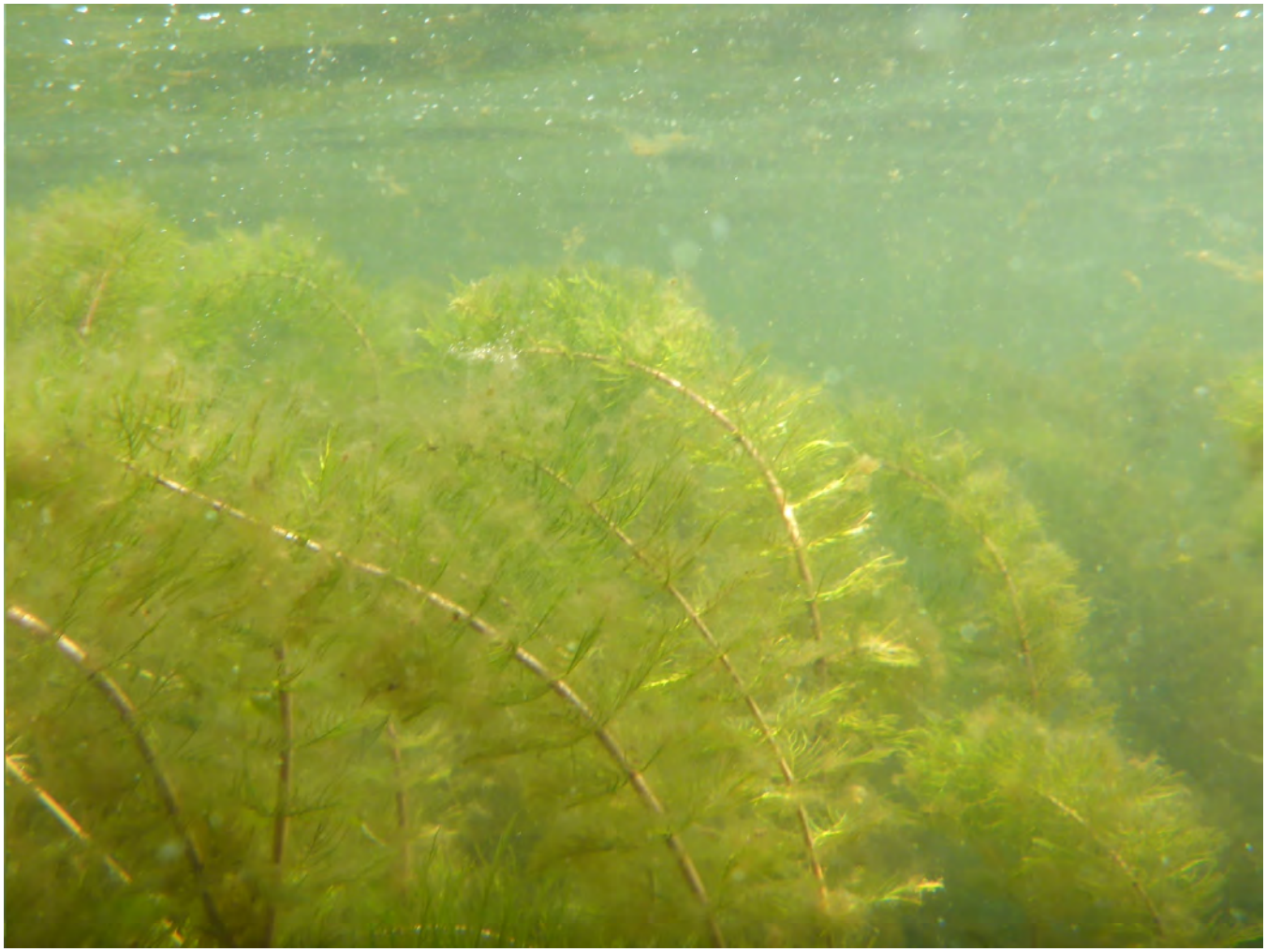


Milfoil in Forest Lake on July 27, 2021

Curlyleaf Pondweed and Eurasian Watermilfoil Delineation, Treatment, and Assessment for Forest Lake, Washington County, 2021

	Delineation	Treatment	Assessment
CLP	April 3 and 30, 2021	May 25 and 26, 2021 (120.33 acres)	June 9, 2021
EWM	June 9, 2021	August 13, 2021 (8.37 acres)	September 9, 2021

