0			0.8	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	0.5	1	0	0			0.7	
	M	4	1.5	2	1	0	2	1.5	2	3	1	2.8	0	1.5	0	0	0.5	1	0	1	0	0			1.2	Moderate
15	S	2	1	0.5	2	0	0.3	1	1	2	0	3.5	0	1	0	2	1	1	0	0	0	0			0.9	
	M	2	0.5	3	1	1	1	1.5	1	2.5	1.3	2.8	0	2	0	0.3	1	1	0.5	0.5	0	0			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	0	0.8	0	0		1	0.5	
	M	4	4	1	1	1	1	1	0.5	1.5	0.5	1.8	0	0	0	0	1	1	0	0.5	0	0.5			1.0	Moderate
17	S	2	1	0.5	1	0	1.5	1	1.5	2	0.5	0	0	0	0	0	1	0	0	0.5	0	0			0.6	Light
	M	4	2	2	1	0	1	0	1.5	1.7	0.3	2	0.3	0	0	0.3	1	1	0	0	0	0			0.9	
18	S	2	0	0.5	0.5	0	1	1	0	2	0.5	0	0	1	0	0	1	0	0	0	0	0			0.5	
	M	4	3	2	1	0	2	1.8	0.8	2.5	0.5	1	0.3	0	0	0	1	0	0.5	0.5	0.3	0.5			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	0	0	0	0			0.7	
	M	5	1.5	2	0.5	0	0.3	0.3	0	0	0	0	0	0	0	0	0	1	0	0	0.5	0		1	0.6	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	0	0	0	0			0.8	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	0	0	0	0		1	0.9	
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	0.5	0	0	0			0.6	Moderate
	M	5	2.5	3.5	0.5	0	2	0.5	1.3	3	0	4	0	0	0	0	0	0	0	0	0	1			1.1	
22	S	3	0.5	0	0	0	0	0	0.5	2	1	1	0	1	0	0	1	0	0	0	0	0			0.5	
	M	5	2	3	1	0	1	1	0.2	1	1	0	0	0	0	0	0.5	0	0	0	0	0			0.7	Moderate
23	S	2	1	0	0.5	0	0	0	0	1	1	0	0	0	0	1	0	1	0.5	0	0	0			0.4	
	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	0	0	0	0		1	0.9	Moderate
24	S	3	1	0.5	0.5	0	0	4	0.5	0	1	0	0	1	1	2	0	1	0	0	0	0			0.7	
	M	5	1.5	4	2	0	1.5	0.5	0.5	1.3	0.5	0	0	1	0	0	1	1	0	0	0	0	1	1	0.9	Moderate
25	S	2	1	0.5	0.5	0	1	2	1.8	2	1	0.5	0	1	1	1	0	2	0.5	1	0	0		2	0.9	
	M	4.7	3	4	0	0	1	1	1.7	0.5	0	0	0	1	0	0	1	0	0	0.8	0	0	1	3	1.0	Moderate
Number of Reds		23	2	4	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0		
Avg CLP Density													0.5	1.1	0.7	1.0	0.8	0.8	0.6	0.9	0.6	1.0	1.0	1.6		

Depth Zones:

S = 0 - 4 feet
M = 5 - 8 feet

Figure 7. Summary of curlyleaf pondweed density for early summer aquatic plant surveys for Spring Lake from 2000 - 2011. 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.

Curlyleaf Pondweed Treatment and Coverage from 2002 - 2013: Spring Lake is a 580 acre eutrophic lake in Scott County, Minnesota with a history of nuisance curlyleaf pondweed growth going back to the 1980s. In 2000, heavy growth of curlyleaf pondweed was estimated at 180 acres. Major nuisance areas of curlyleaf were managed annually in Spring Lake from 2002 through 2006 (5-years). In 2006, there was an estimated 150 acres of curlyleaf pondweed but at mostly low to moderate abundance, prior to treatment. From 2007 through 2012, herbicides have not been applied in offshore areas. However, the coverage of curlyleaf has not increased in this time span. It is not clear why curlyleaf has been under control. In 2007, curlyleaf covered about 113 acres and in 2008 curlyleaf covered about 60 acres in June. In 2009 through 2013, curlyleaf covered about 50 to 90 acres and no heavy growth was observed (Figure 10).

Table 6. Curlyleaf treatment history for 2002 through 2013.

