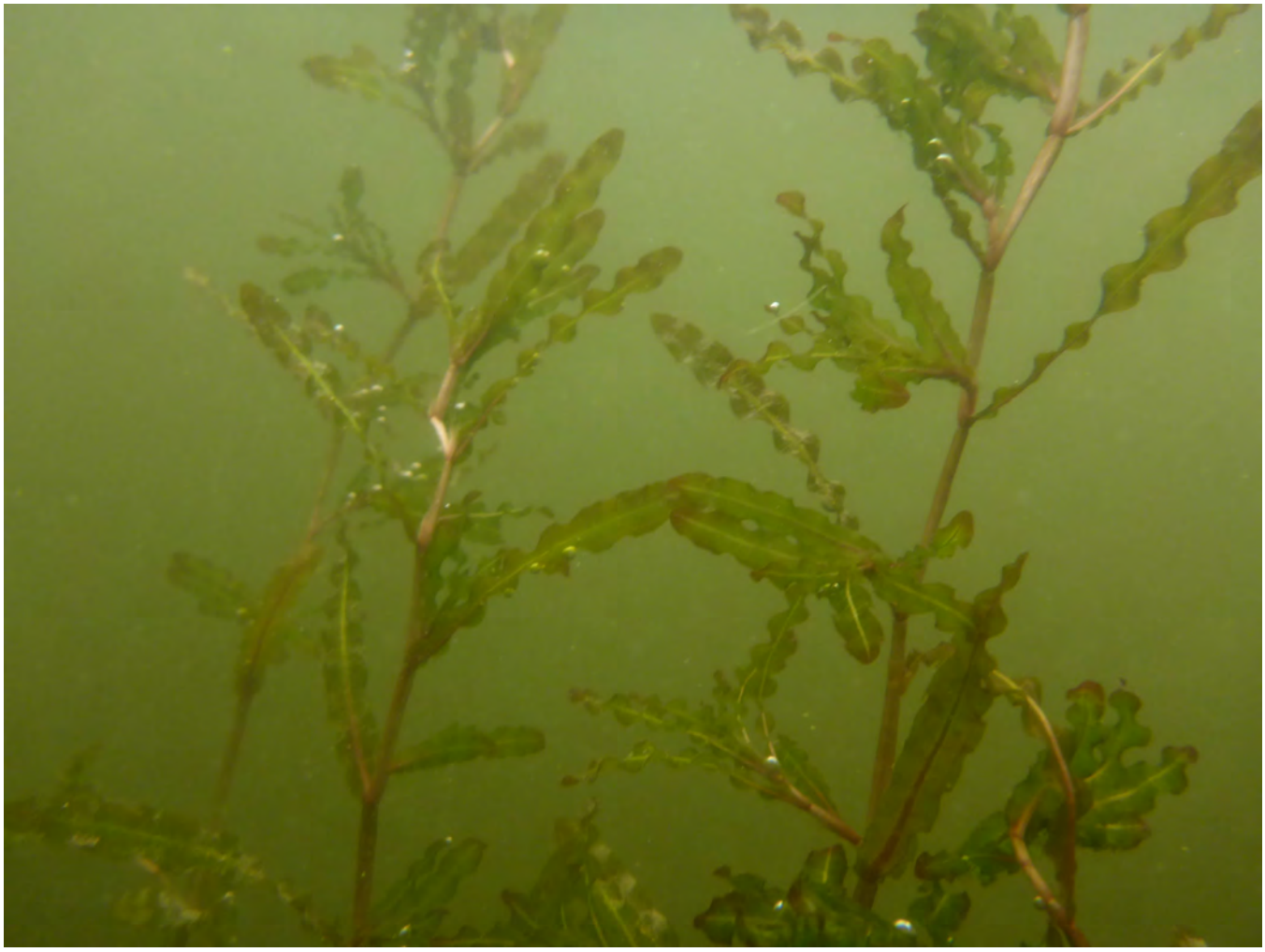


Curlyleaf Pondweed in Forest Lake on June 10, 2016

Curlyleaf Pondweed and Eurasian Watermilfoil Delineation, Treatment, and Assessment for Forest Lake, Washington County, 2016

	Delineation	Treatment	Assessment
CLP	April 12, 2016	May 2 and 4, 2016 (113.7 acres)	June 10, 2016
EWM	June 10, 2016	July 18, 2016 (13.9 acres)	September 15, 2016

Prepared for:
Comfort Lake/Forest Lake Watershed District
Forest Lake, Minnesota

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

January 2017

Curlyleaf Pondweed and Eurasian Watermilfoil Delineation, Treatment, and Assessment for Forest Lake, Washington County, 2016

Summary

Curlyleaf Pondweed (CLP) Delineation, Treatment, and Assessment: Curlyleaf pondweed distribution and abundance were evaluated April 12, 2016. Later, on May 2, 2016 based on that delineation, a total of 113 acres on the 2,271 acre lake were treated to control excessive growth of curlyleaf. A follow-up curlyleaf assessment was conducted on June 10, 2016

In the delineation survey, curlyleaf was somewhat widespread (Figure S1) and potential future heavy growth was estimated at 113 acres. A total of 113.7 acres of curlyleaf areas were treated in May 2, 2016.

The June curlyleaf assessment found curlyleaf growth was light to heavy (Figure S1). Curlyleaf control in the treated areas was below expectations. Several treated areas had poor control. Based on records submitted by the applicator, average water depths used to calculate the quantity of gallons of herbicide to apply were too low and areas were under-dosed with Aquathol, likely producing poor control. This will be corrected in 2017.

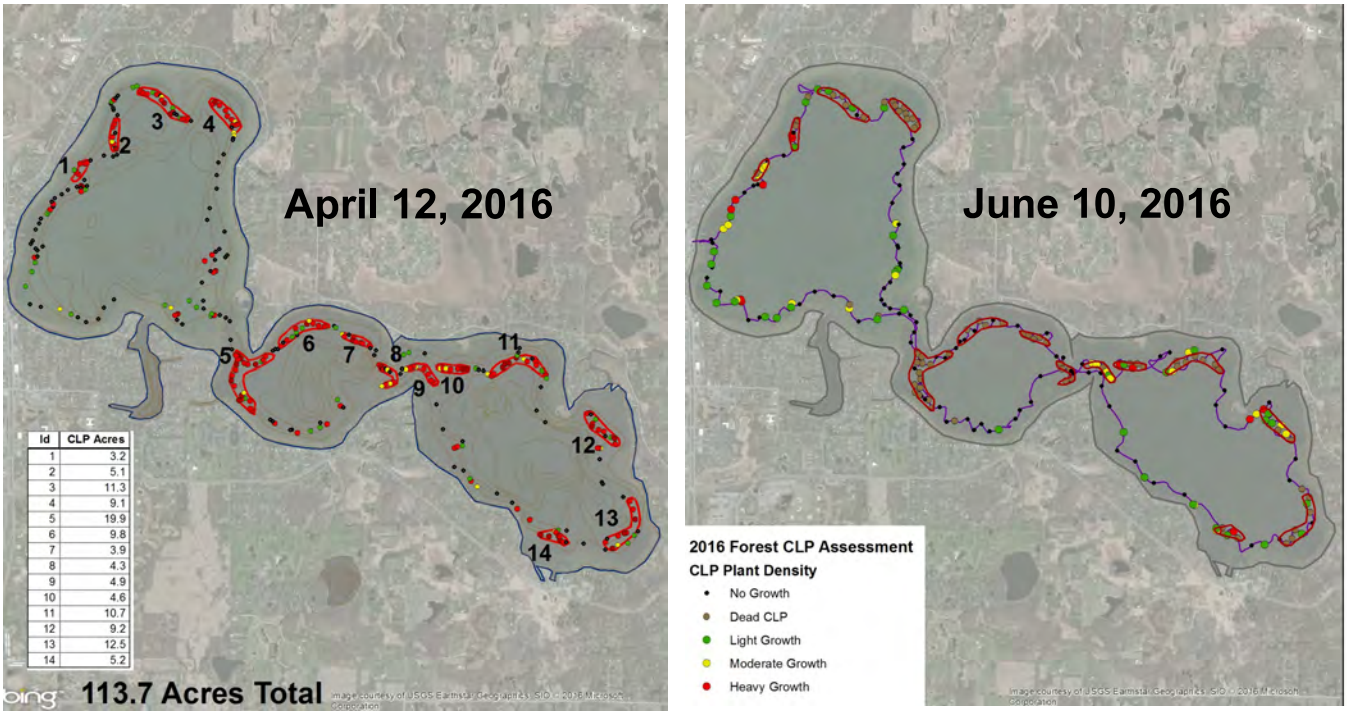


Figure S1. [left] DELINEATION: Map of curlyleaf pondweed distribution from the April 12, 2016 survey. Approximately 114 acres were delineated for CLP treatment. Treatment areas are outlined in red. [right] ASSESSMENT: Map of curlyleaf pondweed assessment sites for June 10, 2016. Key: green dots = light growth, yellow dots = moderate growth, red dots = heavy growth, and black dots = no curlyleaf growth. Red outline areas indicates treatment areas. Purple line is the boat track.

Eurasian Watermilfoil (EWM) Delineation, Treatment, and Assessment: EWM distribution and abundance were evaluated June 10, 2016. Based on that delineation, a total of 13.9 acres of the 2,271 acre lake were treated on July 18 to control heavy growth of Eurasian watermilfoil.

About 2 months after the EWM treatment, an EWM assessment on September 15, 2016 found good control in the treated areas with mostly light growth in a few scattered spots. No EWM was observed in Lakes 2 and 3 in 2016 (Figure S2).

