



Fish Lake, Scott County, Minnesota, on July 30, 2015

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## **Curlyleaf Pondweed Delineation and Point-Intercept Plant Survey for Fish Lake, Scott County, 2015**

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**Delineation Date: May 28, 2015**  
**Point-intercept Survey: July 30, 2015**

**Prepared for:**  
**Prior Lake/Spring Lake**  
**Watershed District**  
**Prior Lake, Minnesota**



**Prepared by:**  
**Steve McComas**  
**Blue Water Science**  
**St. Paul, MN 55116**

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# Curlyleaf Pondweed Delineation and Point-Intercept Survey for Fish Lake, Scott County, 2015

**Curlyleaf Delineation and Point-Intercept Surveys:** A curlyleaf pondweed (CLP) delineation survey was conducted in Fish Lake on May 28, 2015. The delineation survey found curlyleaf pondweed at 7 out of the 24 sites sampled around the entire perimeter of Fish Lake. CLP growth was mostly light except for two small patches of potentially heavy CLP growth (red dots in Figure S1). No treatment was conducted in 2015. Overall curlyleaf growth has been mostly light to moderate in the last few years and that was also the case for 2015. Historically, the west side of Fish Lake has produced moderate to heavy CLP growth, but since 2009 no treatments have been applied in the 15.6 acre area that was treated from 2005-2008.

A summer point intercept survey was conducted on July 30, 2015 to assess the native plant community as well as to check the status of curlyleaf abundance. Native plant growth, especially coontail, was prevalent in 4-7 feet of water in the July survey. A total of 9 plant species were observed growing out to 7 feet of depth and covering about 35 acres out of the 173 acre lake or about 20% coverage.

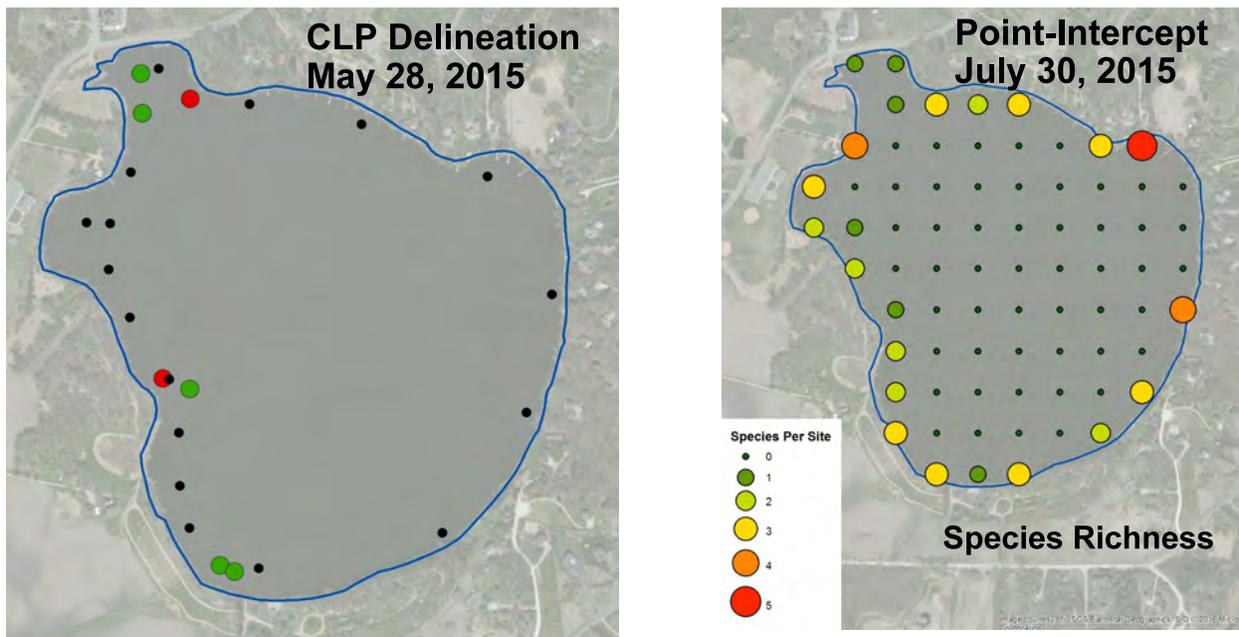


Figure S1. [left] In 2015, the same areas were monitored and curlyleaf was at mostly light conditions with the exception of 2 sites where curlyleaf growth the heavy. The black dots indicate no curlyleaf pondweed was observed.

[right] Aquatic plant coverage and species richness for the July 30, 2015 point-intercept survey.

# Curlyleaf Pondweed Delineation and Point-Intercept Plant Survey for Fish Lake, Scott County, 2015

## Introduction

Fish Lake has a surface area of 173 acres with a littoral zone of 74 acres. After four years of herbicide applications (2005-2008), no herbicide treatments with Aquathol K (active herbicide ingredient is an endothall salt) were conducted in Fish Lake in 2009 through 2015.

The short term objective for herbicide treatments was to reduce, to the greatest extent possible, the occurrence of heavy growth of the non-native plant, curlyleaf pondweed. The long-term objective was to reduce the standing crop of curlyleaf pondweed to non-nuisance conditions.

This report summarizes the curlyleaf abundance after four years of annual herbicide treatment (from 2005-2008) followed by no herbicide treatments for seven consecutive years (2009-2015). Curlyleaf density was sampled at one main location on Fish Lake at a 6-foot depth and was assessed at other sites within a 15.5 acre treatment area. In addition a summer point-intercept aquatic plant survey was conducted to characterize all aquatic plants found in Fish Lake.



