

Coontail in Fish Lake, Scott County, MN, on June 13, 2011

Fish Lake, Scott County, Curlyleaf Pondweed Assessment for 2011

Assessment Dates: May 12, 2011 and June 13, 2011

Prepared for:
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Fish Lake, Scott County, Curlyleaf Pondweed Assessment for 2011

Overview: Two assessments were conducted in Fish Lake within the 15.5 acre area that was treated with an endothall herbicide from 2005-2008 (shaded dark blue in Figure 1). The first assessment was on May 12 and the second one was on June 13, 2011. No herbicides have been used in the 15.5 acre area in 2009, 2010, and 2011. In the first assessment in 2011 curlyleaf pondweed was found at five out of the 11 sites monitored. On the second assessment, curlyleaf had increased in abundance and in distribution and was found at nine out of 11 sites. At Site 9, curlyleaf growth was close to the surface and the coverage of this moderate to heavy growth area was estimated at 3 acres. However, overall curlyleaf growth was growing mostly light to moderate.

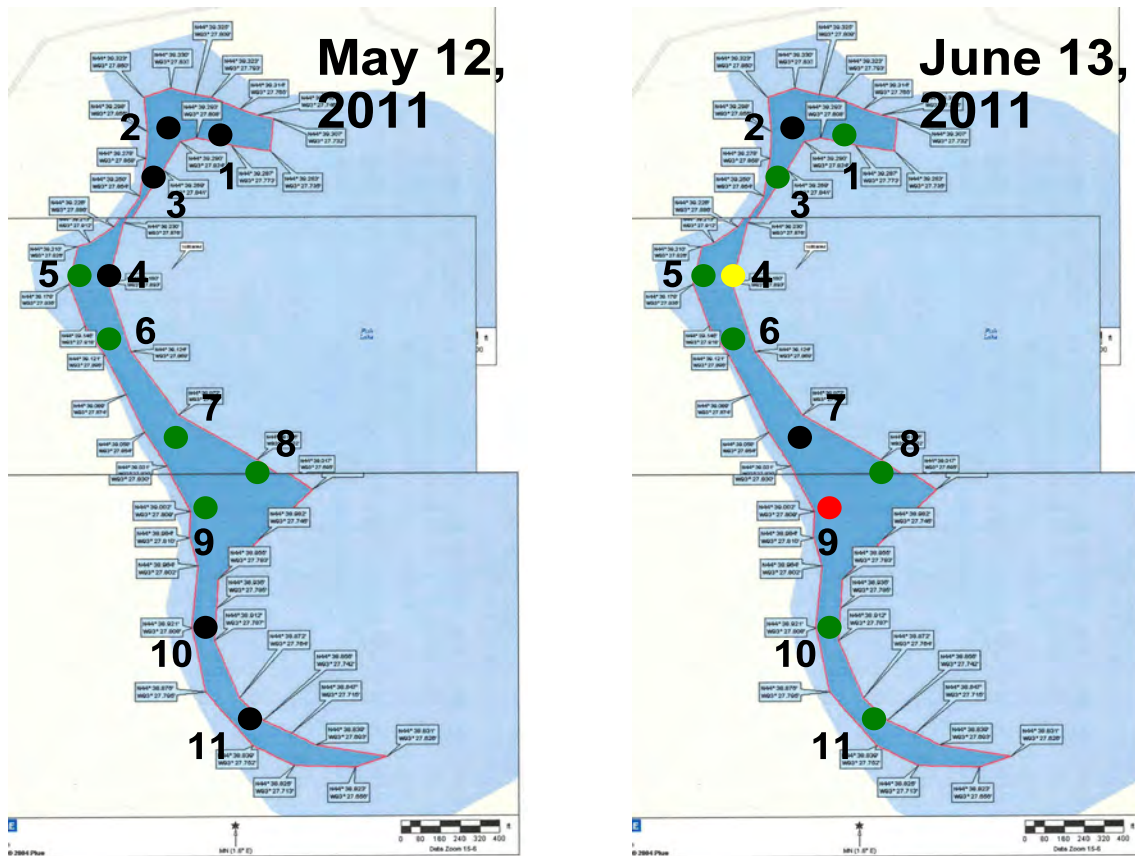


Figure 1. [left] Eleven sites within an area that was treated from 2005-2008 (dark blue shading) were monitored in May and curlyleaf was detected at five sites at low densities (green dots). [right] In June, the same sites were monitored and curlyleaf was detected at nine sites. Growth was heavy at Site 9, moderate at Site 4 and light at other sites where curlyleaf was present.

Curlyleaf Pondweed Distribution in 2011: Curlyleaf density on May 12, 2011 was light, with a density of 1 at five sites with the number of stems on the rake ranging from 1-4 (Table 1). Site 9 had the most stems, but treatment was not recommended. On June 13, 2011 the same 11 sites were checked again. Curlyleaf had increased in density and was highest at Site 9 (Table 1 and Figure 2). Although curlyleaf was fairly widely distributed, its density was mostly light to moderate except for Site 9.

Table 1. Curlyleaf density on a scale from 1 to 5 with 5 the highest and the number of stems collected on the sample rake. Curlyleaf growth was light in May and more abundant in June, but not excessive.

Site	Depth (ft)	May 12, 2011		June 13, 2011	
		Density	Stems/Rake	Density	Stems/Rake
1	5			2	8
2	5				
3	6			1	1
4	6			3	12
5	5	1	3	2	10
6	6	1	1	1	1
7	6	1	2		
8	8	1	2	1	1
9	5	1	4	4	18
10	7			1	1
11	6			2	8

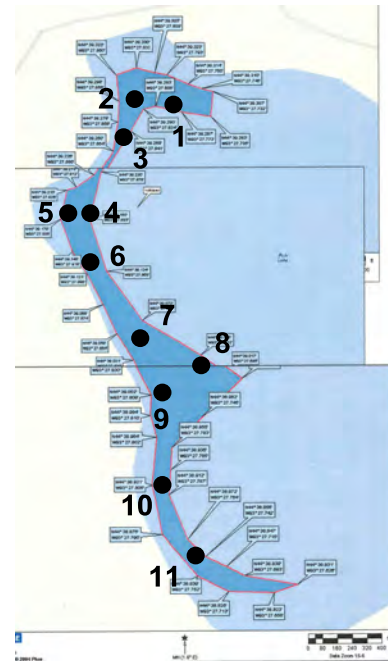


Figure 2. [left] Coontail was the most abundant plant in the survey. [right] Curlyleaf pondweed at Site 9 on June 13, 2011.