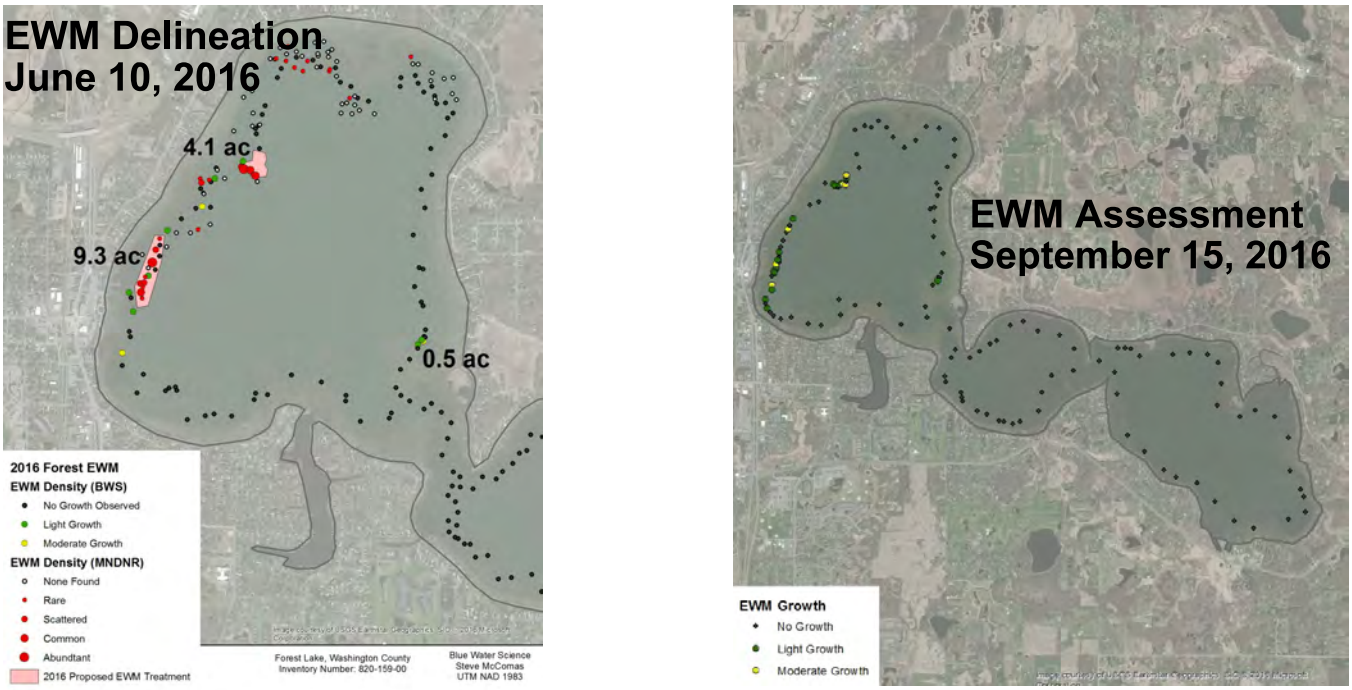


Figure S2. [left] DELINEATION: Map of EWM distribution from the June 10, 2016 survey. Approximately 13.9 acres were delineated for EWM treatment.
[right] ASSESSMENT: Map of EWM assessment on September 15, 2016.
Key: green dots = light growth, yellow dots = moderate growth, red dots = heavy growth, and black dots = no EWM growth.

Forest Lake EWM Treatment Areas for 2015 and 2016

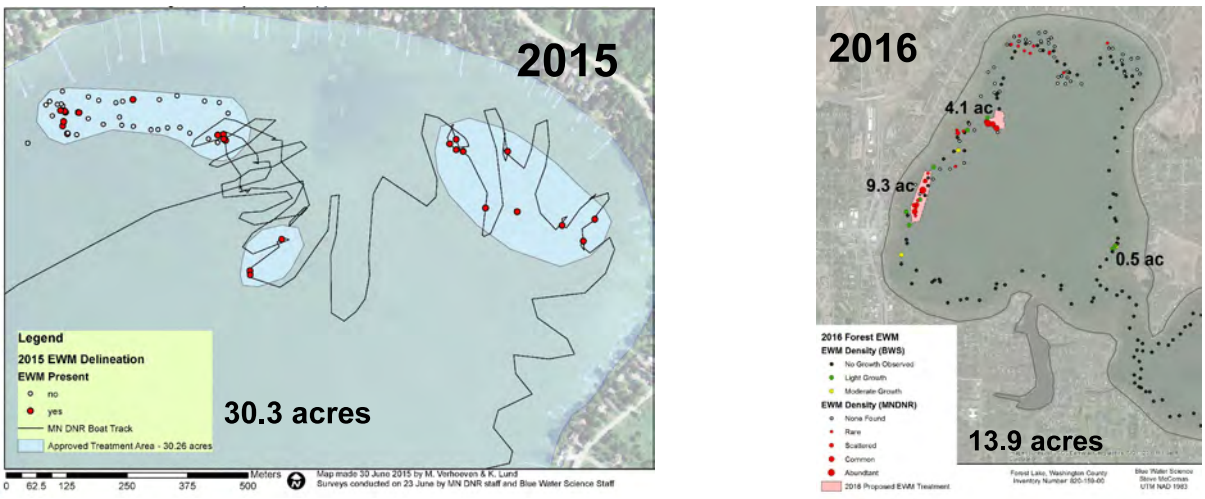


Figure S3. Curlyleaf treatment areas in 2015 and 2016.

Summary of CLP and EWM Treatments from 2009 - 2016: Two non-native aquatic plants were treated with herbicides in 2016 (Table S1). Curlyleaf pondweed treatments have ranged from 60 to 168 acres from 2009 through 2016. Eurasian watermilfoil was discovered in Forest Lake in 2015 and 30 acres were treated. In 2016, 13.9 acres were treated (Table S1).

Table S1. Acres of non-native plants treated from 2009 through 2016.

	CLP (acres)	EWM (acres)
2009	98	
2010	155	
2011	168	
2012	155	
2013	60	
2014	101	
2015	88	30
2016	114	13.9

Curlyleaf pondweed delineation

Eurasian watermilfoil delineation

Curlyleaf pondweed assessment

Eurasian watermilfoil assessment

Curlyleaf Pondweed and Eurasian Watermilfoil Delineation, Treatment, and Assessment for Forest Lake, Washington County, 2016

Introduction

Forest Lake has an area of 2,271 acres with a littoral area of 1,531 acres (MnDNR). The maximum depth of Forest Lake is 37 feet. Heavy growth of curlyleaf pondweed (CLP) has occurred in the past and control methods have been implemented. In 2015, Eurasian watermilfoil (EWM) was discovered in Forest Lake and about 30 acres of EWM were treated. The objectives of the delineation and assessment surveys in 2016 were to determine the acreage of CLP and EWM to treat and then after treatment, evaluate the effectiveness of the treatments.

An initial curlyleaf pondweed delineation was conducted on April 12, 2016. A total of 113.7 acres of curlyleaf pondweed were treated with an endothall herbicide. A follow-up curlyleaf pondweed assessment was conducted on June 10, 2016 to characterize the status of curlyleaf pondweed at it's peak growing period. Curlyleaf growth conditions in April are shown in Figure 1. EWM distribution and abundance were delineated on June 10, 2016 and 13.9 acres were treated.

Figure 1. [left] Curlyleaf pondweed stem count is greater than 4 stems and this area would be treated. [right] Curlyleaf pondweed with a high stem count on a rake sampler. This area would be also treated.

Methods

Curlyleaf Pondweed: At the time of the spring CLP delineations, only a fraction of the peak curlyleaf biomass is present. For spot treatments, the areas to be treated should be delineated prior to curlyleaf developing peak biomass. Curlyleaf stem counts on a rake sampler were used to identify areas that had a potential to produce dense curlyleaf. After a short sweep of about 1-foot (30 cm), 4 curlyleaf stems or more per rake sample generally indicated some CLP plants had developed runners and would likely produce heavy growth in the next few weeks. Alternatively, sites where 3 stems or less were collected per rake sample were not predicted to produce dense growth at the peak growing period. These areas were not treated. This delineation method was used for spot lake treatments in Gleason Lake and has worked for other lakes as well (McComas et al, 2015*).

Eurasian Watermilfoil: Eurasian watermilfoil delineations were conducted by Blue Water Science on June 10, 2016. The delineations involved cruising around the entire lake and observing milfoil growth and sampling aquatic plants with rakes. A total of 229 sample sites were checked. Areas to be treated were selected based on the growth status of milfoil in mid June, the known previous occurrence of EWM and the importance for navigation and/or recreation in the area.

An herbicide application was conducted by Lake Management Inc and a total of 13.9 acres were treated. A follow-up EWM assessment was conducted by Steve McComas, Blue Water Science, on September 15, 2016 to evaluate the effectiveness of the herbicide treatment for EWM control. A total of 139 sites were checked on the September 15 assessment. EWM density ratings used in the July delineation and September assessment are shown in the chart below.