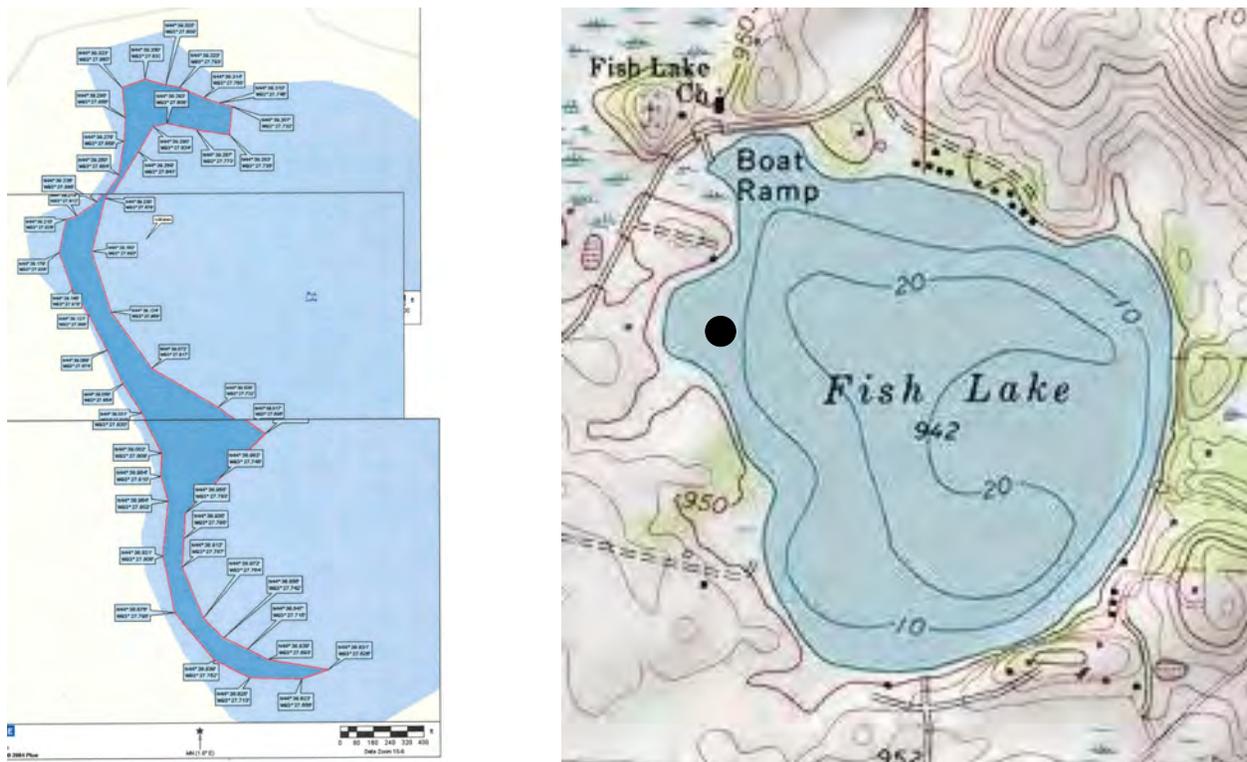
**Figure 1. Herbicides were applied to a 15-acre area from 2005 through 2008. No herbicides have been applied from 2009 through 2015.**

## Methods

After four years of herbicide treatments on 15.5 acres (from 2005-2008)(Figure 2), no Aquathol K has been applied to Fish Lake from 2009 through 2015. Two surveys were conducted in 2015, an early season delineation on May 28, 2015 when curlyleaf was starting to grow and a follow-up assessment survey on July 30, 2015 after curlyleaf reached it's peak biomass.

**Curlyleaf Delineation Methods:** In 2015, sites within a former treatment area were monitored with a rake sampler. At each sampling site, water depth, plant species, and abundance of the plant species were recorded (Figure 2).

**Curlyleaf Stem Density Methods:** In 2015, one site (4-7 feet) was sampled on two sample dates. At the site, a total of ten curlyleaf stem density samples were taken sampling an area of a 0.10 m<sup>2</sup> (Figure 2). The stem density samples were randomly collected along a 50 meter transect line that ran parallel to the shoreline. Other plant species were also counted if present.



**Figure 2. [left]** The area treated from 2005-2008 is shown in dark blue is shown on the map to the left. Sites were samples within the dark blue shading on May 28 and July 30, 2015.

**[right]** Stem density determinations (10 samples) were collected from one site within an area treated from 2005-2015.

## Summer Point-Intercept Plant Survey Methods

An aquatic plant point-intercept survey of Fish Lake was conducted by Blue Water Science. A total 74 points were plotted and sample points were spaced 100 meters apart on a grid that covered the lake (Figure 3). At each sample point, a sampling rake was lowered into the water and a plant sample was taken. The plant species were recorded and the density of each species was assigned. Densities were based on the coverage on the teeth of the rake. Density ratings ranged from 1 to 5 with 1 being sparse and 5 being heavy growth (Figure 4). Based on these sample sites, plant distribution and abundance maps were constructed.

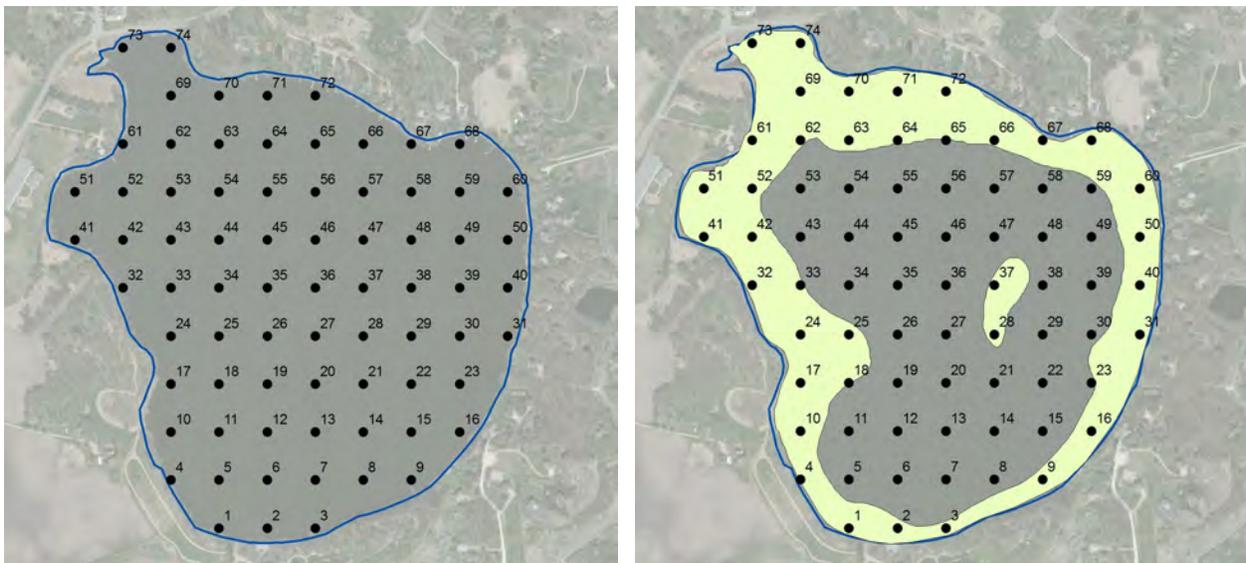


Figure 3. [left] 100m grid was put over the entire lake. [right] showing the 15 foot contour line where plants were likely to grow.