Curlyleaf Pondweed Stem Densities at a Treatment Site: Curlyleaf has been monitored at the same site on early and late season dates from 2005 through 2011 (Figure 3). 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, 2010, and 2011. Although the early season stem density was low at 47 stems/m² on May 12, 2011, the next sample date on June 13, 2011, curlyleaf stem density averaged 120 stems/m². Curlyleaf stem density has not exceeded 130 stems/m² since treatments stopped in 2008 (Table 1 and Figure 4).

Table 1. Summary of curlyleaf pondweed stem densities for both pre and post herbicide conditions in Fish Lake.

	Stem Density (#/m ²)	
	Pre-Herbicide Conditions	Late Spring Conditions
2005 (treated)	379 (n=10) (April 18)	6 (n=10) (May 23)
2006 (treated)	27 (n=10) (April 25)	4 (n=10) (June 2)
2007 (treated)	22 (n=10) (April 16)	5 (n=10) (June 5)
2008 (treated)	3 (n=10) (April 29)	0 (n=10) (June 13)
2009	7 (n=10) (April 23)	130 (n=10) (June 10)
2010	32 (n=10) (April 27)	107 (n=10) (June 2)
2011	47 (n=10) (May 12)	120 (n=10) (June 13)



Figure 3. Underwater monitoring site (shown with a black dot).

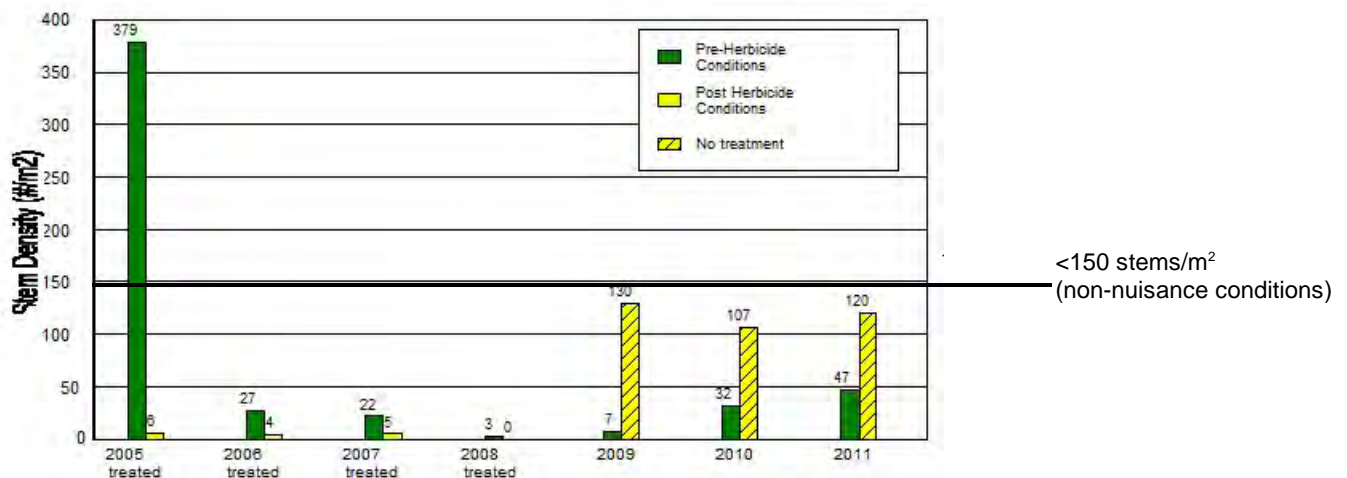


Figure 4. Average of Fish Lake curlyleaf pondweed stem densities for early season and late season conditions in 2005 through 2011 at a 6.0-foot water depth at the monitoring site shown above.

Curlyleaf Pondweed Growth Characteristics in 2011 at the Underwater Monitoring Site (monitoring site is shown in Figure 3)

May 12, 2011



June 13, 2011



Fish Lake Curlyleaf Pondweed Growth Potential 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 2 and Figure 5.

Without herbicide applications in Fish Lake, curlyleaf pondweed growth is predicted to produce mostly light to moderate growth (where plants occasionally top out) for a number of locations around Fish Lake (Figure 5).

Table 2. 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 Curlyleaf Pondweed Growth
Light Growth		6.8	5	4.6	Light (green)
Moderate Growth		6.2	11	5.9	Moderate (yellow)
Heavy Growth		>7.7	>20	<1.6	Heavy (red)
1	5	7.6	3.5	2.38	Moderate
2	5	7.7	2.5	4.39	Moderate
3	5	7.7	5.1	3.12	Moderate
4	5	7.6	6.4	4.13	Light
5	5	8.1	0.9	13.33	Moderate
6	5	7.6	3.7	2.56	Moderate
7	5	7.5	2.2	3.32	Light
8	5	7.5	35.7	2.74	Moderate

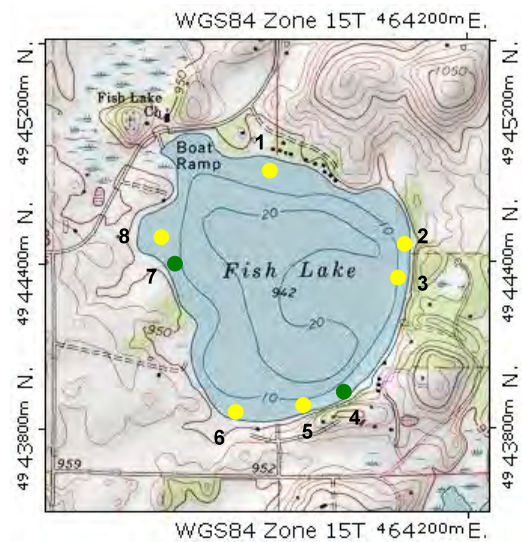


Figure 5. Sediment sample locations are shown with a circle. The circle color indicates the potential for nuisance curlyleaf pondweed to occur at that site. Key: green = light; yellow = moderate;