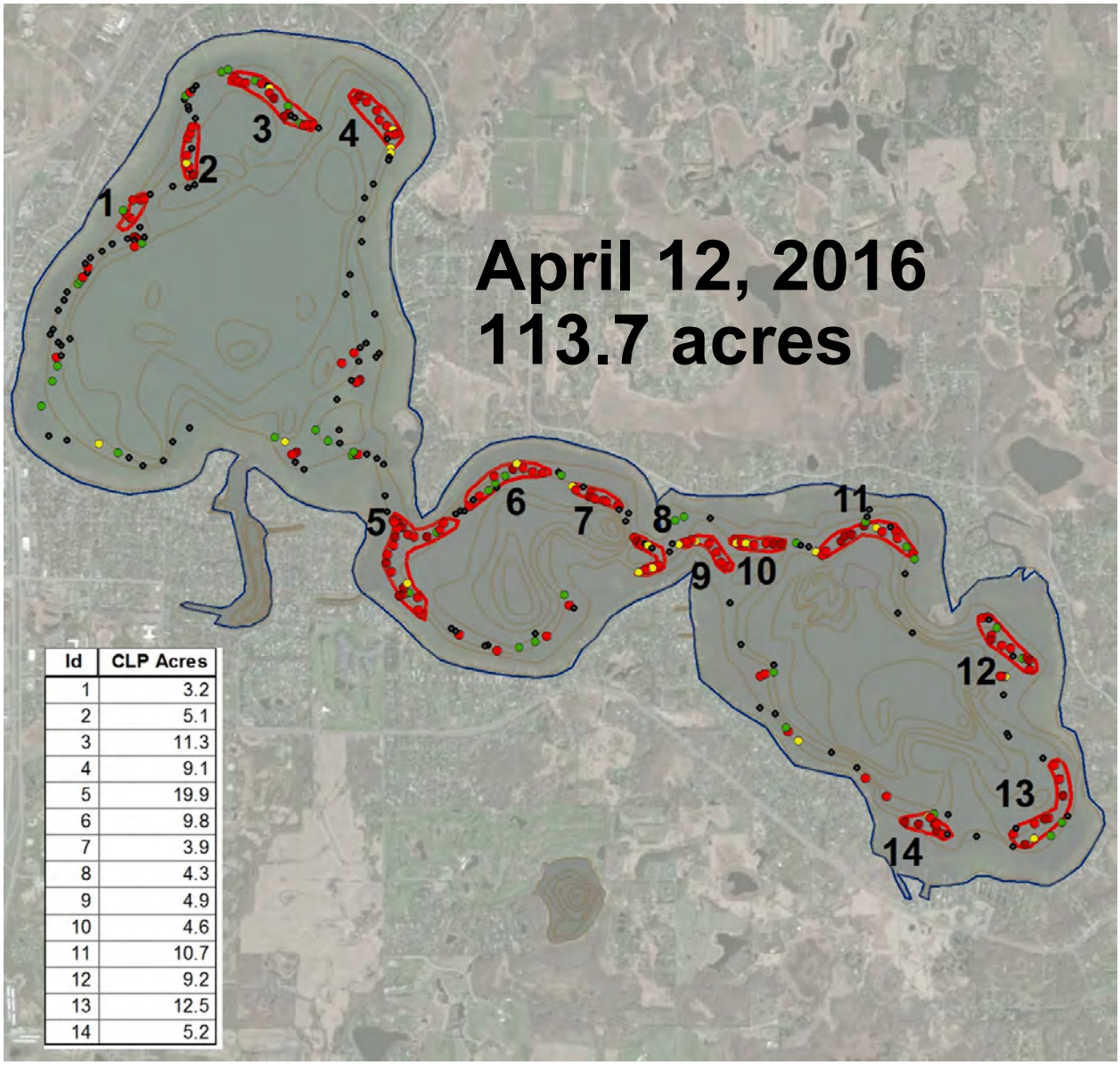
Chart of EWM Density Ratings for EWM

Eurasian watermilfoil rake density ratings from 1 to 4. Native plants used the same rake fullness rating as well.

*McComas, S.R., Y.E. Christianson, and U. Singh. 2015. *Effects of curlyleaf pondweed control on water quality and coontail abundance in Gleason Lake, Minnesota. Lake and Reservoir Management. 31:109-114.*

Curlyleaf Pondweed Delineation on April 12, 2016

A curlyleaf delineation was conducted using rake sampling on April 12, 2016. A total of 323 sites were sampled and 14 areas of significant curlyleaf growth were delineated (outlined in red in Figure 2) totaling about 113.7 acres. At this time of the year curlyleaf was found at low densities but with the potential to produce heavy growth in a number of areas in 3 to 4 weeks (Table 1 and Figure 3).



Id	CLP Acres
1	3.2
2	5.1
3	11.3
4	9.1
5	19.9
6	9.8
7	3.9
8	4.3
9	4.9
10	4.6
11	10.7
12	9.2
13	12.5
14	5.2

Figure 2. Map of curlyleaf delineation in Forest Lake on April 12, 2016. Red lines outline CLP treatment areas. Key for future potential CLP growth: green circles = light, yellow circles = moderate, and red circles = heavy.

Curlyleaf Pondweed Treatment, May 2 and 4, 2016

A total of 113.7 acres of curlyleaf pondweed were treated on May 2 and 4, 2016 using Aquathol K at 1 ppm. Treatment information by areas is summarized in Table 1.

Table 1. Summary of 2016 Forest Lake CLP treatment areas and results. Treatment details are show n below. Treatment date: May 2 (treatment areas 5-8 and 10-14) and May 4 (treatment areas 1-4 and 9) Acres treated: 113.7 acres, Chemical used: Aquathol K, Target concentration of herbicide: 1 ppm, Gallons of herbicide applied per acre-foot to achieve 1 ppm: 0.6 gallons per acre-foot (based on manufacturer specifications). At the time of the herbicide application, water temperature was 54-58°F and the wind speed was 1-6 mph.

Treatment Area	Acres Treated (ac)	Average Depth of Treatment Area Used by Applicator (ft)	Gallons of Herbicide Used in Forest Lake
1	3.2	5	9.6
2	5.1	5	15.3
3	11.3	5	33.9
4	9.1	5	27.3
5	19.9	5	59.7
6	9.8	5	29.4
7	3.9	5	11.7
8	4.3	5	12.9
9	4.9	5	14.7
10	4.6	5	13.8
11	10.7	5	32.1
12	9.2	5	27.6
13	12.5	5	37.5
14	5.2	5	15.6
Total:	113.7	5	341.1

Curlyleaf Pondweed Assessment on June 10, 2016

Curlyleaf pondweed control had a range of results for the 113.7 acres that were treated on May 2 and 4, 2016. Many of the treatment areas had partial control and several areas had good control with dead CLP still present. Results are summarized in Figure 3 and Table 2.

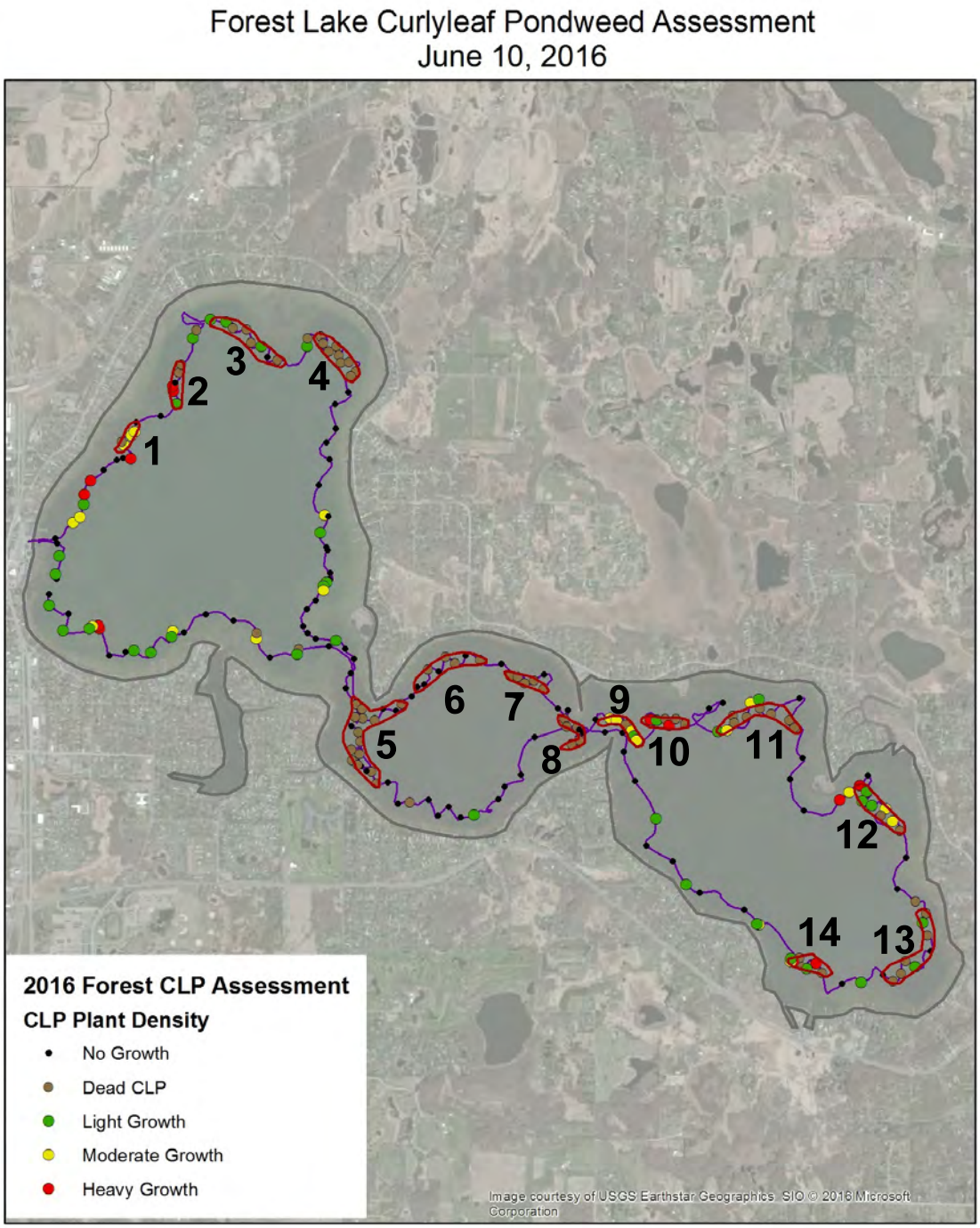


Figure 3. Map of curlyleaf distribution in Forest Lake on June 10, 2016.
Key: green dots = light growth, yellow dots = moderate growth, red dots = heavy growth, and black dots = no curlyleaf. Red outlined areas = treatment areas. Purple line = track of the sample boat.

Curlyleaf Control Review: CLP control could have been more effective. Weather conditions and lake water temperatures were favorable. However, average water depth for all the treatment areas used by the applicator was 5 feet (Table 2). The water depth then dictated the amount of herbicide to be applied to meet the 1 ppm target concentration. Actual average water depths within treatment areas ranged from 8 to 10 feet (Table 2). Basically, none of the treatment areas would have met the 1 ppm treatment dose goal and not enough herbicide was applied. When polygons are placed on a lake contour map, it shows none of the treatment area would have averaged 5 feet deep. Depths taken at individual sample points also show the average depths of the treatment areas to be 8 to 10 feet. Based on these depths, over 600 gallons of herbicide should have been applied when 341.1 gallons were actually applied. This is likely the primary factor for a lack of full CLP control in the treatment areas.

In the future, for Forest Lake, it should be assumed the average depth of the treatment areas is 9 feet.

Table 2. Summary of 2016 Forest Lake CLP treatment areas and results.