## Chart of Aquatic Plant Density Ratings

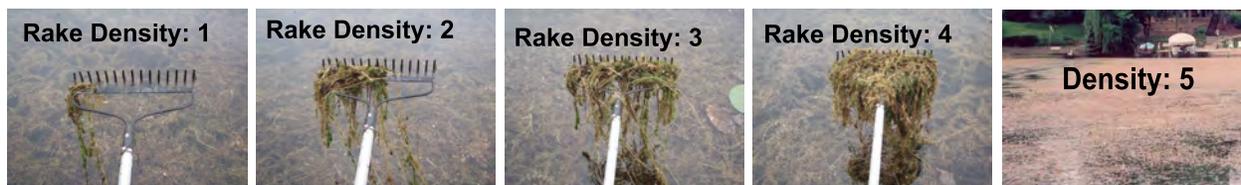


Figure 4. Aquatic plant density ratings from 1 to 5. A density rating of 4.5 or 5 is used for plants topping out at the surface.

# Results

**Curlyleaf Pondweed Delineation in Fish Lake, May 28, 2015:** A total of 24 sites were sampled with rake sampling on May 28, 2015 around the entire perimeter of the Fish Lake. Curlyleaf was found at 7 sample sites out of the 24 that were monitored (Table 1). In the May delineation, based on stem counts, it was predicted curlyleaf may produce heavy growth in at two relatively small sites, totaling less than 1 acre (Table 1 and Figure 5). Herbicide treatments were not conducted in the delineated areas in 2015.

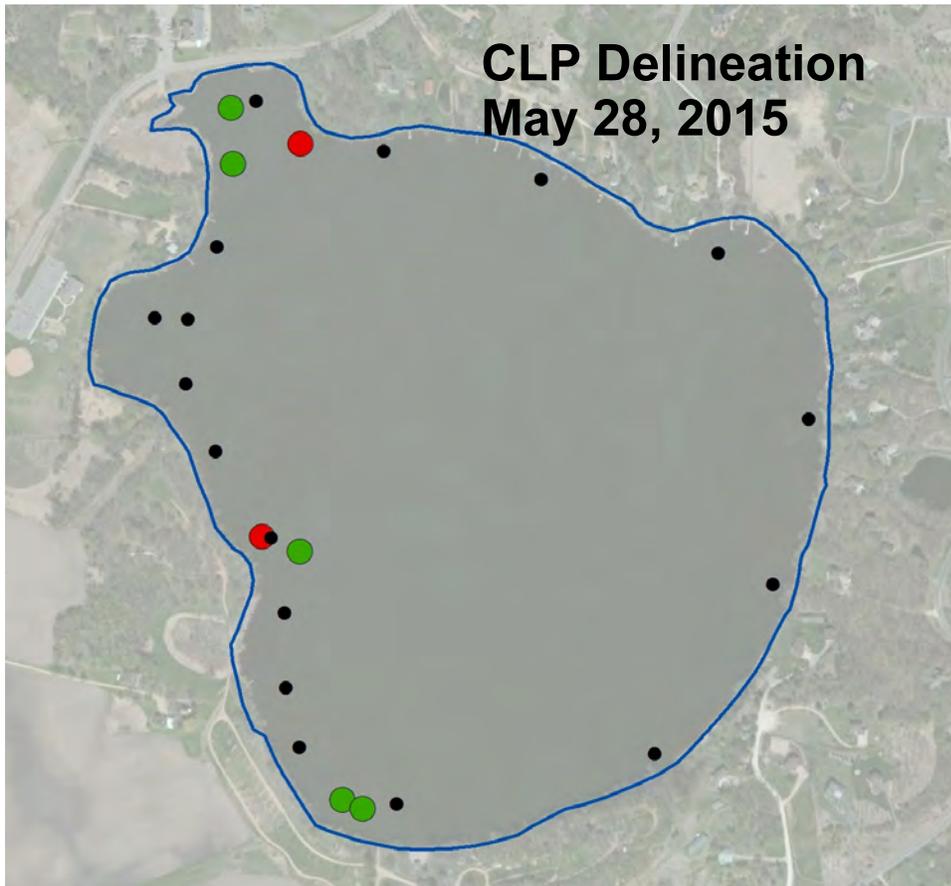
**Table 1. Aquatic plant densities based on rake sampling for May 28, 2015. Densities are based on a scale from 1 to 5 with 5 being the densest. Curlyleaf stems per rake sample were also noted. Areas with green shading are predicted to have light to moderate growth at the peak of the curlyleaf growth cycle. Areas with red shading are predicted to have heavy potential curlyleaf growth.**

Site	Depth (ft)	Coontail	CLP - density	CLP - stems
1	4	3		
2	4	3	1	1
3	4	3	1	1
4	6	2		
5	8	2		
6	4	3		
7	6	3		
8	6	3		
9	5		2	6
10	7	3		
11	7	2	1	2
12	6	3		
13	6	3		
14	6	3		
15	6	3	1	1
16	7	3	1	1
17	10			
18	6	2		
19	6	3		
20	7	1		
21	9	1		
22	7	2		
23	4	1		
24	4	2	1	4
<b>Average</b>		2.5	1.1	2.3
<b>Occurrence (24 sites sampled)</b>		22	7	7
<b>% occurrence</b>		92	29	29



**Figure 5. [left] Curlyleaf pondweed density of “1”. [right] Coontail at a density of a “3”.**

**Curlyleaf Conditions in Fish Lake, May 28, 2015:** Two individual sites were found to have a potential heavy future growth in Fish Lake (Figure 6, red dots). The curlyleaf growth, however, was patchy and intermittent even where growth was heavier. Curlyleaf was not treated in 2015.