Light to moderate growth typically is a non- nuisance condition. 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

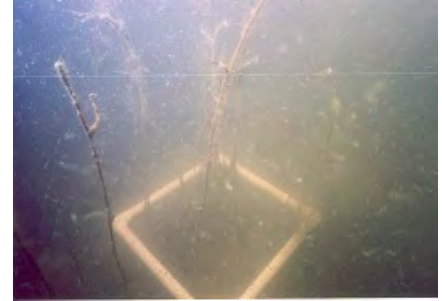
Plants rarely reach the surface.

Navigation and recreational activities are not generally hindered.

Stem density: 0 - 160 stems/m²

Biomass: 0 - 50 g-dry wt/m²

Estimated TP loading: <1.7 lbs/ac



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/m²

Biomass: 50 - 85 g-dry wt/m²

Estimated TP loading: 2.2 - 3.8 lbs/ac



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/m²



Curlyleaf Pondweed Density and Abundance in Fish Lake, Scott County, 2011

Introduction

After four years of herbicide applications (2005-2008), no herbicide treatments with Aquathol K (active ingredient is an endothal salt) were conducted in Fish Lake (171 acres) in 2009, 2010, or 2011.

The short term objective has been to reduce, to the greatest extent possible, the occurrence of the non-native plant, curlyleaf pondweed. The long-term objective is 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. Curlyleaf density was sampled by scuba diving at one site on Fish Lake at a 6-foot depth and was assessed at 11 sites within a 15.5-acre treatment area.



Figure 1. Herbicides were applied to a 15-acre area from 2005 through 2008. No herbicides were applied in 2009, 2010, or 2011.

Methods

After four years of herbicide treatments on 15.5 acres (from 2005-2008), no Aquathol K was applied to Fish Lake in 2009, 2010, or 2011. Two types of surveys, curlyleaf distribution and curlyleaf stem densities were conducted on two dates in 2011. In 2011, plants were sampled on May 12, 2011 when curlyleaf was starting to grow and on June 13, 2011, when curlyleaf was at its peak biomass. Locations of the sample sites are shown in Figure 2.

Aquatic Plant Distribution Surveys: In 2011, eleven 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.

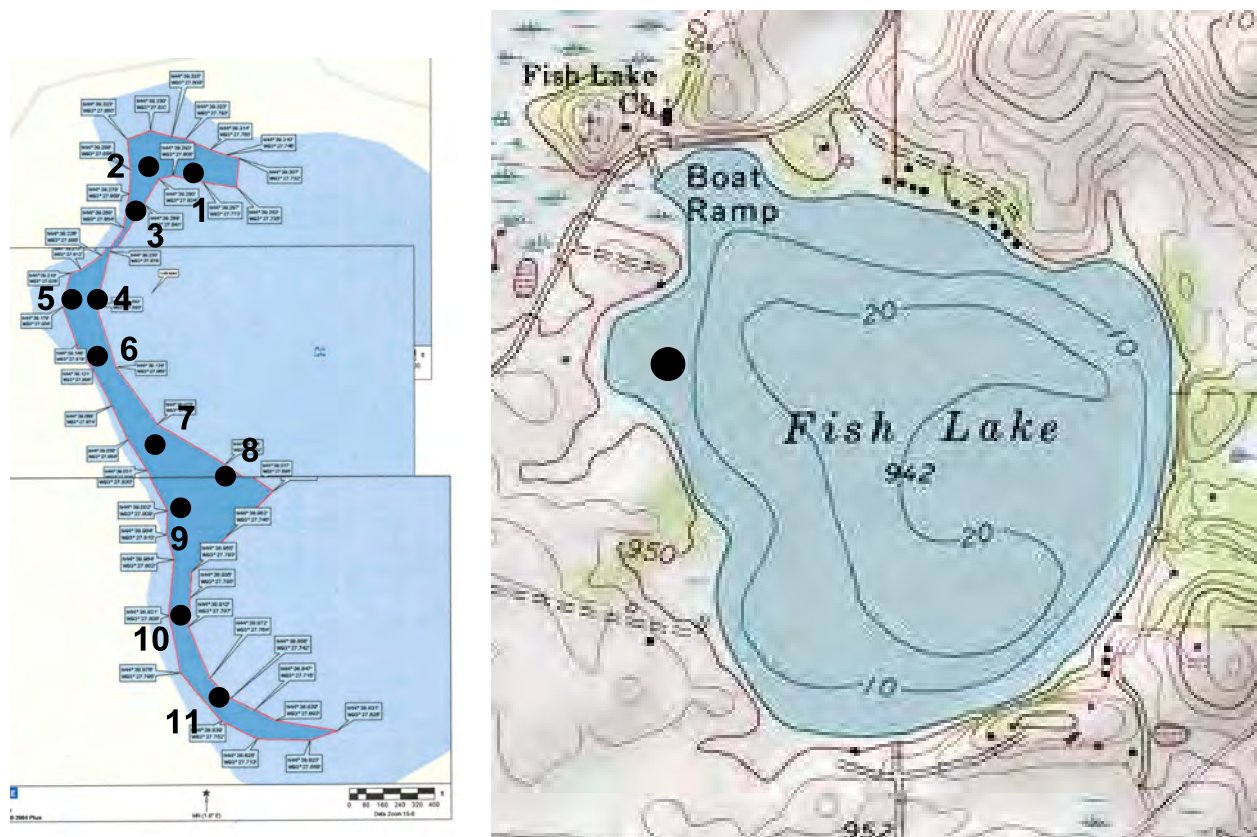


Figure 2. [left] The area treated from 2005-2008 is shown in dark blue is shown on the map to the left. The black dots shows the individual sample sites in the treatment area. Eleven sites were samples on May 12 and on June 13, 2011.