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

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

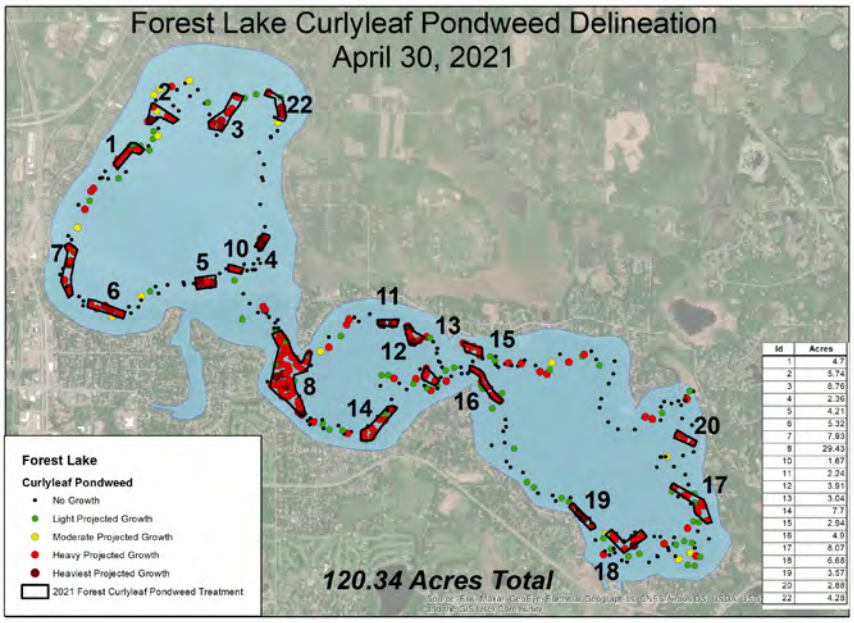
November 30, 2021

Curlyleaf Pondweed and Eurasian Watermilfoil Delineation, Treatment, and Assessment for Forest Lake, Washington County, 2021

Summary

Curlyleaf Pondweed (CLP) Delineation, Treatment, and Assessment: Forest Lake (MnDNR ID#82-015900) is a 2,271 acre lake in Washington County, Minnesota. Early season curlyleaf pondweed distribution and abundance were evaluated April 3 and 30, 2021.

In the delineation survey, heaviest potential curlyleaf growth was found in the Second Lake and potential early summer heavy growth was estimated at 120.34 acres for all 3 basins (Figure S1). A total of 120.34 acres of curlyleaf areas were treated on May 25 and 26, 2021.



A post treatment curlyleaf assessment was conducted on June 9, 2021. The June curlyleaf assessment found excellent control in the treated areas although there was some new curlyleaf pondweed sprouting in 1st and 3rd lake (Figure S1).

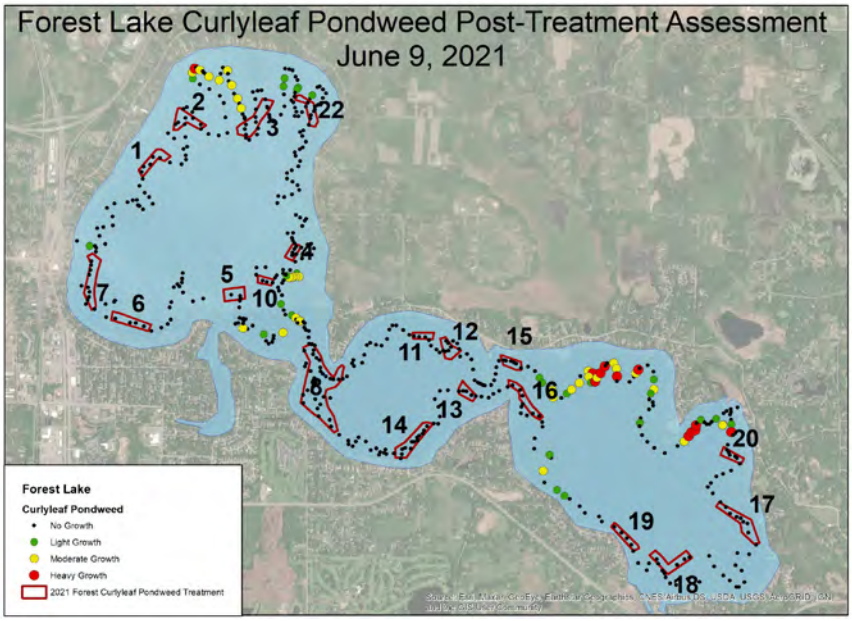
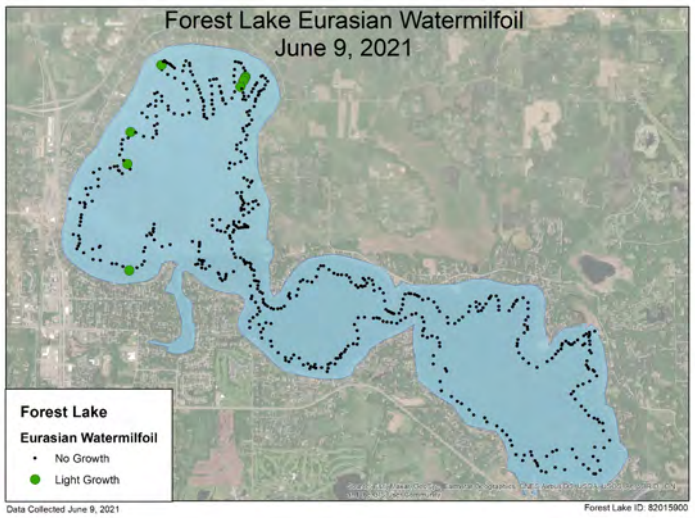