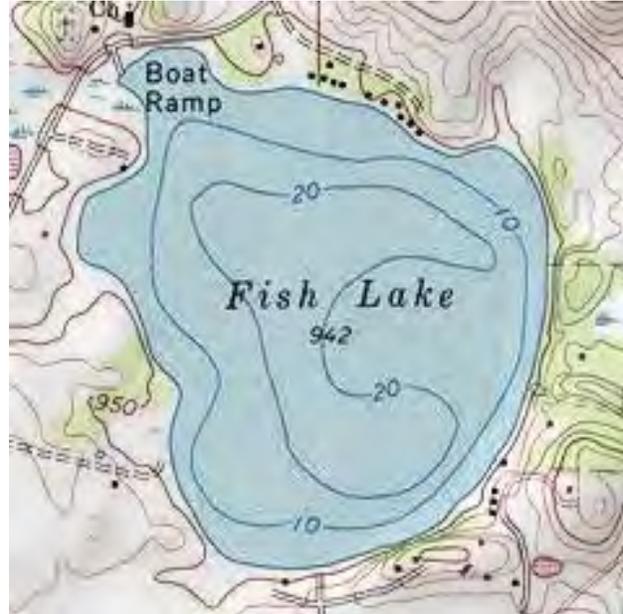
**Figure 6. Curlyleaf delineation in Fish Lake on May 28, 2015.**

**Key: Black dots = no curlyleaf pondweed, green dots = potential light growth with 1-2 stems per rake, and red dots = potential heavy growth based on 4 stems or more per rake sample.**

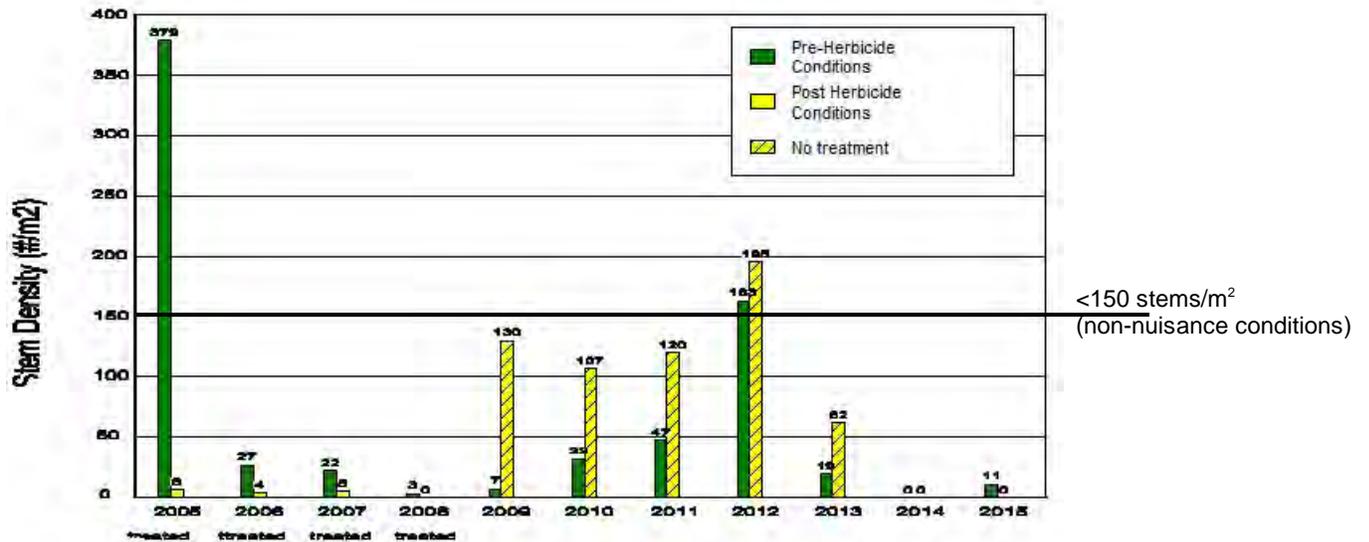
**Curlyleaf Stem Densities at One Location from May to July, 2015:** Curlyleaf stem densities were determined by rake sampling at a location between sample sites 4-5 (Figure 7). Ten samples were taken at this location. The results for 2015 show curlyleaf was found at low stem densities in May and no curlyleaf was sampled in July (Table 2 and Figure 8).

**Table 2. Curlyleaf pondweed stem densities for May and July samples collected at the 6 to 7 foot depth.**

Site 4 - 5 Quadrats	Curlyleaf (stems/m <sup>2</sup> )	
	May 28, 2015	July 30, 2015
1	70	0
2	0	0
3	0	0
4	0	0
5	0	0
6	0	0
7	0	0
8	30	0
9	10	0
10	0	0
<b>Ave</b>	<b>11</b>	<b>0</b>



**Figure 7. Monitoring site (shown with a black dot).**



**Figure 8. Average of Fish Lake curlyleaf pondweed stem densities for early season and late season conditions in 2005 through 2015 at a 6.0-foot water depth at the monitoring site shown in Figure 7.**

**Comparison of Early Season to Late Season Curlyleaf Growth:** In the delineation survey on May 28, 2015, two small patches of potentially heavy growth of curlyleaf pondweed were delineated that measured less than one acre (red dots, Figure 9). No treatment was recommended. During a recheck and full point intercept survey on July 30, 2015, the curlyleaf assessment found no curlyleaf growing in Fish Lake. The same pattern was observed in 2014 (Figure 10).

Fish Lake CLP Stem Counts May 28, 2015

Fish Lake CLP Assessment July 30, 2015

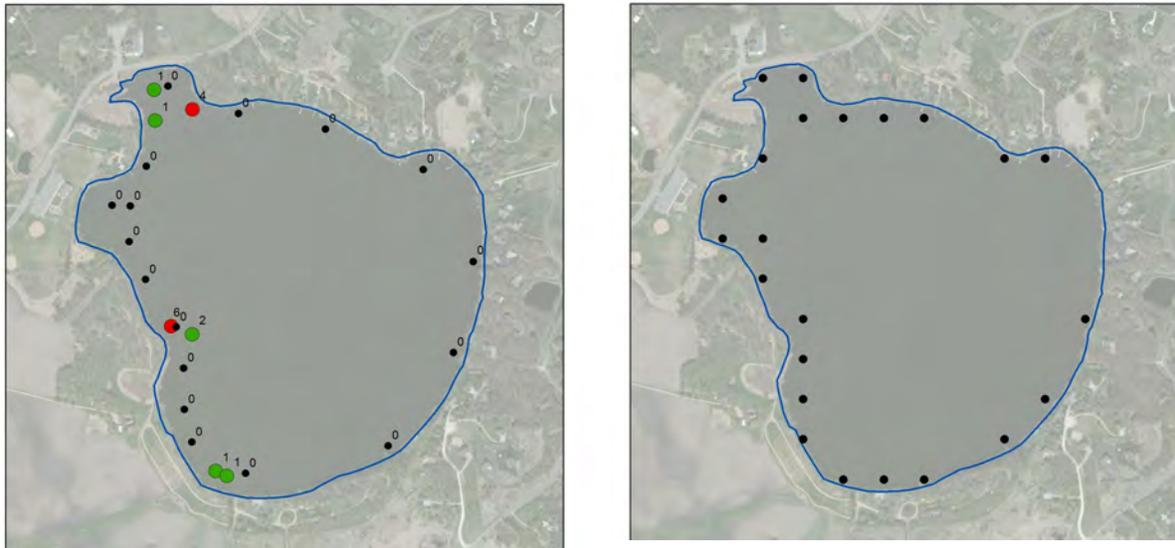


Figure 9. [left] Stem counts for the sample sites monitored on May 28, 2015. [right] Stem counts for the sample sites monitored on July 30, 2015.