Treatment Area	Acres Treated (ac)	Average Depth of Treatment Area Used by Applicator (ft)	Gallons of Herbicide Used in Forest Lake	CLP Control (assessment conducted on June 10, 2016 by BWS)	Actual Average Depth of Treatment Area (ft)	Number of Gallons That Should Have Been Used Based on the Actual Average Depth
1	3.2	5	9.6	Partial, some moderate growth	8.3	15.9
2	5.1	5	15.3	Partial, some heavy growth	10.6	32.4
3	11.3	5	33.9	Partial, some light growth	8.2	55.6
4	9.1	5	27.3	Good control, dead CLP present	10.0	54.6
5	19.9	5	59.7	Good control, dead CLP present	8.9	106.3
6	9.8	5	29.4	Good control, dead CLP present	10.0	58.8
7	3.9	5	11.7	Good control, dead CLP present	9.3	21.8
8	4.3	5	12.9	Good control, dead CLP present	9.3	24.0
9	4.9	5	14.7	Partial, some moderate growth	9.5	27.9
10	4.6	5	13.8	Partial, some heavy growth	10.5	29.0
11	10.7	5	32.1	Fair control, some moderate growth	9.8	62.9
12	9.2	5	27.6	Poor control, light to heavy growth	9.4	51.9
13	12.5	5	37.5	Good control, some light growth	9.1	68.3
14	5.2	5	15.6	Partial control, some heavy growth	9.3	29.0
Total:	113.7	5	341.1	--	--	638.4

Comparison of Early Season to Late Season Curlyleaf Growth

A total of 113.7 acres of curlyleaf pondweed was delineated in the April 12 delineation. After a herbicide treatment on May 2 and 4, a curlyleaf assessment on June 10 found curlyleaf to be growing at light densities with some moderate to heavy growth in some treatment areas (Figure 4).

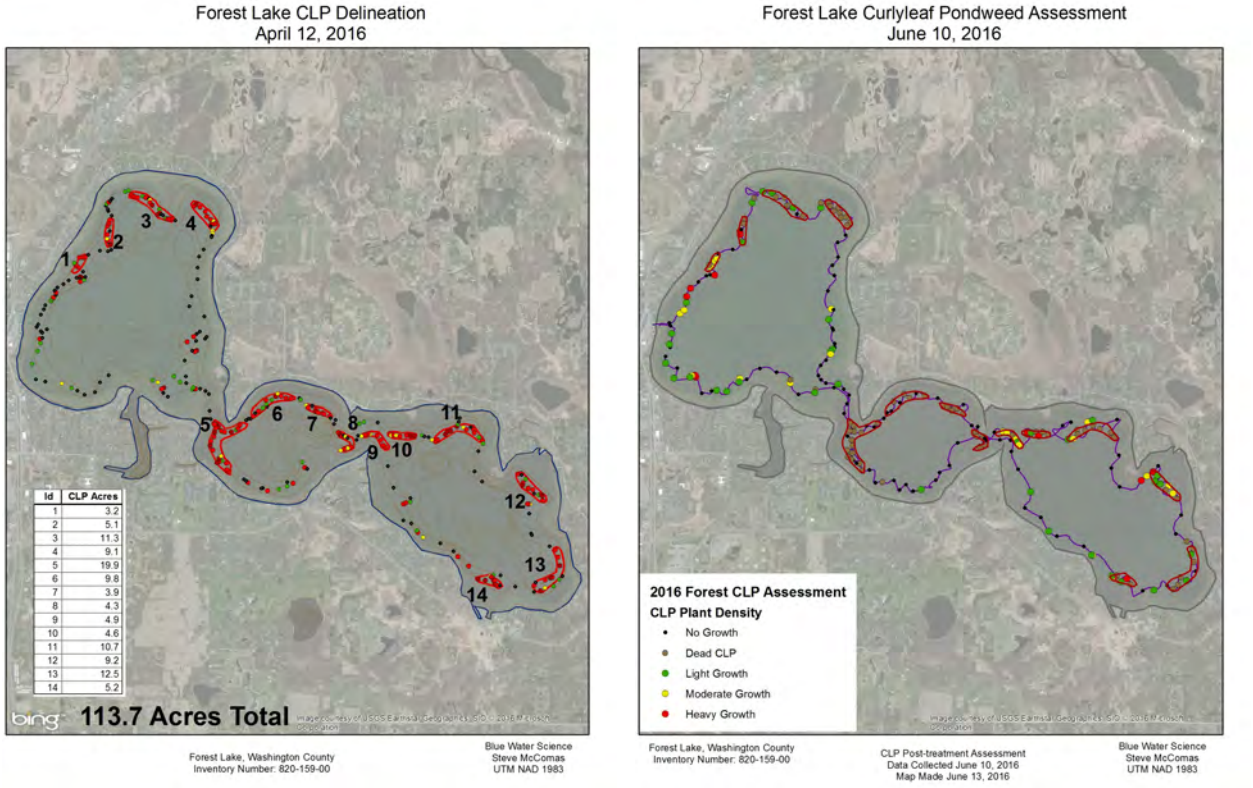


Figure 4. [left] Map of curlyleaf distribution in Forest Lake on April 12, 2016. [right] Map of curlyleaf distribution in Forest Lake on June 10, 2016. Key: green dots = light growth, yellow dots = moderate growth, red dots = heavy growth, and black dots = no curlyleaf. Red/blue outlined areas = treatment areas.

Figure 5. Curlyleaf pondweed was found around Forest Lake on June 10, 2016. [left] Curlyleaf pondweed on a sample rakehead. [right] Underwater view of curlyleaf.

Forest Lake Curlyleaf Treatment Areas for 2009-2016

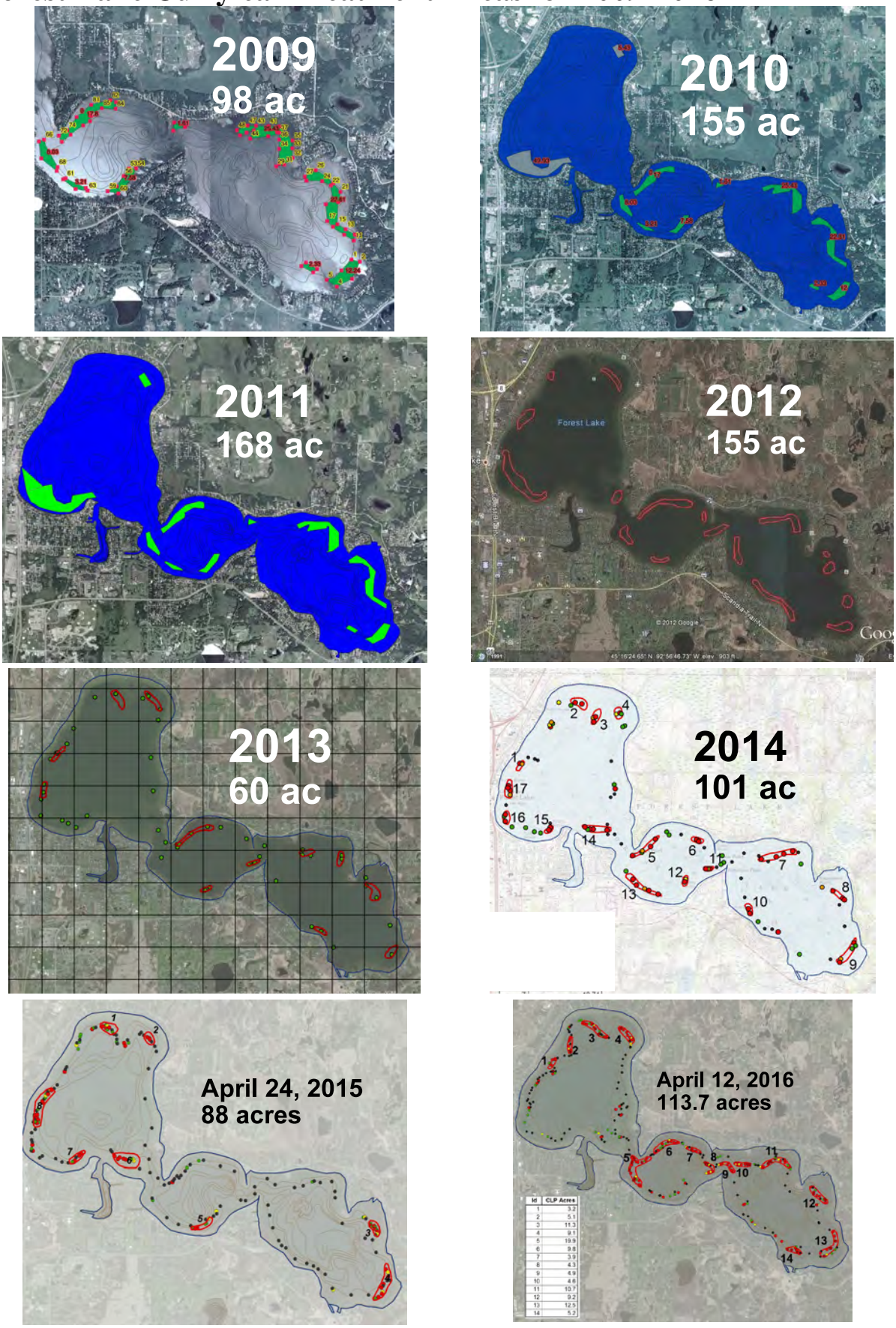


Figure 6. Curlyleaf treatment areas in 2009 through 2016.

Eurasian Watermilfoil Delineation on June 10, 2016

Eurasian watermilfoil growth was delineated on June 10, 2016 and 229 sites were sampled. EWM was found at 12 out of the 229 sites (5% occurrence). Three areas totaling 13.9 acres were treated.