[right] Stem density determinations (10 samples) were collected from one site within an area treated from 2005-2011. Stem densities were determined using scuba diving and a 0.1 m² quadrat.

Curlyleaf Stem Density Methods: In 2011, one depth (5-6 feet) was sampled at one site on two sample dates. At the site, a total of ten curlyleaf stem density samples were taken using a 0.10 m² quadrat (Figure 3). The stem density samples were randomly collected along a 50 meter transect line that ran parallel to the shoreline at each station. Other plant species were also counted if present. The counts were made by scuba diving.

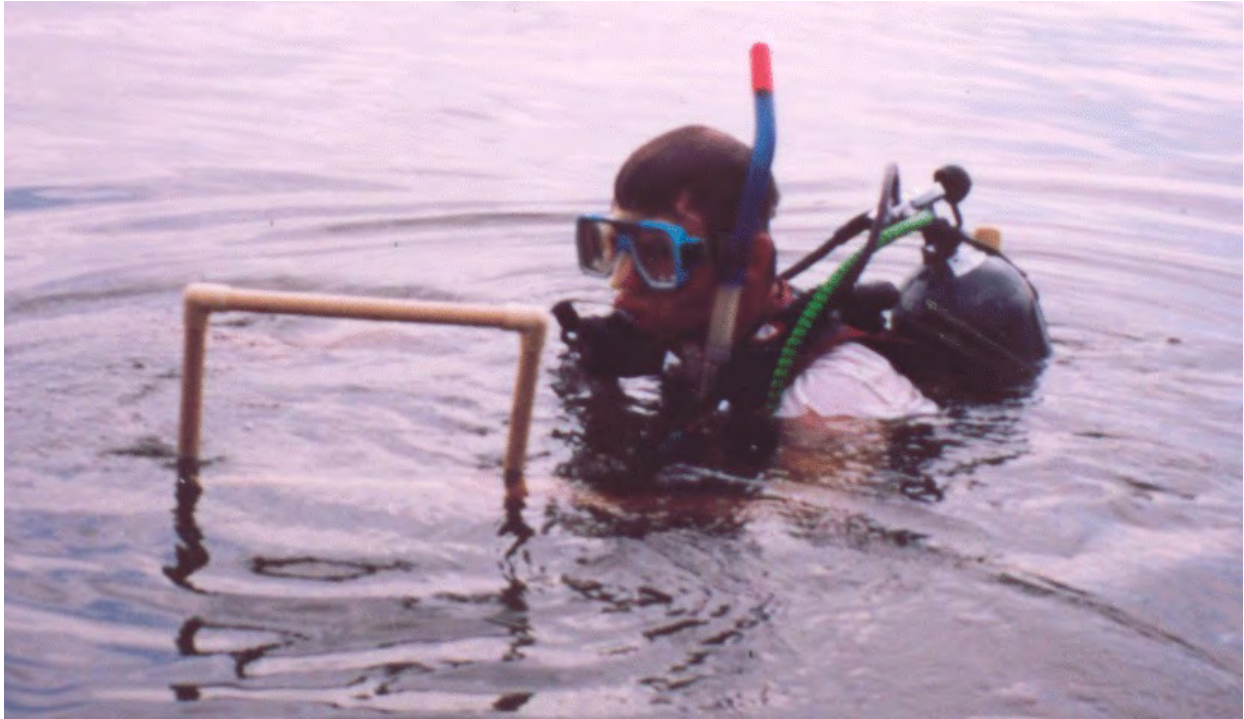


Figure 3. A 0.10 m² quadrat was used to quantify curlyleaf stem densities.

Early Spring Curlyleaf Pondweed Assessment in Fish Lake

A total of 11 sites were monitored with rake sampling on May 12, 2011 in areas that previously had been treated for four consecutive years with an endothal herbicide (Figure 4). Curlyleaf was found at three sample sites out of the 11 that were monitored (Table 1). In May curlyleaf was present in the treated area but was sparse in density and in distribution. Coontail was the dominant plant.

Table 1. Aquatic plant abundance was based on rake sampling for May 12, 2011. Densities are based on a scale from 1 to 5 with 5 being the densest.

Aquatic Plant Assessment (sampling with a rake)					
Site	Depth (ft)	May 12, 2011			
		Curly-leaf	Coon-tail	Water stargrass	FA - benthic (filamentous algae)
1	5				
2	4.5		1		
3	5		2		
3	6		3		
4	9		1.5		
5	4		3		
5	6	3 stems	2		
6	6	1 stem	1.5		
7	5	2 stems	2		
8	7	2 stems	2		
9	7	4 stems	2		
10	6.5				2
11	5		3		

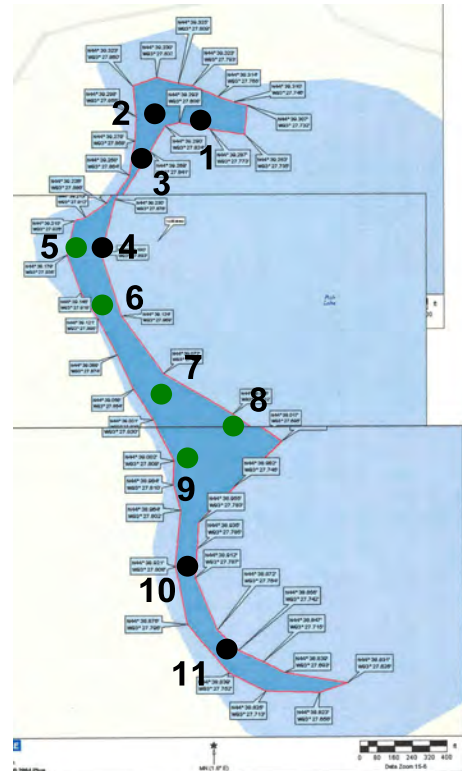


Figure 4. Map of sample locations for the May 12, 2011 curlyleaf assessment. Green dots represents curlyleaf pondweed was found at low densities. Black dots represent sample location and no curlyleaf pondweed found. Dark blue shading indicates area of treatment from 2005-2008.