2014 Fish Lake May 21, 2014  
Site Map

2014 Fish Lake June 19, 2014  
Stem Counts

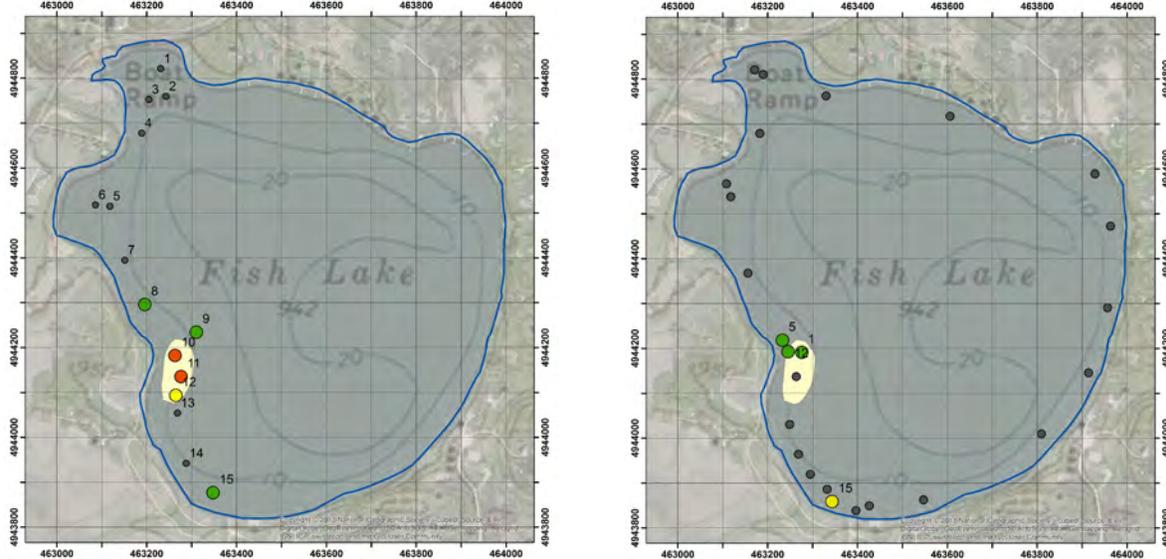


Figure 10. [left] Fifteen sites within an area that was treated from 2005-2008 were monitored on May 21, 2014 and curlyleaf was detected at 3 sites at low densities (green dots), 1 site at moderate densities (yellow dot), and 2 sites at high densities (red dots). Black dots indicate no curlyleaf pondweed observed. [right] In June, the same areas were monitored and curlyleaf was detected at four sites. Green dots indicate curlyleaf pondweed was observed at low densities (3 sites) and yellow dot indicates curlyleaf was observed a moderate density (1 site).

**Curlyleaf Pondweed Stem Densities at Long-Term Sample Site from 2005-2015 (location shown in Figure 7):** Curlyleaf has been monitored at the same site on early and late season dates from 2005 through 2015. Curlyleaf stem densities were initially high on April 18, 2005. Curlyleaf was treated within this site for four years (2005-2008). No herbicide was used in 2009 through 2015.

**Table 3. Summary of curlyleaf pondweed stem densities prior to the effects of herbicide treatment and after the herbicide treatment.**

Site	Stem Density (stems/m <sup>2</sup> )										
	Spring Status										
	5 - 6 foot Depth										
	2005 (Apr 18) (n=10)	2006 (Apr 25) (n=10)	2007 (Apr 16) (n=10)	2008 (Apr 29) (n=10)	2009 (Apr 23) (n=10)	2010 (Apr 27) (n=10)	2011 (May 12) (n=10)	2012 (Apr 17) (n=10)	2013 (May 23) (n=10)	2014 (May 21) (n=10)	2015 (May 28) (n=10)
1	290	50	0	10	10	20	60	120	30	0	70
2	460	0	0	20	10	60	70	180	40	0	30
3	270	0	0	0	20	60	100	90	30	0	10
4	260	10	0	0	0	80	50	220	0	0	0
5	480	20	30	0	30	0	60	90	0	0	0
6	250	80	40	0	0	40	30	240	0	0	0
7	540	60	30	0	0	40	30	30	0	0	0
8	370	20	80	0	0	20	50	280	60	0	0
9	270	30	20	0	0	0	20	360	0	0	0
10	600	30	20	0	0	0	20	20	30	0	0
<b>Ave</b>	<b>379</b>	<b>27</b>	<b>22</b>	<b>3</b>	<b>7</b>	<b>32</b>	<b>47</b>	<b>163</b>	<b>19</b>	<b>0</b>	<b>11</b>

Site	Stem Density (stems/m <sup>2</sup> )										
	Early Summer Status										
	5 - 6 foot Depth										
	2005 (May 23) (n=10)	2006 (June 2) (n=10)	2007 (June 5) (n=10)	2008 (June 13) (n=10)	2009 (June 10) (n=10)	2010 (June 2) (n=10)	2011 (June 13) (n=10)	2012 (June 5) (n=10)	2013 (June 13) (n=10)	2014 (June 19) (n=10)	
	treated	treated	treated	treated							
1	10	10	0	0	50	70	200	60	10	0	
2	20	10	0	0	50	120	160	240	20	0	
3	30	10	0	0	220	20	40	290	20	0	
4	0	10	10	0	130	20	240	320	230	0	
5	0	0	30	0	90	10	100	190	40	0	
6	0	0	10	0	50	360	60	170	210	0	
7	0	0	0	0	100	140	110	320	0	0	
8	0	0	0	0	150	90	120	250	80	0	
9	0	0	0	0	110	230	60	50	10	0	
10	0	0	0	0	320	10	100	60	0	0	
<b>Ave</b>	<b>6</b>	<b>4</b>	<b>5</b>	<b>0</b>	<b>130</b>	<b>107</b>	<b>119</b>	<b>195</b>	<b>62</b>	<b>0</b>	