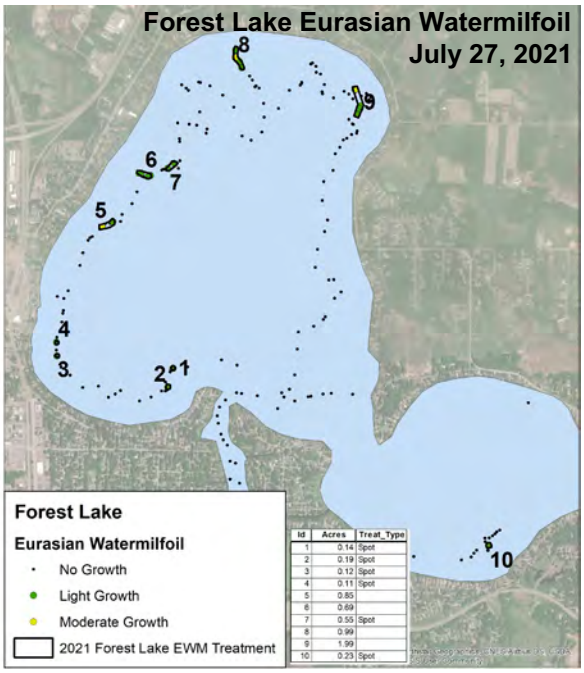
Figure S1. [top] DELINEATION: Map of curlyleaf pondweed distribution from the April 30, 2021 survey. Approximately 120.34 acres were delineated for CLP treatment.
[bottom] ASSESSMENT: Map of curlyleaf pondweed assessment sites for June 9, 2021.
Key: green dots = light growth, yellow dots = moderate growth, red dots = heavy growth, and black dots = no curlyleaf growth. Orange shaded areas indicates treatment areas.

Eurasian Watermilfoil (EWM) Delineation, Treatment, and Assessment: EWM distribution and abundance were evaluated June 9, 2021. EWM growth was light and based on that delineation, no treatment was recommended for 2021.

Later in the summer, another EWM delineation was conducted on July 27, 2021 and a few EWM locations were found that could be treated. Based on this delineation combined with a delineation by PLM (the herbicide applicator) a total of 8.37 acres were treated on August 13, 2021.

Later in the summer, after the EWM treatment, an EWM assessment on September 9, 2021 found good control in the treated areas with growth in only a few scattered areas outside of the treatment polygons (Figure S2).





Treatment of 8.37 acres on August 13, 2021

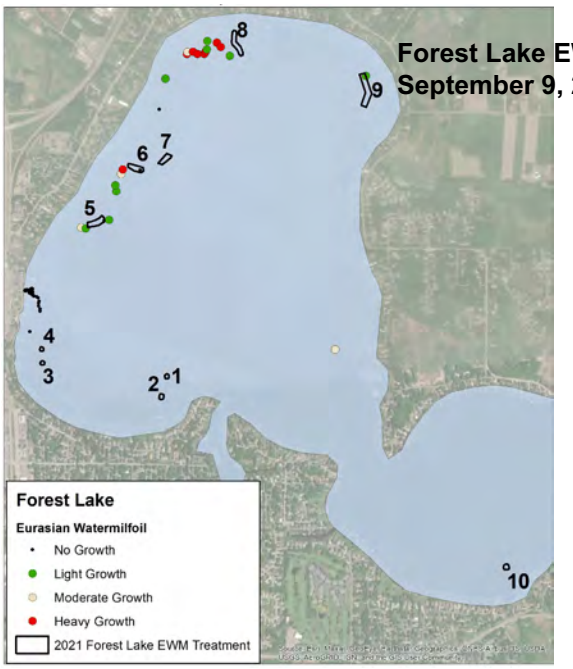


Figure S2. [top-left] DELINEATION: Map of EWM distribution from the June 9, 2021 survey. [top-right] Proposed treatment map, July 27, 2021. [bottom-left] PLM treatment map for 2021. [bottom-right] ASSESSMENT: Map of EWM assessment on September 9, 2021.