Curlyleaf Stem Densities at One Location, May 12, 2011

Curlyleaf stem densities were determined by scuba diving at a location between sample sites 4-5 (Figure 1). Ten quadrat samples were taken at this location. The results for 2011 show curlyleaf was found at low stem densities (Table 2) but has increased slightly since 2008 (Figure 3). These stem densities were higher compared to densities found in 2008, but are still very low compared to pre-treatment stem densities from 2005 (Figure 5).

Table 2. Curlyleaf pondweed stem densities for May 12, 2011.

Scuba Diving - May 12, 2011		
Site 4 - 5 Quadrat	Curlyleaf (stems/m ²)	Coontail (stems/m ²)
1	60	20
2	70	20
3	100	10
4	50	30
5	60	0
6	30	0
7	30	0
8	30	0
9	20	0
10	20	0
Ave	47	8

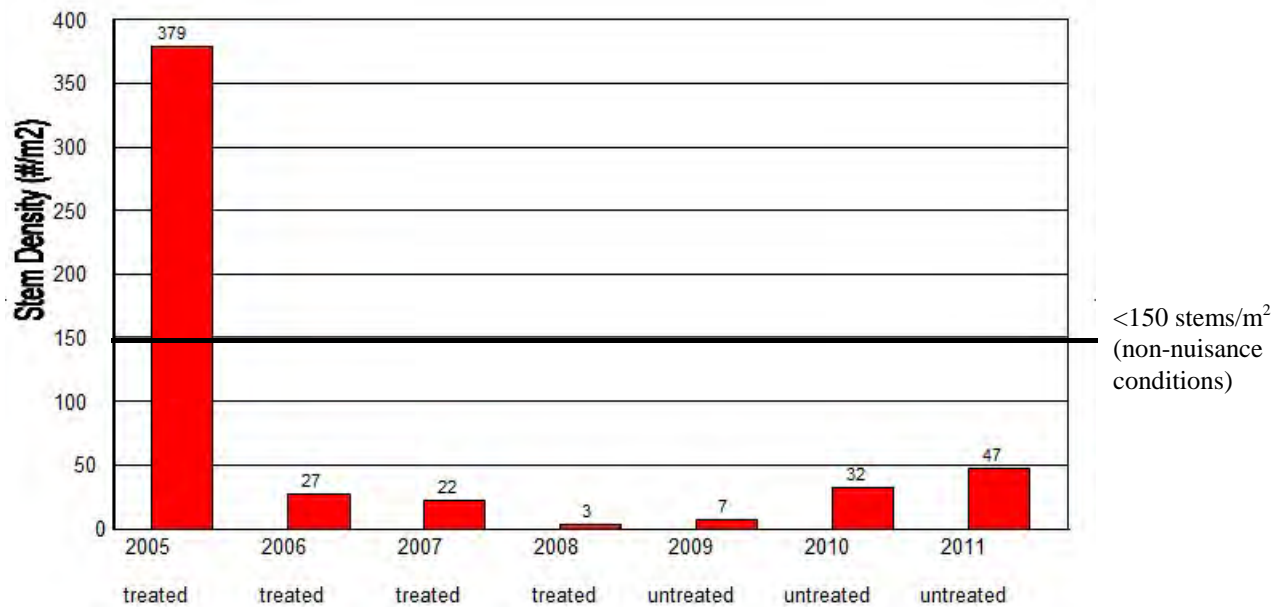


Figure 5. Curlyleaf stem densities for early season monitoring (using scuba diving) for 2005-2011.

Curlyleaf Conditions in Fish Lake, May 12, 2011



Figure 6. [top] The white frame is a quadrat sampler. All stems within the quadrat are counted. Curlyleaf was found at low densities at the sample sites monitored by scuba diving. [bottom] Curlyleaf pondweed and coontail were found together at 40% of the quadrat samples.

Late Spring Curlyleaf Pondweed Assessment in Fish Lake

A total of 11 sites were monitored with rake sampling on June 13, 2011 in areas that previously had been treated for four consecutive years with an endothall herbicide. There was no herbicide use in 2011. Curlyleaf was found at 9 out of 11 sample sites and coontail was found at 8 out of 11 sites. Northern milfoil was found at one site.

Curlyleaf at Site 9 had moderate to heavy growth. This type of growth is sometimes controlled.

Table 3. Aquatic plant abundance was based on rake sampling for June 13, 2011. Densities are based on a scale from 1 to 5 with 5 being the densest.

Aquatic Plant Assessment (sampling with a rake)							
Site	Depth (ft)	June 13, 2011					
		Curly-leaf	Coon-tail	Northern watermilfoil	Stringy pondweed	Spatter-dock	Fila algae
1	4	2					3
2	5						3
3	5	1	2	1			
4	7	2	3		2		
5	4		4				
5	5	2					
6	4		2				
6	7	1	2				
7	5		2			2	
8	7	1	2				
9	5	3					1
9	5	4			1		
10	6	1	2			2	
11	7	2	3				

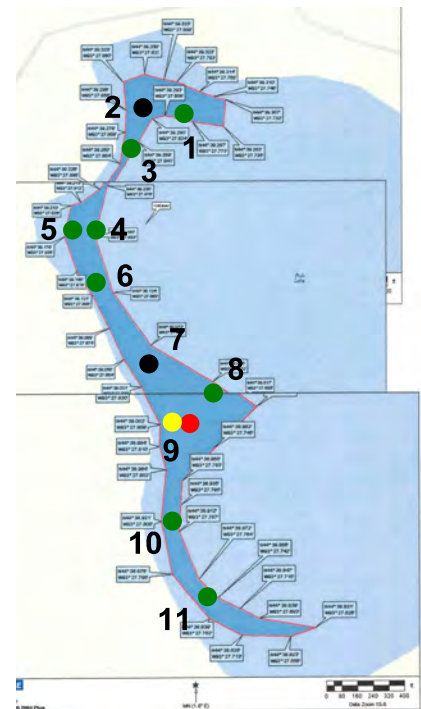


Figure 7. Map of sample locations for the June 13, 2011 curlyleaf assessment. Green dots represents curlyleaf pondweed was found at low densities. Yellow dots represents curlyleaf was found at moderate densities. Red dots represents curlyleaf was found at heavy densities. Black dots represents sample location and no curlyleaf found. Dark blue shading indicates area of treatment from 2005-2008.