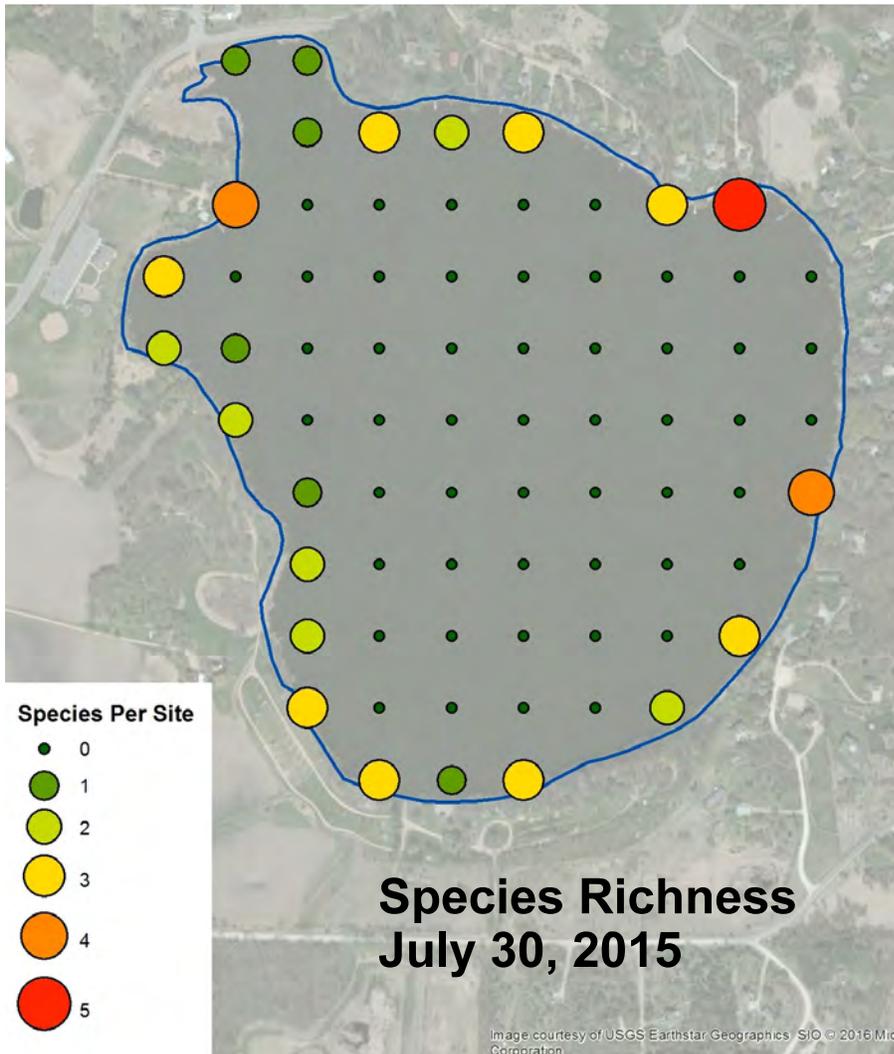
## Point-Intercept Summer Survey for Fish Lake

In Fish Lake a total of 30 sites located in the littoral zone (water less than 15 feet deep) were sampled with rake sampling on July 30, 2015 for a point-intercept survey. Sites that had curlyleaf present in the spring (May 28, 2015) plant delineation were revisited as well. In the July survey, curlyleaf was not found at any of the sample sites. Coontail was the most common plant and was found at 21 out of 30 sample sites. (Table 4).

**Table 4. Aquatic plant occurrences and densities based on rake sampling for July 30, 2015. Densities are based on a scale from 1 to 5 with 5 being the densest. In July there was no observed curlyleaf pondweed growth.**

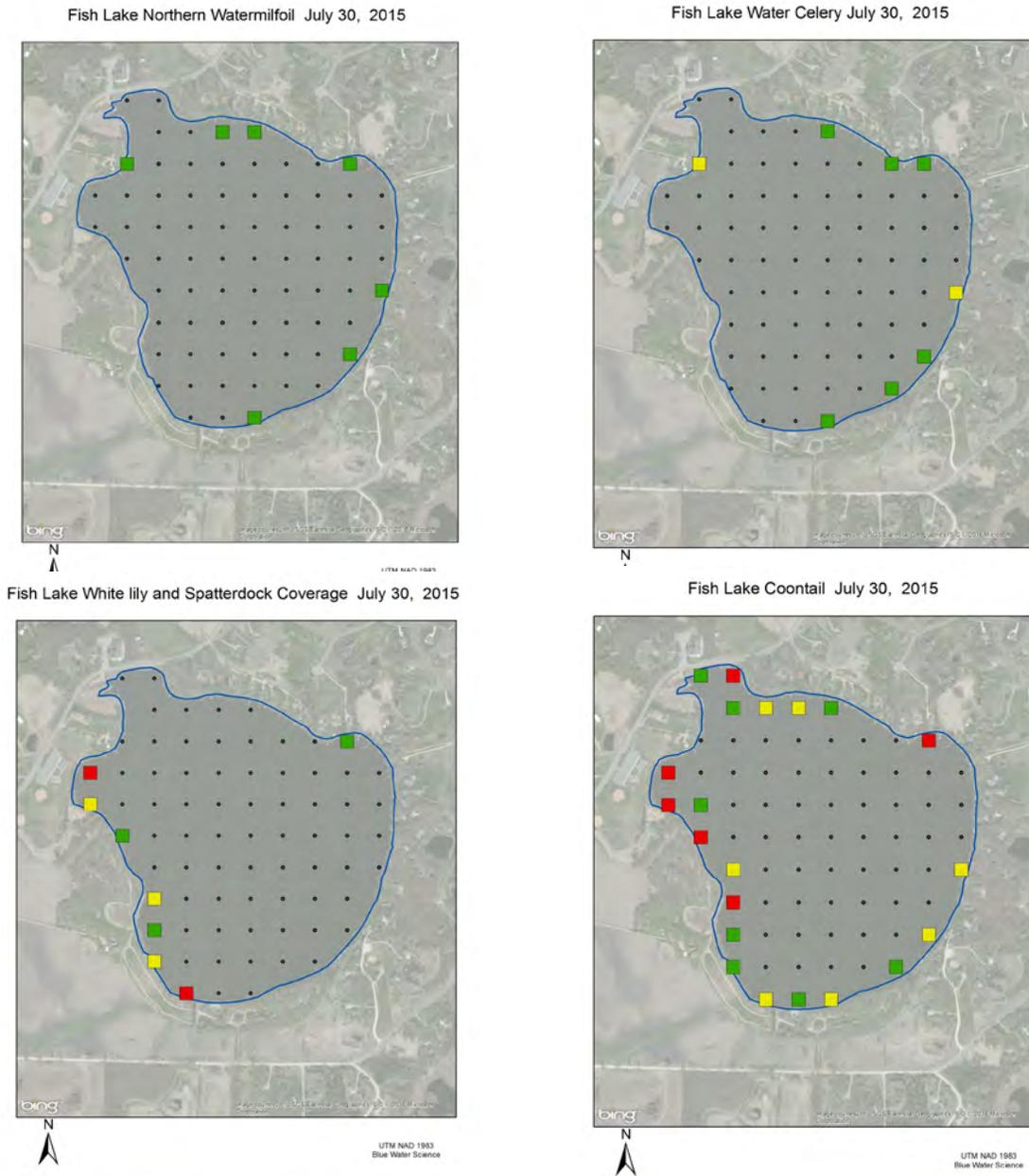
Site	Depth (ft)	Spatter-dock	White lilies	Chara	Coontail	Floating-leaf	Northern watermilfoil	Sago	Water celery	Water stargrass	No plants
1	3	4	1		3						
2	7				2						
3	3				3		1		1		
4	4	3	2		2						
8	18										1
9	5				1				1		
10	5		1		2						
16	5				3		1		1		
17	4	3			5						
24	7				3						
25	11										1
31	5				3		1	1	3		
32	4	1			4						
40	9										1
41	3		3		4						
42	7				2						
50	11										1
51	4		4		4					1	
52	11										1
60	9										1
61	4			1		1	1		3		
62	16										1
67	3					3			1	2	
68	4		1		4		1		1	1	
69	7				2						
70	4				3	1		3			
71	6				3		2				
72	4				2		2		2		
73	4				1						
74	4				4						
Average		2.8	2.0	1.0	2.9	1.7	1.3	2.0	1.6	1.3	
Occurrence (n=30)		4	6	1	21	3	7	2	8	3	7
% occur		13	20	3	70	10	23	7	27	10	