Summary of CLP and EWM Treatments from 2009-2021: Historically two non-native submerged aquatic plants were treated with herbicides, again in 2021 both curlyleaf pondweed and Eurasian watermilfoil were treated (Table S1 and Figure S3). Curlyleaf pondweed treatments have ranged from 16 to 169 acres from 2009 through 2021 with variability from year to year.

Eurasian watermilfoil was discovered in Forest Lake in 2015 and 30 acres were treated in the first year. From 2016 through 2021, EWM treatments have ranged from 8.37 acres to 53.83 acres (Table S1 and Figure S3). Eurasian watermilfoil has been confined mostly to the first lake but there is some growth in the second lake at the end of 2021. The greatest number of acres treated were in 2020 (Figure S3).

Table S1. Acres of non-native plants treated from 2009 through 2021.

	CLP (acres)	EWM (acres)
2009	98	
2010	155	
2011	168	
2012	155	
2013	60	
2014	101	
2015	88	30
2016	114	13.9
2017	169	33.35
2018	16.59	40.74
2019	99.11	49.34
2020	59.29	53.83
2021	120.33	8.37

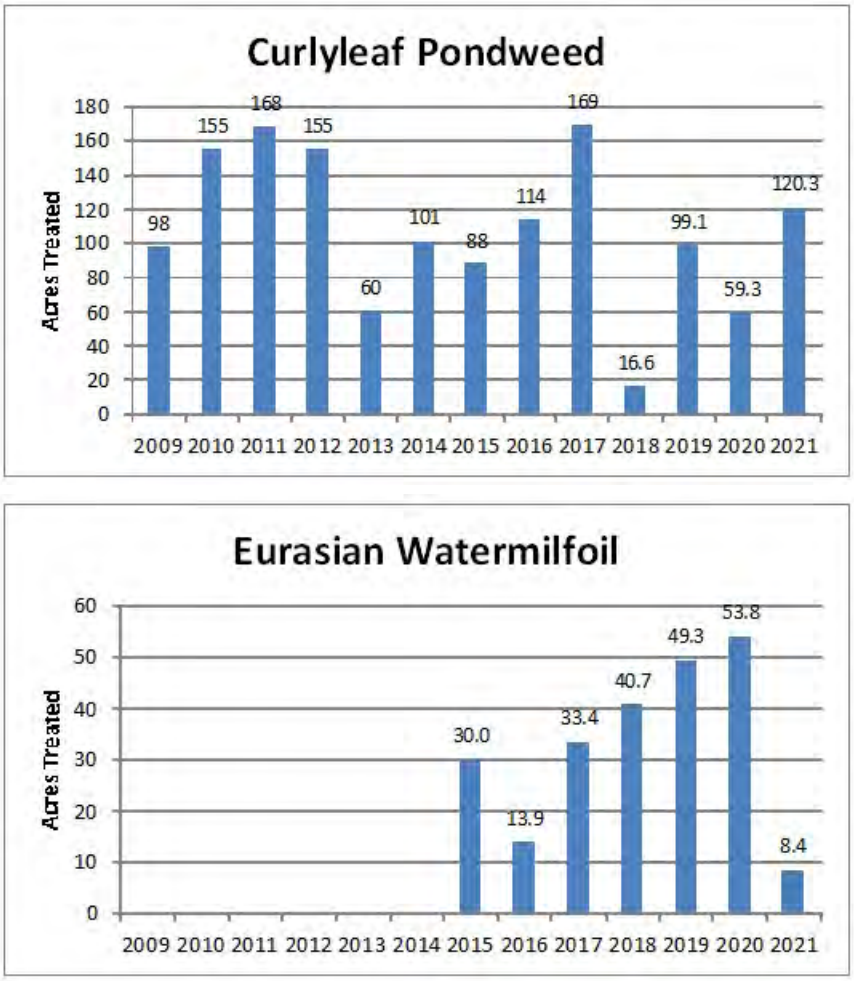


Figure S3. [top] Curlyleaf pondweed treated from 2009-2021. [bottom] Eurasian watermilfoil treated from 2015-2021. Eurasian watermilfoil was first found in Forest Lake in 2015.