Curlyleaf Stem Densities at One Location, June 13, 2011

Curlyleaf stem densities were determined by scuba diving at a location between sample sites 4-5 (Figure 1). Ten quadrat samples were taken at this location. The results for 2011 show curlyleaf was found at relatively low stem densities (Table 4). A high density is regarded to be at 150 stems/m² or greater.

Table 4. Curlyleaf pondweed stem densities for June 13, 2011.

Scuba Diving - June 13, 2011			
Site 4 - 5 Quadrat	Curlyleaf (stems/m ²) 4 feet	Coontail (stems/m ²) 4 feet	Curlyleaf (stems/m ²) 5-6 feet
1	10	20	200
2	0	20	160
3	0	20	40
4	0	30	240
5	0	30	100
6	0	20	60
7	0	30	110
8	0	30	120
9	0	20	60
10	0	20	100
Ave	1	24	119

Curlyleaf Conditions in Fish Lake, June 13, 2011



Figure 8. [top] The white frame is a quadrat sampler. All stems within the quadrat are counted. Curlyleaf was found at low densities at the sample sites monitored by scuba diving. [bottom] Curlyleaf pondweed was reaching within a couple of feet of the water surface in a couple of sites.

Stem Density Results for 2005-2011 at Sample Site 4-5

A summary from the sampling site for curlyleaf pondweed stem densities for pre-herbicide and post herbicide conditions is shown in Table 5.

Stem density results for May conditions were higher in 2011 than in 2006 - 2010. Curlyleaf stem densities for May conditions in 2011 averaged 47 stems/m².

In 2011, stem densities in June were higher compared to years with herbicide treatments but slightly lower compared to 2009.

Table 5. Summary of curlyleaf pondweed stem densities prior to the effects of herbicide treatment and after the herbicide treatment.

Site	Stem Density (stems/m ²)						
	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)
1	290	50	0	10	10	20	60
2	460	0	0	20	10	60	70
3	270	0	0	0	20	60	100
4	260	10	0	0	0	80	50
5	480	20	30	0	30	0	60
6	250	80	40	0	0	40	30
7	540	60	30	0	0	40	30
8	370	20	80	0	0	20	50
9	270	30	20	0	0	0	20
10	600	30	20	0	0	0	20
Ave	379	27	22	3	7	32	47

Site	Stem Density (stems/m ²)						
	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)
	treated	treated	treated	treated			
1	10	10	0	0	50	70	200
2	20	10	0	0	50	120	160
3	30	10	0	0	220	20	40
4	0	10	10	0	130	20	240
5	0	0	30	0	90	10	100
6	0	0	10	0	50	360	60
7	0	0	0	0	100	140	110
8	0	0	0	0	150	90	120
9	0	0	0	0	110	230	60
10	0	0	0	0	320	10	100
Ave	6	4	5	0	130	107	119

Subsurface Curlyleaf Pondweed Conditions in Fish Lake in 2005, 2006, 2007, 2008, 2009, 2010, 2011