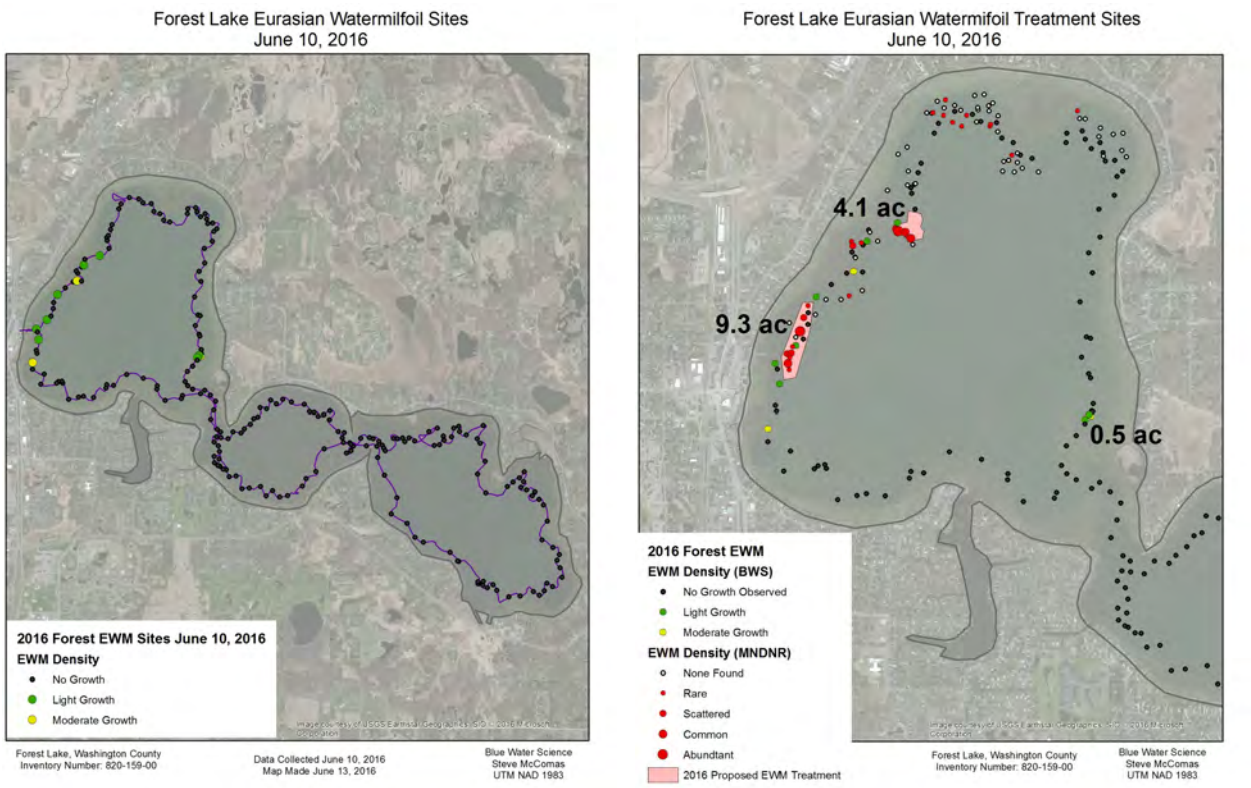


Figure 7. [left] Whole lake delineation. EWM was only observed in the 1st lake. [right] Combined delineation using points from Blue Water Science and MnDNR. A total of 13.9 acres was delineated for treatment.

EWM Treatment, July 18, 2016

On July 18, 2016, EWM was treated with a 2,4-D herbicide (Brand name: Alligare 2,4-D Amine) in 3 areas totaling 13.9 acres. The herbicide was applied at 4 ppm to half of the treatment area in the first pass and then about 10 hours later, the herbicide was applied at 4 ppm to the second half of the treatment area (Table 3).

The September EWM assessment found fair control in the areas treated in 2016 (Figures 8 and 9). Actually, good control was also observed in the 3 areas treated in 2015 (Figure 8).

Table 3. EWM treatment details for 2016 for 3 areas totaling 13.9 acres.

	Treatment Areas		
	0.5 ac	**9.3 ac**	**4.1 ac**
1st Pass			
Treated area (ac)	0.25	4.65	2.05
Time	10:15 am	11:01 am	10:30 am
gallons applied	4.26	99	52.2
Concentration (ppm)	4.0	4.0	4.0
2nd Pass			
Treated area (ac)	0.25	4.65	2.05
Time	8:03 pm	7:12 pm	8:27 pm
gallons applied	4.26	9.9	52.2
Concentration (ppm)	4.0	4.0	4.0
Average depth (ft)	6	7.5	9.0
gallons/ac	17.0	21.3	25.5
Target conc (ppm)	4.0	4.0	4.0

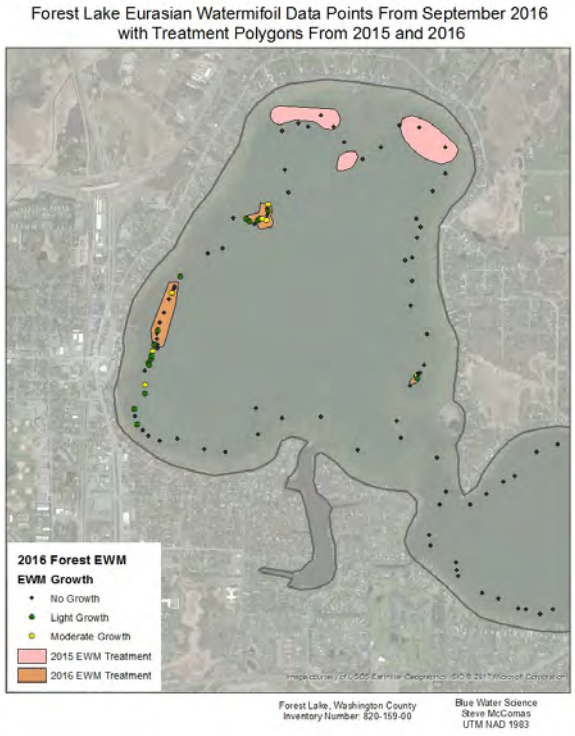


Figure 8. EWM distribution and abundance in 2016. Treatments in 2015 and 2016 appear to have produced good EWM control.

Eurasian Watermilfoil Assessment on September 15, 2016

About 2 months after 13.9 acres of EWM were treated an EWM assessment that sampled 139 points was conducted on September 15. All three basins were surveyed and EWM was only found in the 1st lake in several groupings. EWM growth was light to moderate at the 23 sites where it was observed. EWM was present in the 3 treated areas, but at light to moderate growth (Figure 9).

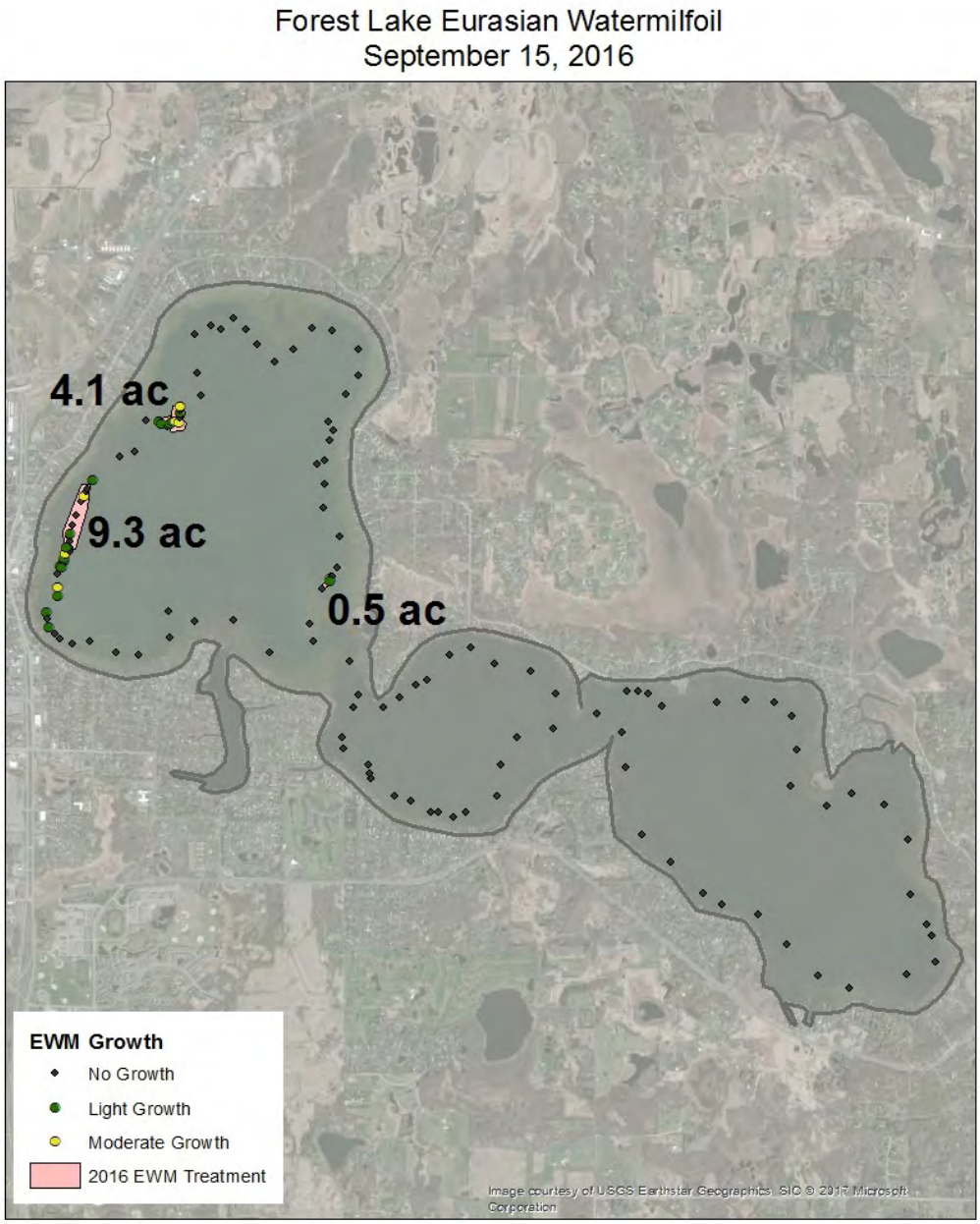


Figure 9. Map of Eurasian watermilfoil distribution in Forest Lake on September 15, 2016. Key: green dots = light growth, yellow dots = moderate growth, and black dots = no EWM. Pink areas = treatment areas.

Comparison of Early Season to Late Season Eurasian Watermilfoil

In 2016, EWM was only observed in the 1st Lake. EWM was treated on July 18, 2016 and in the September 18, 2016 assessment, EWM was found in the 1st Lake but at light to moderate densities (Figure 10).