A hotspot map of curlyleaf pondweed treatment areas over the last 10 years is shown in Figure S4. There appears to be about 100 acres of persistent curlyleaf in the 3 basins. The actual acreage of curlyleaf treated varies from year to year based on climatic factors. A hotspot map of EWM areas that have been treated from 2015 to 2020 is shown in Figure S4. EWM is found primarily in the 1st lake.

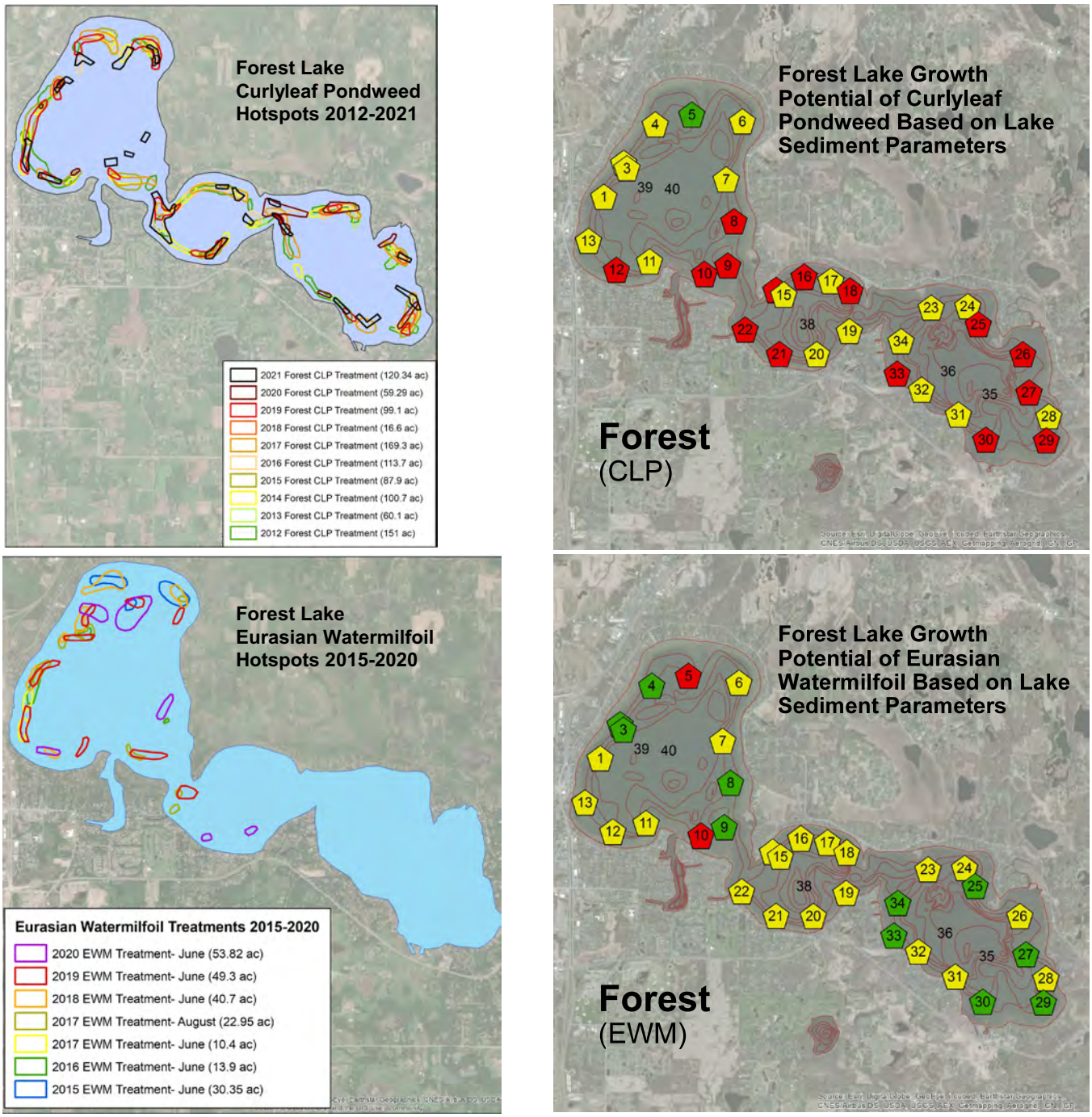


Figure S4. [top-left] Map of historical treatment of curlyleaf pondweed in Forest Lake, 2012-2021.
[top-right] Curlyleaf potential growth based on lake sediment analyses for Forest Lake.
Key: green = light growth, yellow = moderate growth, and red = heavy growth.
[bottom-left] Map of historical treatment of Eurasian watermilfoil in Forest Lake, 2015-2020.
[bottom-right] Eurasian watermilfoil potential growth based on lake sediment analyses for Forest Lake.
Key: green = light growth, yellow = moderate growth, and red = heavy growth.