	Between T4 & T5	Between T19-25	Shorelines
2002	herbicides (14 ac)	harvesting (60 ac)	herbicides (individual permits)
2003	herbicides (14 ac)	harvesting (74 ac)	herbicides (individual permits)
2004	herbicides (14 ac)	herbicides (45 ac)	herbicides (individual permits)
2005	herbicides (14 ac)	herbicides (45 ac)	herbicides (individual permits)
2006	herbicides (14 ac)	herbicides (45 ac)	herbicides (individual permits)
2007	no treatment	no treatment	no treatment
2008	no treatment	no treatment	herbicides (individual permits)
2009	no treatment	no treatment	herbicides (individual permits)
2010	no treatment	no treatment	herbicides (individual permits)
2011	no treatment	no treatment	herbicides (individual permits)
2012	no treatment	no treatment	herbicides (individual permits)
2013	no treatment	no treatment	herbicides (individual permits)

Recommendations for 2014: Based on the findings for the last few years, no offshore herbicide treatments for the areas of T4-T5 (14 ac) and T19-25 (45 ac) are expected. However, early season scouting and plant surveys should be conducted to monitor potential curlyleaf problems. A late summer survey is recommended as well. It appears native plants may be increasing in Spring Lake and this survey would document the dynamics of the aquatic plant community.

Figure 8. Curlyleaf pondweed growth was very heavy in 2000.

Figure 9. Curlyleaf pondweed growth was light in 2010.

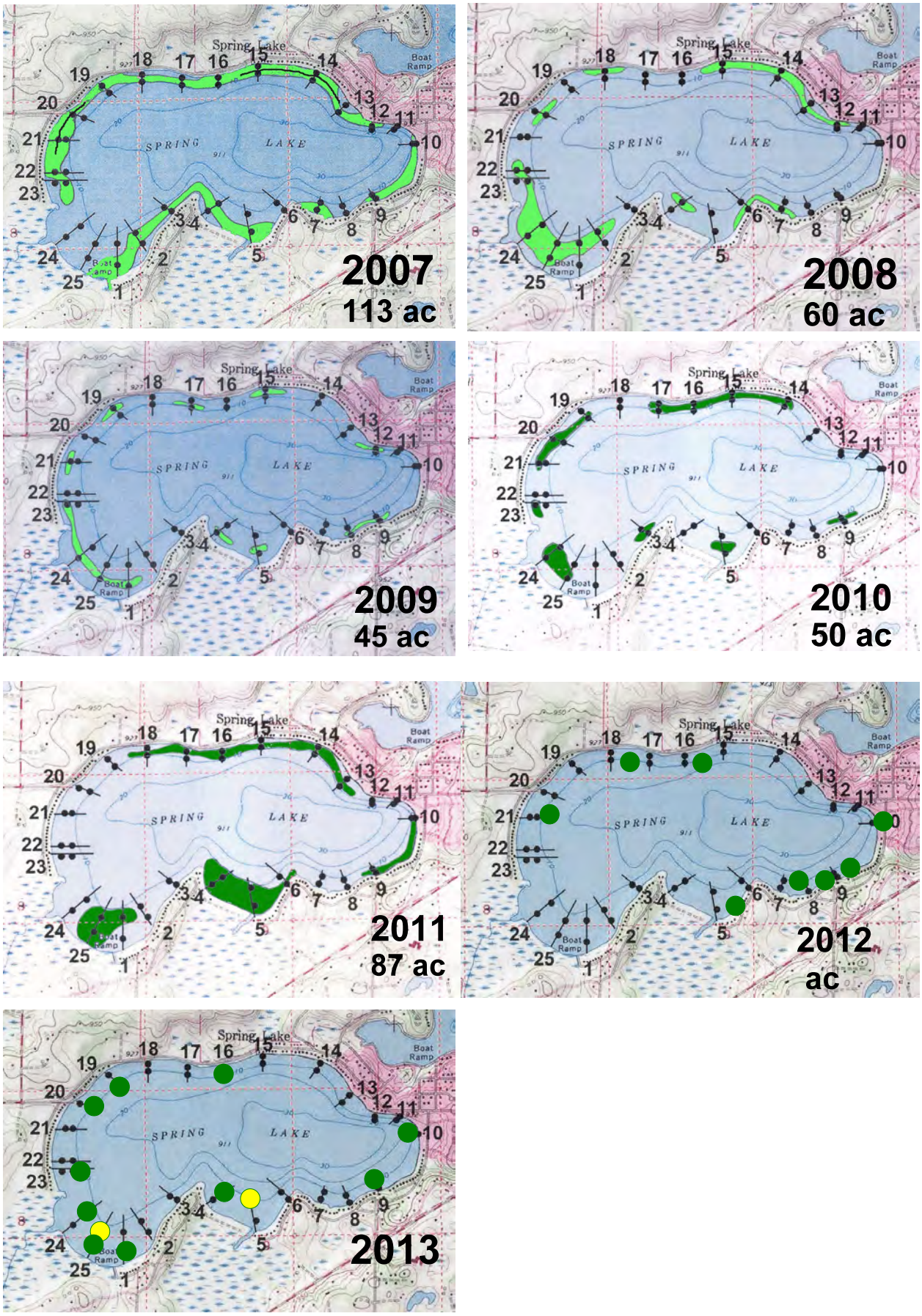


Figure 10. Curlyleaf pondweed distribution from 2007 through 2013.