Pre-Herbicide Conditions

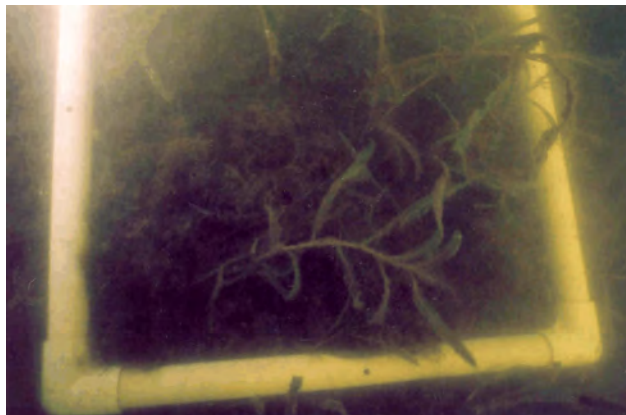
Post Herbicide Conditions



April 18, 2005



May 23, 2005



April 25, 2006



June 2, 2006



April 16, 2007

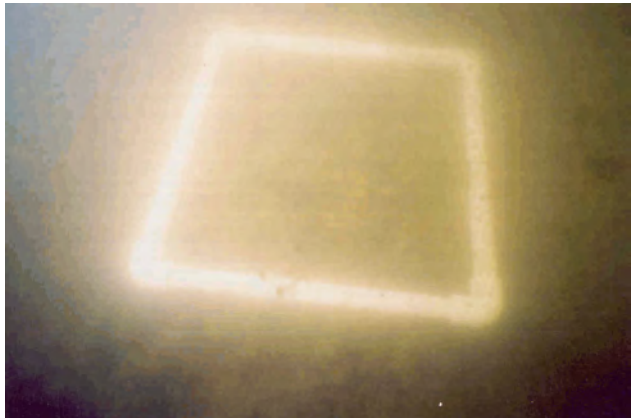


June 5, 2007

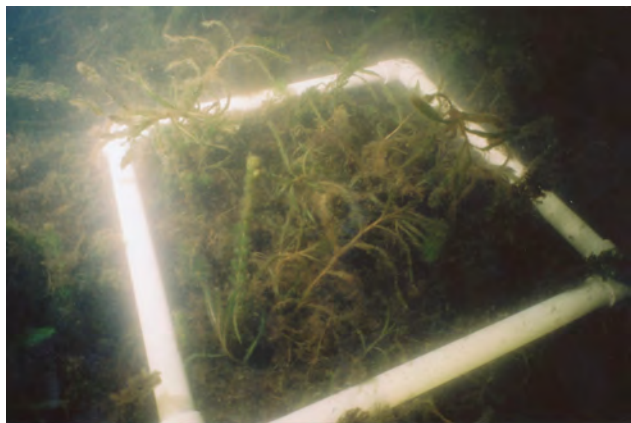
Pre-Herbicide Conditions



April 29, 2008



April 23, 2009



April 27, 2010

Post Herbicide Conditions



June 13, 2008



June 10, 2009



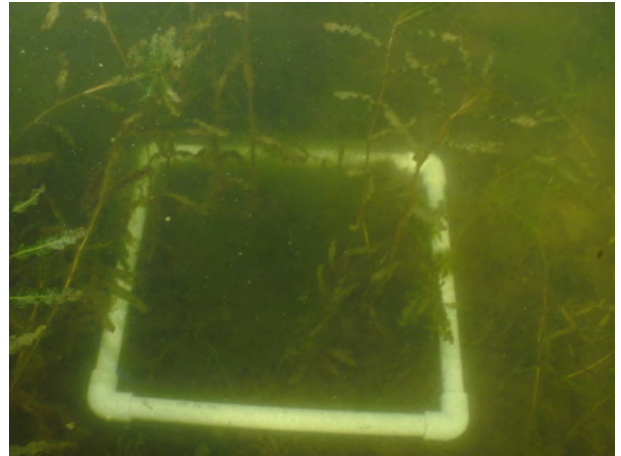
June 2, 2010

Pre-Herbicide Conditions



May 12, 2011

Post Herbicide Conditions



June 13, 2011

Curlyleaf Pondweed Conditions in early June in 2003 and 2005-2011



2003



2005



2006



2007



2008



2009

Curlyleaf Pondweed Conditions in early June in 2003 and 2005-2011



2010



2011

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 6 and Figure 10.

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 10).

Table 6. 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	

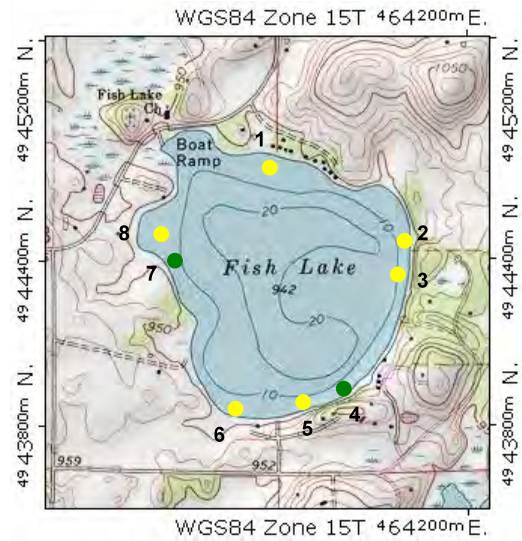


Figure 10. Sediment sample locations are shown with a circle. The circle color indicates the potential for nuisance curlyleaf pondweed to occur at that site. Key: green = low; yellow = medium; red = high potential.

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

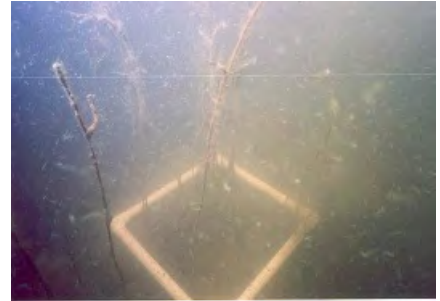
Plants rarely reach the surface.

Navigation and recreational activities are not generally hindered.

Stem density: 0 - 160 stems/m²

Biomass: 0 - 50 g-dry wt/m²

Estimated TP loading: <1.7 lbs/ac



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/m²

Biomass: 50 - 85 g-dry wt/m²

Estimated TP loading: 2.2 - 3.8 lbs/ac



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/m²



Conclusions: At the curlyleaf monitoring site used in this study, prior to a herbicide application in 2005, curlyleaf stem densities were recorded at an average stem density of 379 stems/m². This would put curlyleaf growth into the moderate to heavy growth category. After one season of an herbicide treatment program (in 2005), curlyleaf stem densities were dramatically reduced the following season (2006) in Fish Lake. Stem densities in April of 2006 (prior to the 2006 herbicide treatment) were 27 stems/m².

Because of the low pH in the lake sediments at the 2011 sample Site 4-5 it is predicted that curlyleaf stem densities in the future could regrow to a moderate abundance condition. A low sediment pH (less than 7.7) seems to be a key variable that is correlated with light to moderate curlyleaf growth. In 2006 the sediment pH at the assessment Site 4 was 7.5.

On a lakewide basis, lake sediment results indicate a potential for light to moderate growth for curlyleaf pondweed in Fish Lake. It should be noted that moderate growth of curlyleaf pondweed can be perceived by lake users as a condition that should be managed. This type of curlyleaf

growth, which would be predicted to occur if herbicide applications are discontinued in Fish Lake, represents a slight navigational problem and a moderate phosphorus loading condition.

Within the 15.5 acre treatment area, up to 10 acres could be a candidate area for curlyleaf control with herbicides in 2012 although a treatment area of up to 3 acres is more likely.