ADDITIONAL INFORMATION

Curlyleaf Pondweed and Eurasian Watermilfoil Delineation, Treatment, and Assessment for Forest Lake, Washington County, 2021

Overview: 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 2021 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 3 and 30, 2021. A total of 120.33 acres of curlyleaf pondweed were treated with an endothall herbicide on May 25 and 26, 2021. A follow-up curlyleaf pondweed assessment was conducted on June 9, 2021 to characterize the status of CLP at its peak growing period. Eurasian watermilfoil distribution and abundance were delineated on June 9, 2021 and July 27, 2021. On August 13, 2021, 8.37 acres of EWM were treated. An EWM assessment for all treatment areas occurred on September 9, 2021.

Figure 1. [left] June 9, 2021: Curlyleaf pondweed growth was light to heavy in untreated areas after the herbicide treatment in 2021.
[right] June 9, 2021: EWM growth was light and was only sampled at 15 sample sites. EWM was treated on August 13, 2021.

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: A Eurasian watermilfoil delineation was conducted by Blue Water Science on June 9, 2021 and 560 sites were sampled. The delineation involved surveying the entire lake nearshore area, observing milfoil growth, and sampling aquatic plants with rakes. 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.

A herbicide application was conducted on August 13, 2021 for EWM. A follow-up EWM assessment was conducted by Steve McComas, Blue Water Science, on September 9, 2021 to evaluate the EWM growth. A total of 204 sites were checked on the September 9 assessment. EWM density ratings used in the June delineation and August assessment are shown in the chart below.

Chart of Density Ratings for Plant Growth

Aquatic plant density ratings from 1 to 3.

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 3 and 30, 2021

A curlyleaf delineation was conducted using rake sampling on April 3, 2021. A total of 100 sites were sampled. This was a delineation of First Lake to see how the curlyleaf pondweed was growing. The April 13, 2021 survey appeared to be too early to gage the potential heavy curlyleaf that could occur in June.

Another curlyleaf delineation was conducted using rake sampling on April 30, 2021. A total of 375 sites were sampled and 20 areas of significant curlyleaf growth were delineated (outlined in orange shading in Figure 2) totaling about 120.33 acres. At this time of the year curlyleaf was found at low to high stem densities with the potential to produce heavy growth in a number of areas by mid-June (Table 1 and Figure 3).

Curlyleaf was treated on May 25 and 26, 2021 using Alligare diquat at 2 gallons per acre.