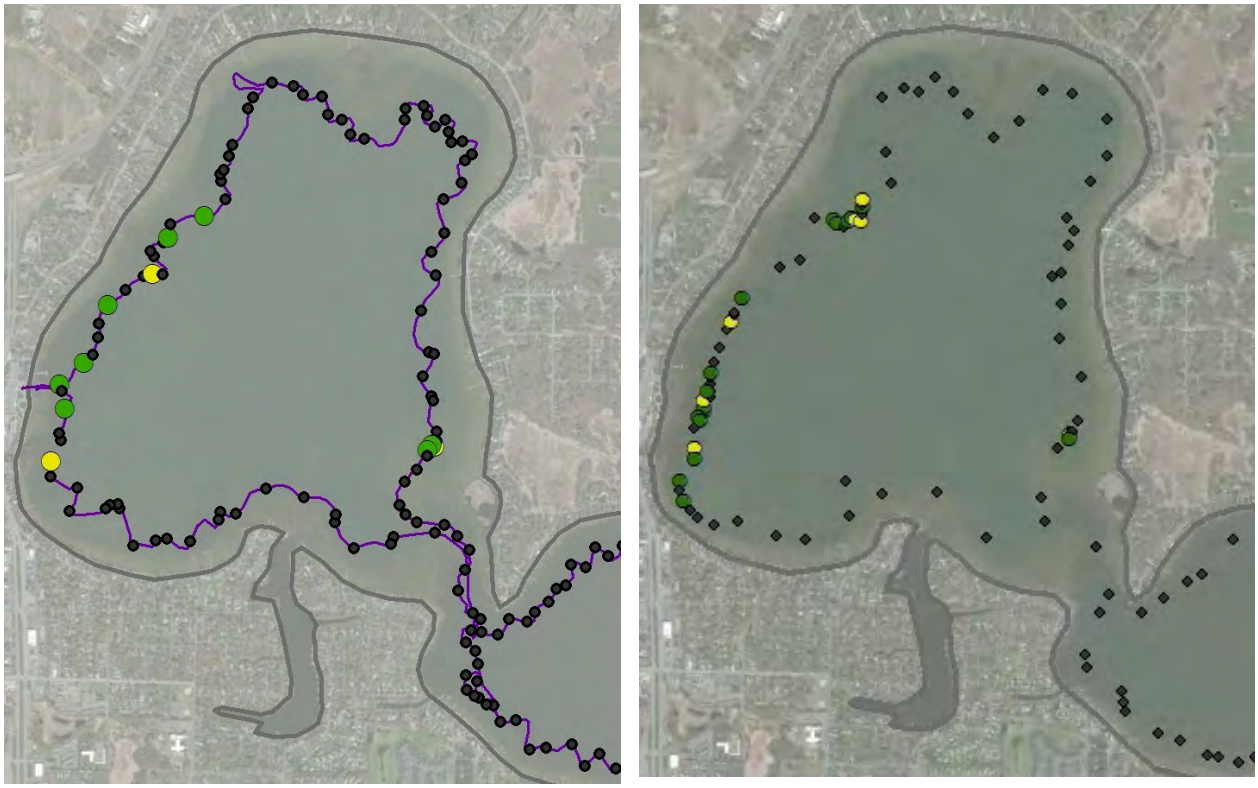


Figure 10. [left] EWM delineation on June 10, 2016. EWM was only observed in the 1st lake. [right] EWM assessment on September 15, 2016. EWM was found in a couple locations and only in 1st lake. Key: green = light growth, yellow = moderate growth, black = no growth. Purple line = path the boat took around the lake.

What's Next for 2017?

Curlyleaf Pondweed: Treating heavy growth of curlyleaf pondweed based on early season curlyleaf distribution is a challenge. Curlyleaf in early May has just started 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 Forest Lake, the method has been to use past treatment history combined with early season scouting and then a recheck after treatment to evaluate treatment effectiveness and see if curlyleaf areas were missed. Using this technique, most of the heavy growth of curlyleaf pondweed was treated in 2016.

In 2017, the same techniques will be applied that were used in 2016. Treatment areas in 2017 will likely be in the range of areas treated from 2009 through 2016. Maps of treatment areas for 2009 through 2016 are shown in Figure 6.

Eurasian Watermilfoil: Two passes with a liquid 2,4-D herbicide for EWM control prevented the occurrence of heavy EWM growth in 2016. The first pass treats half the area and the second pass treats the other half of the area. The same approach is suitable for EWM control in 2017.

APPENDIX

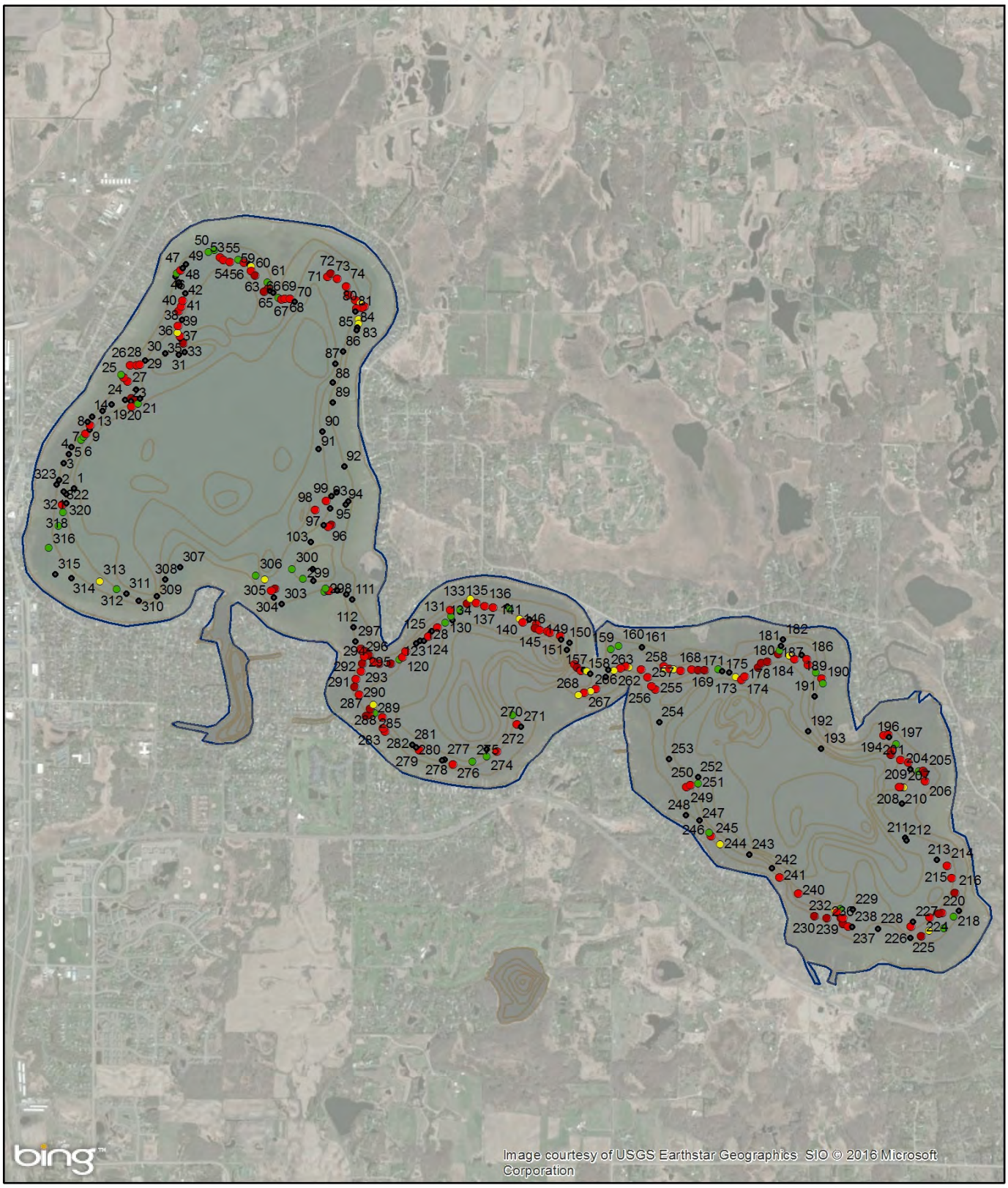
2016 Individual Point Data for Aquatic Plants

APRIL 12, 2016: Summary of water depths and CLP stems at each sample point within 14 treatment areas collected on April 12, 2016.

Treatment Area	Site	Depth (ft)	CLP stems	CLP Density	Average Depth (ft)
1	25	7	2	2	8.3
	26	8	10	5	
	27	9	9	5	
	28	9	7	5	
2	33	10	15	5	10.6
	34	11	0		
	35	11	6	5	
	36	9	3	3	
	37	11	8	5	
	38	13	0		
	39	9	10	5	
	40	10	10	5	
	41	11	5	5	
3	52	9	4	4	8.2
	53	10	5	5	
	54	10	7	5	
	55	10	1	1	
	56	9	8	5	
	57	7	0		
	58	7	3	3	
	59	7	4	4	
	60	8	12	5	
	61	6	1	1	
	62	8	4	4	
	63	9	12	5	
	64	7	0		
	65	6	0		
	66	8	1	1	
	67	9	8	5	
	68	8	6	5	
	69	10	4	4	
4	71	9	5	5	10.0
	72	10	15	5	
	73	10	8	5	
	74	10	8	5	
	75	11	8	5	
	76	11	5	5	
	77	10	3	3	
	78	10	10	5	
	79	9	4	4	
	80	12	4	4	
	81	13	0		
	82	9	3	3	
	83	8	3	3	
	84	8	0		
5	283	9	8	5	8.9
	284	12	4	4	
	285	10	1	1	
	286	9	8	5	
	287	8	12	5	
	288	11	15	5	
	289	13	3	3	
	290	7	10	5	
	291	7	15	5	
	292	8	4	4	
	293	9	7	5	
	294	7	12	5	
	295	8	10	5	
	296	7	8	5	
6	125	8	5	5	10.0
	126	7	0		
	127	9	10	5	
	128	12	1	1	
	129	13	0		
	130	11	1	1	
	131	11	9	5	
	132	13	1	1	
	133	9	15	5	
	134	7	3	3	
	135	9	8	5	
	136	10	10	5	
	137	11	4	4	
7	140	11	3	3	9.3
	141	11	4	4	
	142	7	0		
	143	9	10	5	
	144	10	15	5	
	145	9	10	5	
	146	9	4	4	
	147	9	6	5	
	148	9	6	5	