**Native Plant Conditions in Fish Lake, July 30, 2015:** A total of 7 submerged and 2 floatingleaf plant species were sampled in the point-intercept survey. The most common plant species distribution and abundance are shown in Figure 12. Aquatic plants grew out to a water depth of 7 feet. One site had 5 aquatic plant species (Figure 11).



**Figure 11. Aquatic plant coverage and species richness for the July 30, 2015 point-intercept survey.**

Distribution and abundance of major Fish Lake plants are shown in Figure 12. Coontail was the most abundant plant.



**Figure 12. The dominant plant species from a point- intercept survey that was conducted in Fish Lake on July 30, 2015. No herbicides were applied 2009 through 2015.**

**Key: Black dots = no growth, green dots = light growth, yellow dots = moderate growth, and red dots = heavy growth.**

**Summary:** A curlyleaf pondweed (CLP) delineation survey was conducted in Fish Lake on May 28, 2015. The delineation survey found curlyleaf pondweed at 7 out of the 24 sites sampled around the entire perimeter of Fish Lake. CLP growth was mostly light except for two small patches of potentially heavy CLP growth (red dots in Figure S1). No treatment was conducted in 2015. Overall curlyleaf growth has been mostly light to moderate in the last few years and that was also the case for 2015. Historically, the west side of Fish Lake has produced moderate to heavy CLP growth, but since 2009 no treatments have been applied in the 15.6 acre area that was treated from 2005-2008.

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# APPENDIX

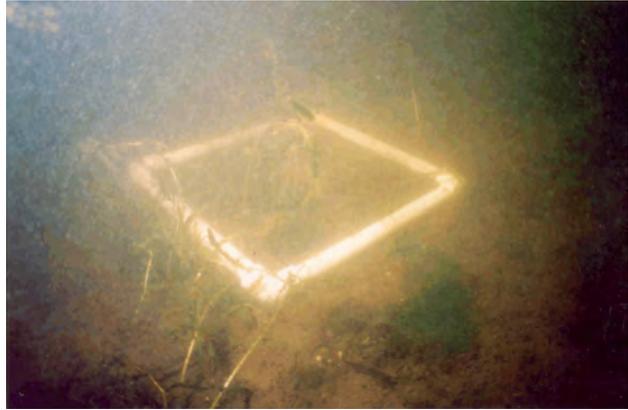
## Subsurface Curlyleaf Pondweed Conditions in Fish Lake in 2005 Through 2012. Herbicides Were Used in 2005-2008.