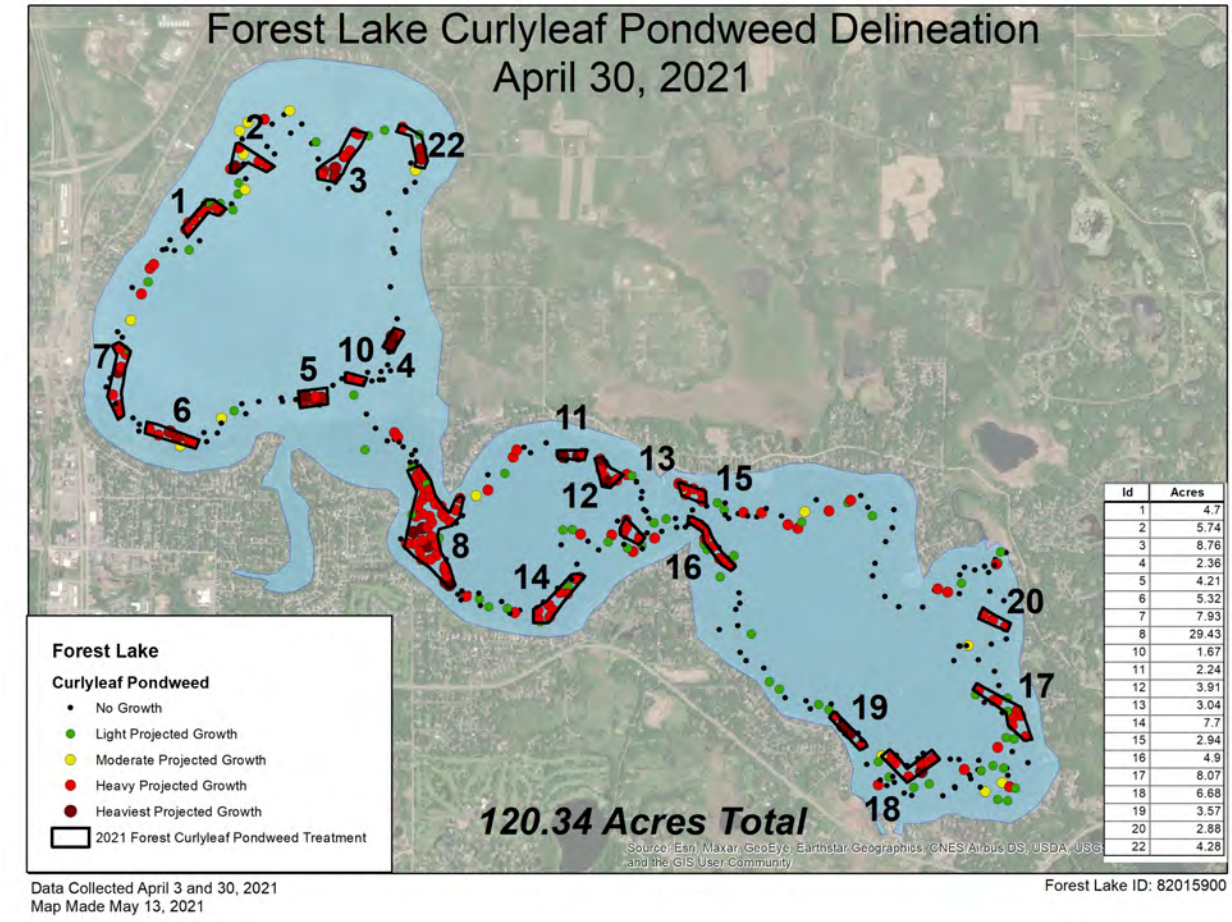


Figure 2. Map of curlyleaf delineation in Forest Lake on April 3 and 30, 2021.
Key for future potential CLP growth: green dots = light, yellow dots = moderate, and red dots = heavy. Orange shaded areas indicates treatment areas.

Curlyleaf Pondweed Assessment on June 9, 2021

A post treatment curlyleaf assessment was conducted on June 9, 2021 to assess the control of curlyleaf pondweed. The June curlyleaf assessment found curlyleaf growth was controlled in the treated areas (Figure 3). However there was some untreated CLP growth in 1st and 3rd lakes that ranged from light to heavy growth.