Treatment Area	Site	Depth (ft)	CLP stems	CLP Density	Average Depth (ft)
8	152	6	4	4	9.3
	153	8	15	5	
	154	10	0		
	155	11	10	5	
	156	9	0		
	157	8	3	3	
	265	11	6	5	
	266	11	3	3	
	267	11	8	5	
	268	8	3	3	
9	255	10	6	5	9.5
	256	9	5	5	
	257	9	6	5	
	258	10	4	4	
	259	10	3	3	
	260	11	4	4	
	261	10	4	4	
	262	7	3	3	
10	162	10	10	5	10.5
	163	11	3	3	
	164	11	4	4	
	165	11	3	3	
	166	10	10	5	
	167	11	9	5	
	168	10	20	5	
	169	10	20	5	
11	174	9	8	5	9.8
	175	11	4	4	
	176	12	15	5	
	177	10	20	5	
	178	11	15	5	
	179	11	12	5	
	180	9	1	1	
	181	7	0		
	182	5	0		
	183	11	3	3	
	184	12	8	5	
	185	9	0		
	186	9	5	5	
	187	11	4	4	
	188	10	2	2	
	189	9	5	5	
12	194	6	4	4	9.4
	195	6	6	5	
	196	6	0		
	197	6	2	2	
	198	8	10	5	
	199	10	15	5	
	200	11	6	5	
	201	12	8	5	
	202	13	0		
	203	12	2	2	
	204	11	6	5	
	205	11	15	5	
	206	10	4	4	
13	214	11	8	5	9.1
	215	10	10	5	
	216	9	15	5	
	217	8	0		
	218	8	1	1	
	219	9	5	5	
	220	9	15	5	
	221	11	6	5	
	222	7	1	1	
	223	11	3	3	
	224	10	15	5	
	225	5	0		
	226	10	5	5	
14	230	7	15	5	9.3
	231	8	15	5	
	232	10	3	3	
	233	13	2	2	
	234	10	10	5	
	235	10	14	5	
	236	9	20	5	
	237	8	4	4	
	238	7	0		
	239	11	10	5	

Forest Lake CLP Delineation
April 12, 2016



Blue Water Science

Sample site locations for Forest Lake. Key: green dots = light growth, yellow dots = moderate growth, red dots = heavy growth, and black dots = no growth.

JUNE 10, 2016: Aquatic plant densities for CLP and EWM are based on rake sampling for June 10, 2016. Plant densities are based on a scale from 1 to 5 with 5 being the densest.

Site	Depth (ft)	CLP	CLP-dead	EWM	EWM-stems	Flowering rush	Natives	Chara	Coontail	No plants	Notes
1	5			1	1						
2	8	3		1	1						
3	10	3									
4	12	1									
5	9	4									
6	8	4		1	2						
7	5							3			
8	4							3			
9	6			2	9			3			
10	10	4									
11	9	3									T1 poor to good
12	9		3								T1 poor to good
13	10	3									T1 poor to good
14	10	3		1	1						T1 poor to good
15	7						1				T1 poor to good
16	6			1	3			3			
17	10	1									T2 fair
18	9	4									T2 fair
19	10	4									T2 fair
20	12									1	T2 fair
21	9		3								T2 fair
22	11		2								T2 fair
23	8	2									
24	9		3								
25	8	1									T3 fair to good
26	10	2									T3 fair to good
27	10		2								T3 fair to good
28	6		1						2		T3 fair to good
29	8		3								T3 fair to good
30	6	1						3			T3 fair to good
31	6							3			T3 fair to good
32	8		3								T3 fair to good, Turions present
33	11	1									
34	10		2								
35	9		3								T4 good to excellent
36	10		1								T4 good to excellent
37	10		3								T4 good to excellent
38	9		3								T4 good to excellent
39	10		2								T4 good to excellent
40	8		2								T4 good to excellent
41	8		1								T4 good to excellent
42	8		2								T4 good to excellent
43	10		2								T4 good to excellent
44	7						2				
45	11						1				
46	5							2			
47	7						1	2			
48	5						1	2			
49	7						2				
50	10	3									
51	8							3			
52	11	1									
53	9						2				
54	8							2			
55	6			1				3			6 inch EWM stem
56	8			3	10						
57	8						4				
58	8						2				
59	9	1		1	2						
60	9	2		1	1						
61	8	3									
62	3						1				
63	3						1				
64	4							2			
65	5							2			
66	5						1				
67	7	2									
68	7						2				
69	3										
70	7						2				

JUNE 10, 2016: Aquatic plant densities for CLP and EWM are based on rake sampling for June 10, 2016. Plant densities are based on a scale from 1 to 5 with 5 being the densest.

Site	Depth (ft)	CLP	CLP-dead	EWM	EWM-stems	Flowering rush	Natives	Chara	Coontail	No plants	Notes
71	6						2				
72	7		3								T5 excellent
73	7		4								T5 excellent
74	9		3								T5 excellent
75	9		1								T5 excellent
76	6						3				T5 excellent
77	12									1	T5 excellent
78	11		1								T5 excellent
79	8						3				
80	6						3				T6 excellent
81	7						3				T6 excellent
82	8		3				2				T6 excellent
83	13										T6 excellent
84	9		2				2				T6 excellent
85	12		2								T6 excellent
86	7						3				T6 excellent
87	9		2				2				T6 excellent
88	7						3				
89	10		2								T7 excellent
90	8		3								T7 excellent
91	8		3								T7 excellent
92	9		3								T7 excellent
93	7						3				
94	11		1								T7 excellent
95	6						2				
96	4						2				
97	9		2				3				T8
98	12		1								T8
99	11		1								T8
100	13									1	T8
101	11		3								T8
102	11		2								T8
103	5						3				T8
104	10	3									T9 partial
105	9	3									T9 partial
106	9		1								T9 partial
107	9	3									T9 partial
108	9	2					2				T9 partial
109	9	3					2				T9 partial
110	9	4									T10 partial
111	10	2					1				T10 partial
112	9		1								T10 partial
113	8	4					3				T10 partial
114	9		1								T10 partial
115	10		3								T10 partial
116	4						2				
117	8						3				
118	10	1									T11
119	10	3									T11
120	10		4								T11
121	12		2								T11
122	10		3								T11
123	7	3					3				
124	8	1					4				
125	8		3								T11
126	12		2								T11
127	4						2				
128	12		1								T11
129	10		1								T11
130	4						2				
131	8						3				
132	12						1				
133	7	4									
134	7	3									
135	6	4									T12 partial
136	4						3				T12 partial
137	7	2					2				T12 partial
138	8	1									T12 partial
139	10	2									T12 partial
140	9	3									T12 partial

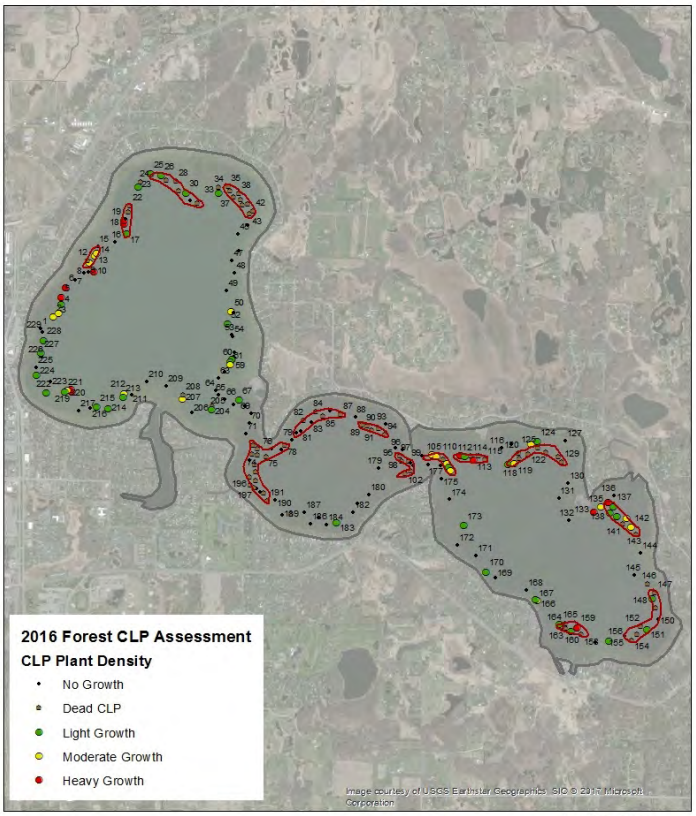
JUNE 10, 2016: Aquatic plant densities for CLP and EWM are based on rake sampling for June 10, 2016. Plant densities are based on a scale from 1 to 5 with 5 being the densest.

Site	Depth (ft)	CLP	CLP-dead	EWM	EWM-stems	Flowering rush	Natives	Chara	Coontail	No plants	Notes
141	13		1								T12 partial
142	12	3									T12 partial
143	10		3								T12 partial
144	3						1	1			T12 partial
145	7							3			T12 partial
146	12		2								T12 partial
147	9		3								T13
148	10	1									T13
149	8		3								T13
150	7							1			T13
151	9	2									T13
152	10		2								T13
153	10		4								T13
154	10		3								T13
155	7							3			T13
156	5	1					2				
157	6						3				
158	7		1								T14 poor to good
159	10	4									T14 poor to good
160	7	2									T14 poor to good
161	7		3								T14 poor to good
162	8		3								T14 poor to good
163	7	4									T14 poor to good
164	7	3									T14 poor to good
165	8	1									T14 poor to good
166	7	3									
167	7	1									
168	7					1	1				
169	9						3				
170	5	2					3				
171	13									1	
172	3							3			
173	7	1					3				
174	5						3				
175	6						2				
176	6						2				
177	4						3				
178	14						1				T8
179	6						2				
180	5						2				
181	6						2				
182	5						2				
183	7	1					3				
184	8						3				
185	13									1	
186	6						3				
187	16									1	
188	9		2				2				
189	6						2				
190	15									1	
191	7		2								T5
192	8		1								T5
193	8						3				T5
194	10		1								T5
195	8		3								T5
196	8		1				2				T5
197	8		1								T5
198	7						2				T5
199	11		3								T5
200	11		2								T5 good
201	8						2				T5 good
202	8		3								T5 good
203	6						2				
204	7		3								
205	7	1									
206	6						3				
207	9	3									
208	11		1								
209	3						2				
210	8						3				

JUNE 10, 2016: Aquatic plant densities for CLP and EWM are based on rake sampling for June 10, 2016. Plant densities are based on a scale from 1 to 5 with 5 being the densest.