Summary of All Species in Aquatic Plant Surveys from 1948 - 2013

Since 1948, a number of plant species within the aquatic plant community have appeared and others have disappeared (Table 7). The percent occurrence of the native plants elodea and water stargrass have decreased since 2000. Curlyleaf distribution and curlyleaf density are lower in 2013 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.

Figure 11. Aquatic plants in Spring Lake on June 24, 2013.

Table 7. List of aquatic plants found in past surveys. Surveys from 1948 to 1988 were conducted by MnDNR. Surveys in 2000 and 2002 through 2013 were conducted by Blue Water Science. Numbers for plant species in 2000 and 2002 through 2013 represent percent occurrence.

Year	1948	1973	1982	1986	1988
Date (month.day)	9.18	7.9	8.16	7.2	8.15
Secchi disc (ft)	2.6	3.0	3.3	--	2.5
Lesser duckweed (*Lemna minor*)				X	R
Duckweed (*Lemna sp*)			O		
White waterlilies (*Nymphaea tuberosa*)					
Greater duckweed (*Spirodela polyrhiza*)				X	
Coontail (*Ceratophyllum demersum*)	R	O	A	X	O
Chara (*Chara sp*)					
Elodea (*Elodea canadensis*)			O		O
Moss (*Drepanocladus sp*)					
Naiads (*Najas flexilis*)					
Berchtold's pondweed (*Potamogeton berchtoldi*)	R	O			
Curlyleaf pondweed (*P. crispus*)			R	X	
Variable pondweed (*P. gramineus*)	R	C	O		
Floatingleaf (*P. natans*)	R	C			P
Stringy pondweed (*P. pusillus*)					
Claspingleaf (*P. Richardsonii*)	R	C			O
Stringy pondweed (*P. strictifolius*)					
Narrowleaf pondweed (*P. sp*)			O	X	
Sago* (*Stuckenia pectinata*)	R	C			C
Star duckweed (*Lemna trisulca*)		C			
Wild celery (*Vallisneria americana*)			O		P
Mud plantain* (*Zosterella dubia*)	R	R	C		C
Number of submerged species	7	8	8	5	8

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

Table 7. Concluded.

Year	2000		2002		2003	2004			2005			2006			2007			2008			2009			2010		2011		2012		2013	
Date (month.day)	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	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
Secchi disc (ft)	7.0					7.1	7.2	3.5	16.7	6.9	2.0	4.7	5.0	2.0				2.3	3.9		3.5	6.2	2.9		2.2		5.6				
Lesser duckweed (*Lemna minor*)																	2														
Duckweed (*Lemna sp*)											6																				
White waterlilies (*Nymphaea tuberosa*)																															
Greater duckweed (*Spirodela polyrhiza*)								2																							
Coontail (*Ceratophyllum demersum*)		29	4	22		13	28	40	8	14	58	16	26	50	22	28	30	8	30	16	4	8	24	18	26	16	22	4	30	3	6
Chara (*Chara sp*)		4		2			4									2				8		2		12							
Elodea (*Elodea canadensis*)		25	8	18	6	25	48	68	22	54	76	64	68	48	20	6	2			4			4	2	2	2	4	2			2
Moss (*Drepanocladus sp*)																		1													
Naiads (*Najas flexilis*)																							6								
Berchtold's pondweed (*Potamogeton berchtoldi*)																															
Curlyleaf pondweed (*P. crispus*)	98	40	86	4	72	78	6	10	58	72	12	64	64	2	44	58		5	38	8	10	28	18	50	42	20	36	14	16	5	23
Variable pondweed (*P. gramineus*)																															
Floatingleaf (*P. natans*)																															
Stringy pondweed (*P. pusillus*)		2	6	8	2			4		6	8		20			26															
Claspingleaf (*P. Richardsonii*)				10				6		2	4		2	4		2	2		2	2		2	6		4		2			2	
Stringy pondweed (*P. strictifolius*)														2	2		2			24		14	66	52	34		64	36	92	5	16
Narrowleaf pondweed (*P. sp*)																						2									
Sago* (*Stuckenia pectinata*)	40	15		36	2		24	6		6	14			6		8	2	1	24	8		24	20		26						16
Star duckweed (*Lemna trisulca*)																															
Wild celery (*Vallisneria americana*)		6		16			2	22		2	32		2	18		6	12			18		2	18		4		2		6		
Mud plantain* (*Zosterella dubia*)		17		22				24			30			4						8			24								
Number of submerged species	2	8	4	9	4	3	6	9	3	7	9	3	6	8	4	8	6	4	4	9	2	8	9	5	7	3	6	4	4	4	5