### Pre-Herbicide (Early) Conditions

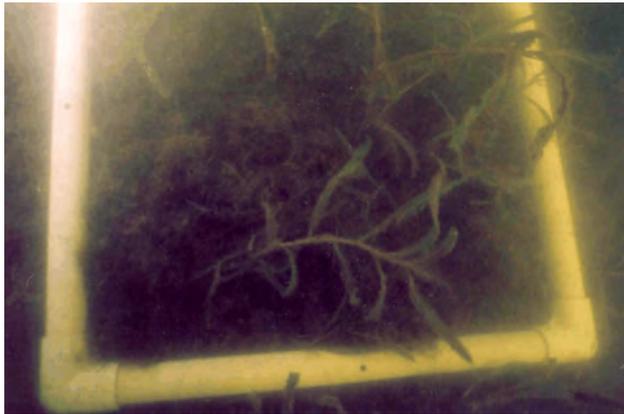


April 18, 2005

### Post Herbicide (Late) Conditions



May 23, 2005



April 25, 2006



June 2, 2006



April 16, 2007



June 5, 2007

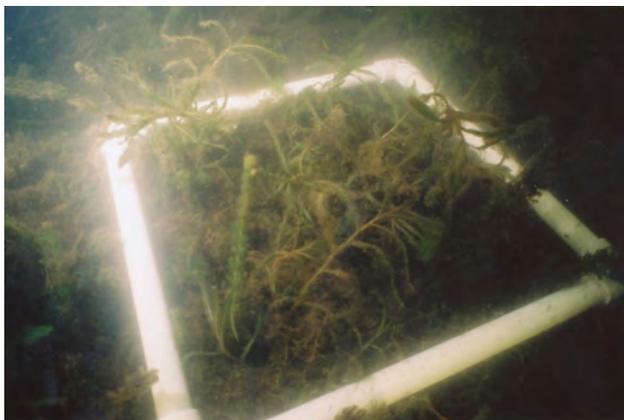
**Pre-Herbicide (Early) Conditions**



**April 29, 2008**



**April 23, 2009**



**April 27, 2010**

**Post Herbicide (Late) Conditions**



**June 13, 2008**



**June 10, 2009**



**June 2, 2010**

**Pre-Herbicide (Early) Conditions**

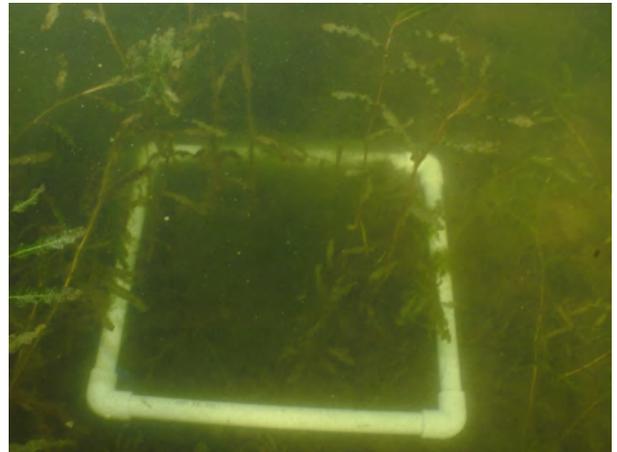


**May 12, 2011**

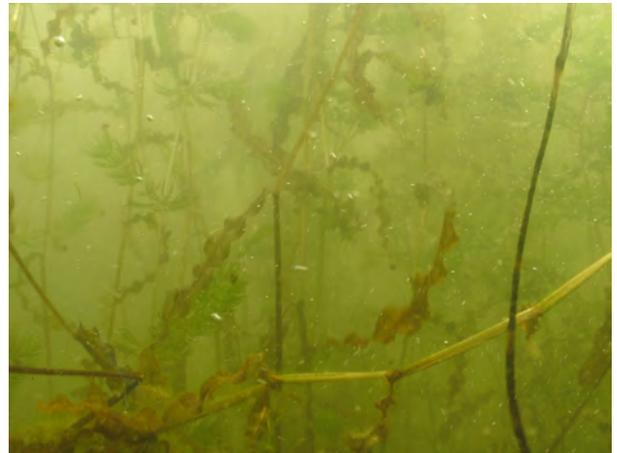


**April 17, 2012**

**Post Herbicide (Late) Conditions**



**June 13, 2011**



**June 5, 2012**

# Curlyleaf Pondweed Conditions in early June in 2003 and 2005-2013



2003



2005



2006

2007



2008

2009

# Curlyleaf Pondweed Conditions in early June in 2003 and 2005-2013



2010



2011



2012



2013

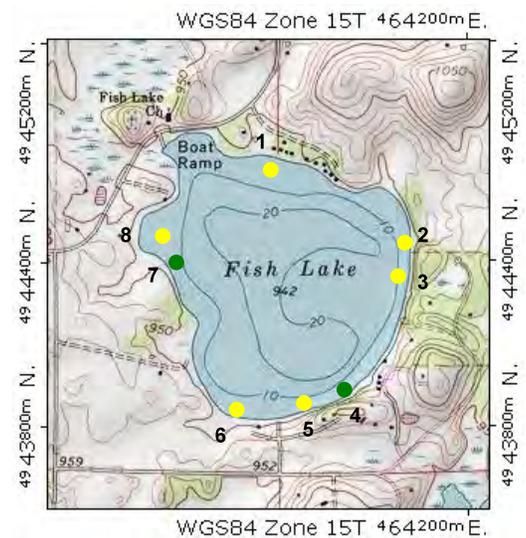
# Predicted Curlyleaf Pondweed Growth Based on Lake Sediment Characteristics

Lake sediment sampling results from 2006 have been used to predict lake bottom areas that have the potential to support nuisance curlyleaf pondweed plant growth in Fish Lake. Based on the key sediment parameters of pH, organic matter, and the Fe:Mn ratio (McComas, unpublished), the predicted growth characteristics of curlyleaf pondweed are shown in Table A-1 and Figure A-1.

If herbicide applications were to stop in Fish Lake, curlyleaf pondweed growth is predicted to produce mostly light nuisance growth (where plants occasionally top out) for a number of locations around Fish Lake (Figure A-1).

**Table A-1. Fish Lake sediment data and ratings for potential curlyleaf pondweed growth. Sediment collected in 2006.**

Site	Depth (ft)	pH (su)	Organic Matter (%)	Fe:Mn Ratio	Potential for Heavy Curlyleaf Pondweed Growth
Light Growth		6.8	5	4.6	Low (green)
Moderate Growth		6.2	11	5.9	Medium (yellow)
Heavy Growth		>7.7	>20	<1.6	High (red)
1	5	7.6	3.5	2.38	
2	5	7.7	2.5	4.39	
3	5	7.7	5.1	3.12	
4	5	7.6	6.4	4.13	
5	5	8.1	0.9	13.33	
6	5	7.6	3.7	2.56	
7	5	7.5	2.2	3.32	
8	5	7.5	35.7	2.74	



**Figure A-1. Sediment sample locations are shown with a circle. The circle color indicates the potential for nuisance curlyleaf pondweed to occur at that site. Key: green = low; yellow = medium; red =**

Light nuisance growth has intermediate growth characteristics between non- nuisance and nuisance growth. Non- nuisance growth refers to curlyleaf growth that is mostly below the surface and is not a recreational nor an ecological problem. Heavy growth refers to nuisance matting curlyleaf pondweed. This is the kind of nuisance growth predicted by high sediment pH and a low iron to manganese ratio. A chart showing the three types of growth conditions is shown on the next page.

# Examples of Curlyleaf Pondweed Growth Characteristics

## Light Growth Conditions

Plants rarely reach the surface.

Navigation and recreational activities are not generally hindered.

Stem density: 0 - 160 stems/m<sup>2</sup>  
Biomass: 0 - 50 g-dry wt/m<sup>2</sup>  
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<sup>2</sup>  
Biomass: 50 - 85 g-dry wt/m<sup>2</sup>  
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<sup>2</sup>  
Biomass: >300 g-dry wt/m<sup>2</sup>  
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.*