Site	Depth (ft)	CLP	CLP-dead	EWM	EWM-stems	Flowering rush	Natives	Chara	Coontail	No plants	Notes
211	4						3				
212	8	3									
213	8	1					3				
214	10	1					3				
215	10	2									
216	8						1				
217	5						3				
218	10	4									
219	10	4									
220	11	3									
221	12	1									
222	10	1									
223	14									1	
224	8	2									
225	6			2	9		3				
226	6						3				
227	6	1									
228	7	1		1	4		2				
229	6						3				
Average		2.3	2.2	1.3	3.9	1.0	2.3	2.5	2.0		
Occurrence (229 sites)		70	71	12	11	1	81	19	1	8	
% occurrence		31	31	5	5	0	35	8	0		

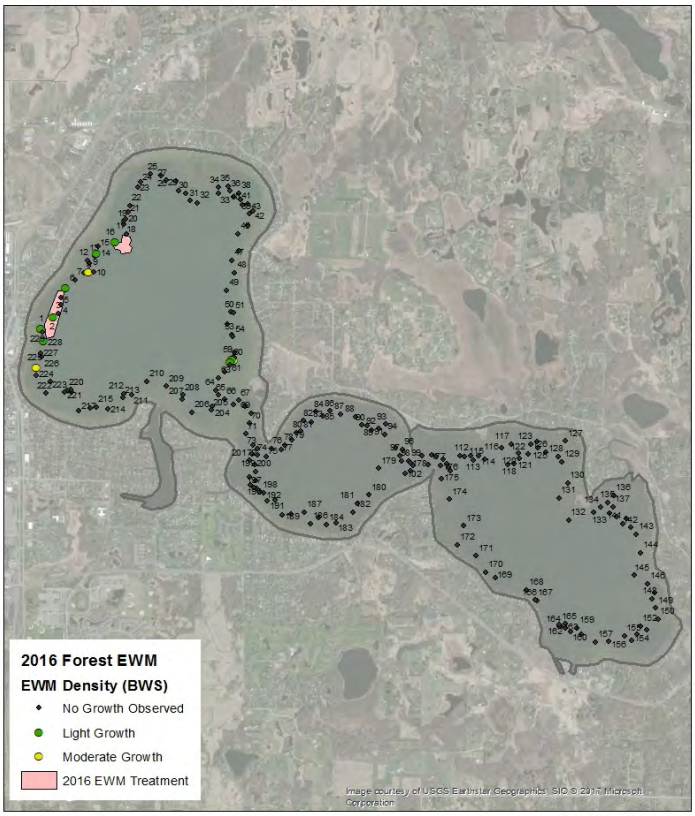
Forest Lake Curlyleaf Pondweed Assessment
June 10, 2016



Forest Lake, Washington County
Inventory Number: 820-159-00

Blue Water Science
Steve McComas
UTM NAD 1983

Forest Lake Eurasian Watermilfoil
June 10, 2016



Forest Lake, Washington County
Inventory Number: 820-159-00

Blue Water Science
Steve McComas
UTM NAD 1983

2016 Forest EWM

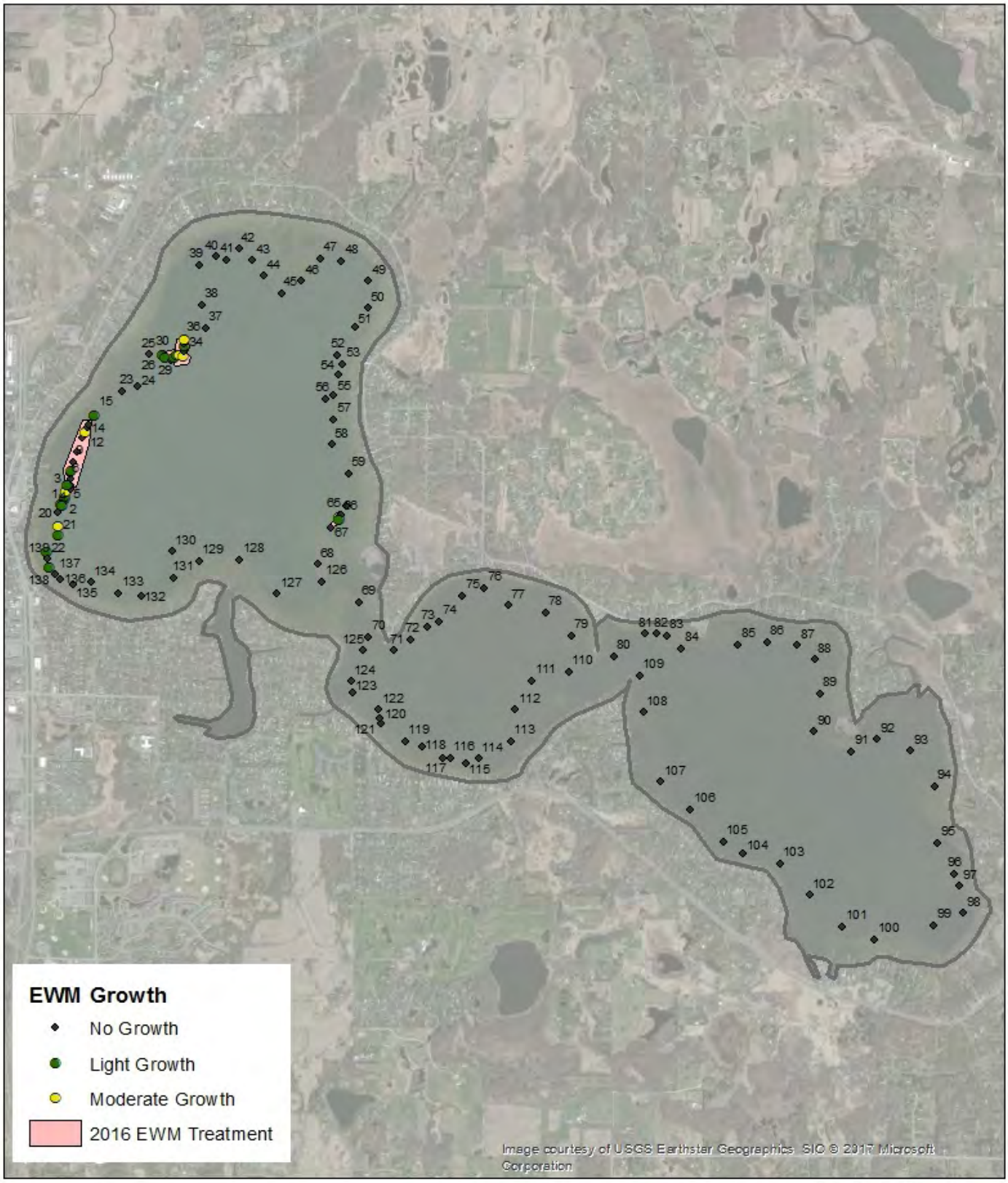
SEPTEMBER 15, 2016: Aquatic plant densities are based on rake sampling for September 15, 2016. Plant densities are based on a scale from 1 to 5 with 5 being the densest.

Site	Depth (ft)	EWM	Natives	Coontail	CLP	NWM	ZM/plants	No plants	Notes
1	9	2							ZM on plants common in 1st lake, east and west
2	9	2	2						
3	9	3	2				1		
4	10		1					1	
5	10							1	
6	9							1	
7	9				1			1	
8	8	1							
9	9				1				
10	10		1	1	1		9		
11	10			2			yes		
12	9	3							
13	9				1				
14	9				3				
15	8	2					yes		
16	8	1							
17	8	2							
18	8	2							
19	7		3						
20	8	3				2			
21	9	2							
22	8	1				1	yes		
23	5							1	
24	14							1	
25	8		1						
26	8	2							
27	9	1	2						
28	10							1	
29	10	1			1				
30	8	1	1						
31	8	3	1						
32	2	3							
33	8		2						
34	8	2							
35	8			3					
36	10	3							
37	17							1	
38	10							1	
39	8		2						
40	6							1	
41	11							1	
42	9			3					
43	8			2					
44	8			3					
45	9							1	
46	9							1	
47	7		3						
48	9			1					
49	10							1	
50	7		2						
51	9							1	
52	10							1	
53	7		3						
54	7		2						
55	7		2						
56	10							1	
57	7		2						
58	10							1	
59	8							1	
60	6		2						
61	9		3						
62	9		3						
63	9	3	2						
64	8		3	2					
65	8		3	3					
66	9	2	1						
67	9		3						
68	4		2						
69	4		1						
70	7		2						
71	7		2						No zm in 2nd lake on east side
72	8		3						
73	6		3						
74	9		2						
75	9		2						
76	6		3						
77	9		1						
78	8			3					
79	6		3						
80	6		2						No zm in 3rd lake
81	6		2						
82	6		4						

SEPTEMBER 15, 2016: Aquatic plant densities are based on rake sampling for September 15, 2016. Plant densities are based on a scale from 1 to 5 with 5 being the densest.

Site	Depth (ft)	EWM	Natives	Coontail	CLP	NWM	ZM/plants	No plants	Notes
83	5		4						
84	6		2						
85	8		1						
86	8		2						
87	8		1						
88	10		2						
89	7		1						
90	9		2						
91	9		3						
92	8		2						
93	8		2						
94	4		1						
95	7		2						
96	9		2						
97	9		2						
98	7		2						
99	10		2						
100	3		1						
101	6		3						
102	4		2						
103	13							1	
104	6		2						
105	8							1	
106	9							1	
107	4		3						
108	5		3						
109	6		3						
110	7		2						2nd lake
111	7		1						
112	12							1	
113	6		3						
114	9		1						
115	7		3						
116	7		2						
117	7		3						
118	8		2				2		
119	9		2						
120	7		2						
121	8		2						
122	9		1						
123	6		2						
124	6		3						
125	8		2		1				
126	7		2						1st lake
127	7		3						
128	4		1						
129	5		2						
130	11							1	
131	9							1	
132	8		2						
133	7		2						
134	10							1	
135	9		2						
136	8		1						
137	9		2						
138	9	2	2						
139	7		3						
Average		2.0	2.1	2.3	1.3	1.5	4.0		
Occurrence (139 sites)		23	89	10	7	2	3	26	
% occurrence		17	64	7	5	1	2		

Forest Lake Eurasian Watermilfoil
September 15, 2016



Forest Lake, Washington County
Inventory Number: 820-159-00

Blue Water Science
Steve McComas
UTM NAD 1983