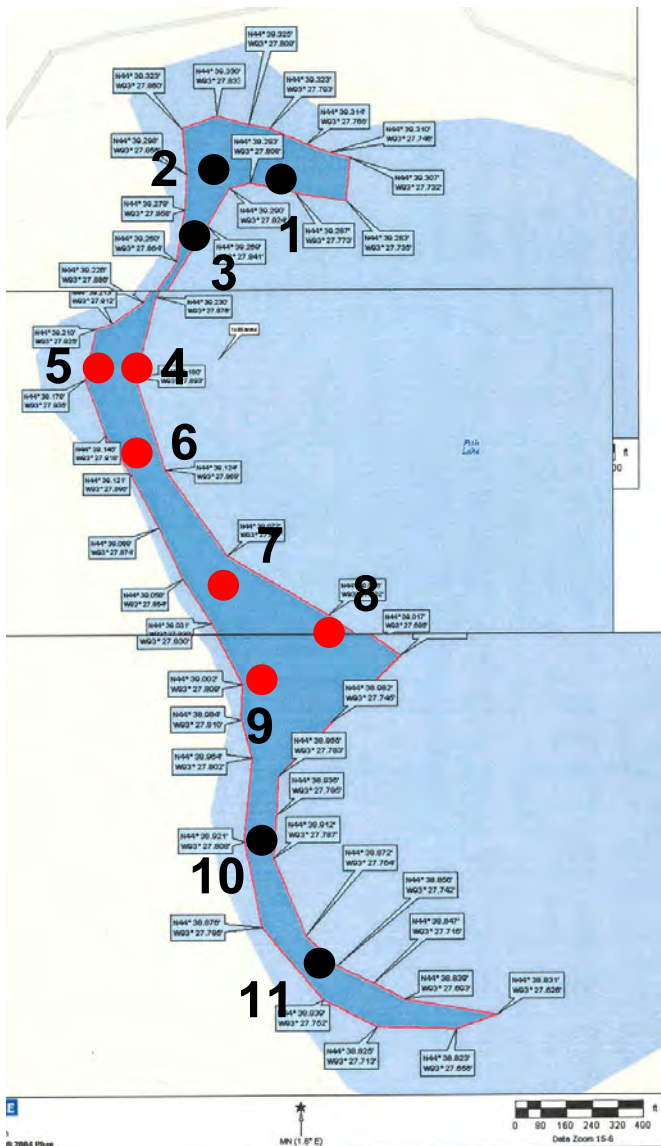


Figure 11. The red dots represent potential treatment areas totaling about 10 acres for 2010.

APPENDIX

Curlyleaf Pondweed Abundance in 2010: Two assessments were conducted in Fish Lake within the 15.5 acre treatment area. The first one was on April 27 and the second one was on June 10, 2010. The area shaded dark blue was treated with Aquathol from 2005 through 2008. No herbicides were used in the 15.5 acre area in 2009 and 2010. In the first assessment curlyleaf pondweed was found at only one site out of the 11 sites monitored. On the second assessment curlyleaf had increased in abundance and in distribution and was found at 5 out of 11 sites. At Site 9, curlyleaf growth was close to the surface. The coverage of this moderate to heavy growth was estimated at 3 acres.

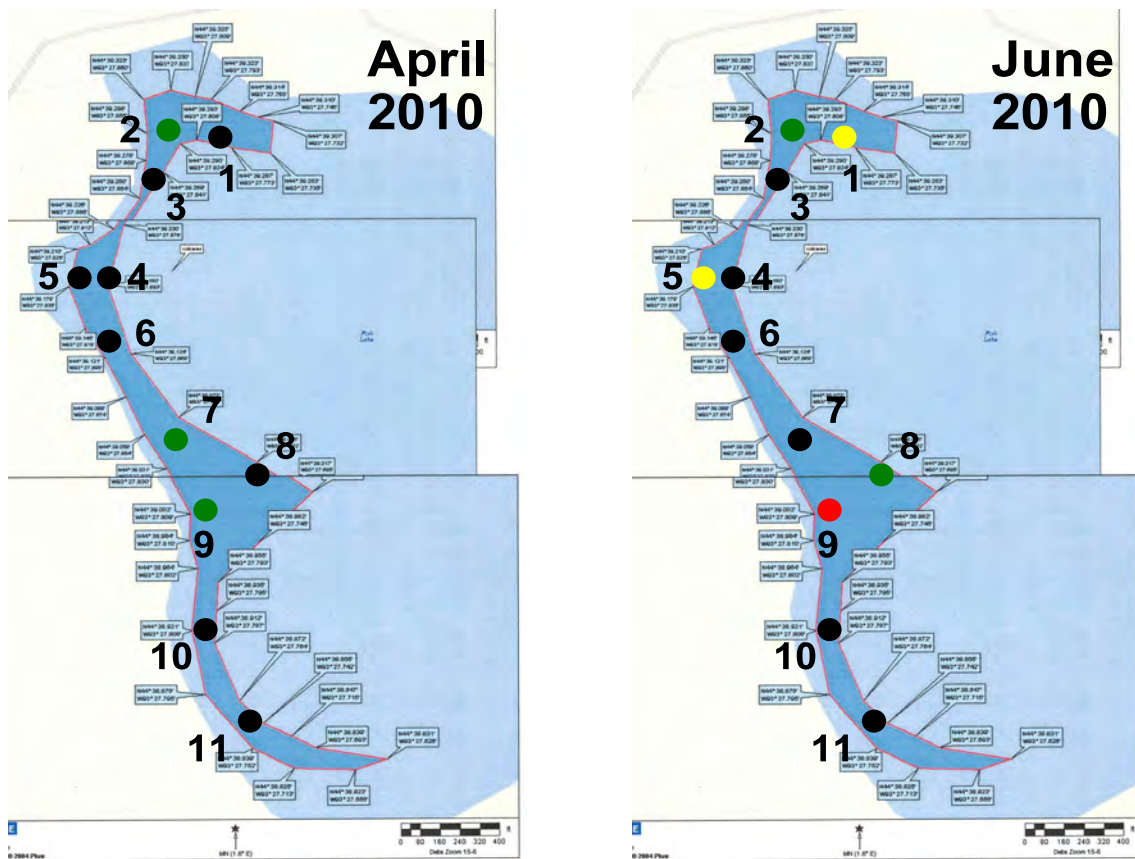


Figure 1. [left] Eleven sites within an area that was treated from 2005-2008 (dark blue shading) were monitored in April and curlyleaf was detected at three sites at low densities (green dots). [right] In June, the same sites were monitored and curlyleaf was detected at five sites. Growth was heavy at Site 9, moderate at Sites 1 and 5 and light at Sites 2 and 8.