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

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 12.

Except for two sites, curlyleaf pondweed growth is predicted to produce mostly light to moderate growth around the lake based on lake sediment characteristics (Figure 12).

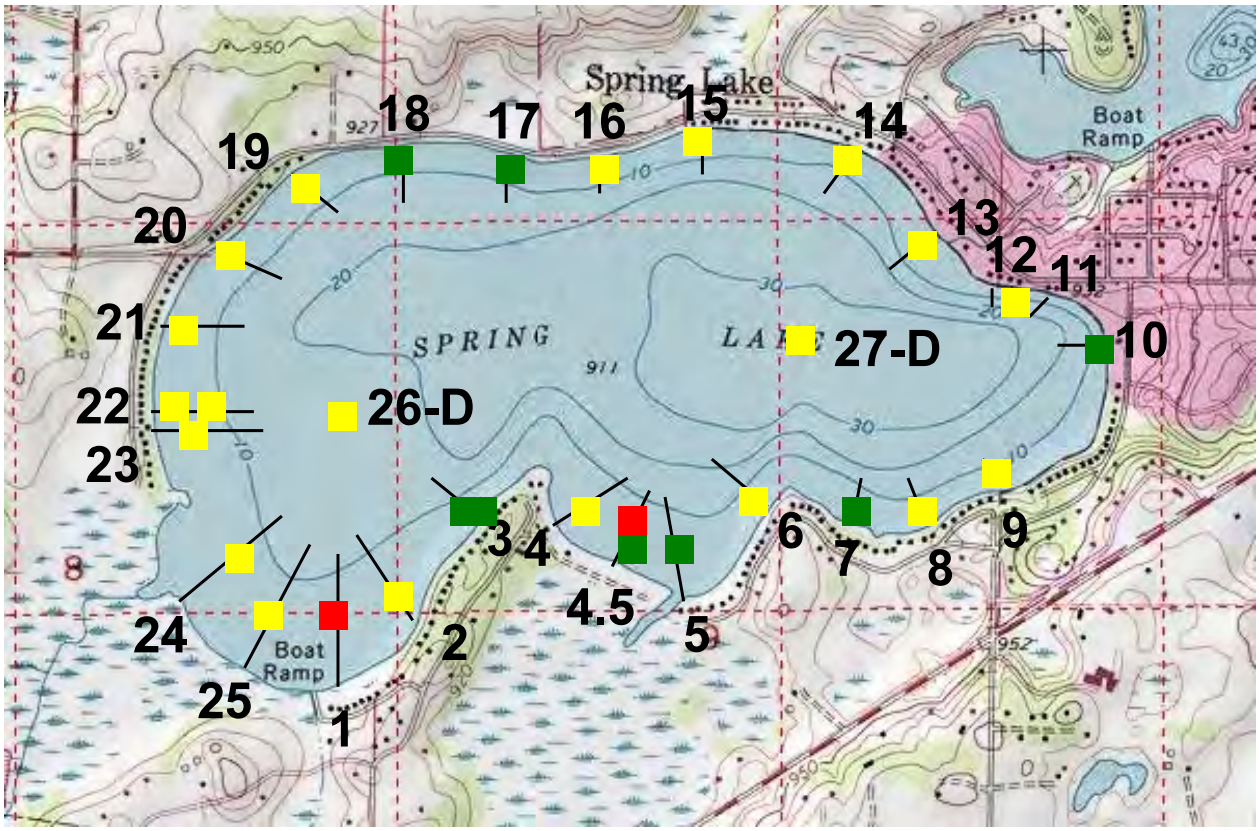


Figure 12. Sediment sample locations are shown with a square. The square color indicates the potential for curlyleaf pondweed growth to occur at that site. Key: green = light; yellow = moderate; red = heavy. A key that illustrates the three types of growth is shown on the next page.