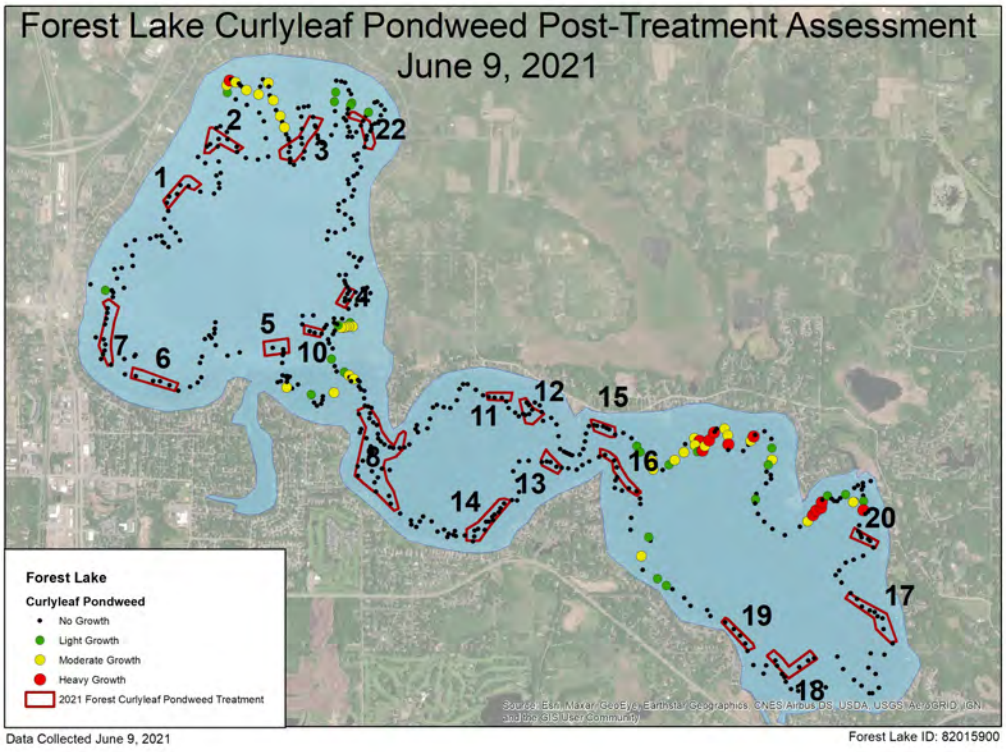


Figure 3. Map of curlyleaf distribution in Forest Lake on June 9, 2021. Key: green dots = light growth, yellow dots = moderate growth, red dots = heavy growth, and black dots = no curlyleaf.

Table 1. Forest Lake, 2021 curlyleaf pondweed herbicide treatment. Two gallons per acre was applied.

Treatment Area	Acres	Curlyleaf Control*
Lake 1		
1	4.7	Excellent
2	5.74	Excellent
3	8.76	Excellent
4	2.36	Excellent
5	4.21	Excellent
6	5.32	Excellent
7	7.93	Excellent
10	1.67	Excellent
22	4.28	Excellent
Total for Lake 1	44.97	
Lake 2		
8	29.43	Excellent
11	2.24	Excellent
12	3.91	Excellent
13	3.04	Excellent
14	7.7	Excellent
15	2.94	Excellent
16	4.9	Excellent
Total for Lake 2	54.16	
Lake 3		
17	8.07	Excellent
18	6.68	Excellent
19	3.57	Excellent
20	2.88	Excellent
Total for Lake 3	21.2	
Total for Forest Lake	120.33	

*based on assessment survey map, Figure 3.

Compilation of Curlyleaf Treatment Areas from 2012 through 2021

Curlyleaf pondweed growth patterns are somewhat established in Forest Lake. All treatment areas from 2012 through 2021 are compiled in Figure 4. These "hotspot" areas represent about 100 acres of curlyleaf growth. The curlyleaf growth pattern varies from year to year. Some years there will be more than 100 acres and other years there will be less than 100 acres to treat (Table 2). Variables to growth include previous treatments, snow cover, ice off, sunny days, and water temperatures.

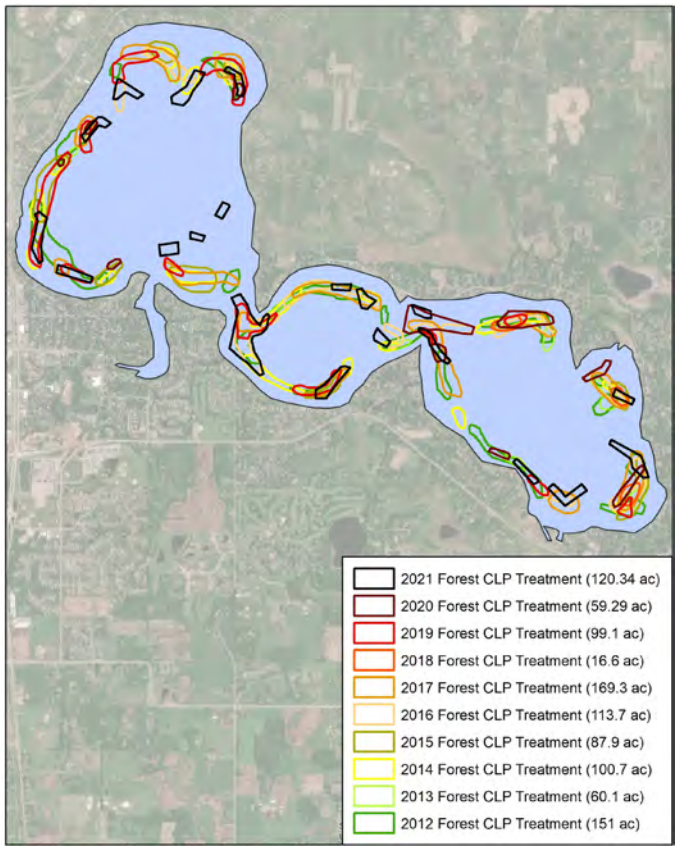


Figure 4. Map of historical treatment of curlyleaf pondweed in Forest Lake, 2012-2020, with hotspot areas shaded black.

Table 2. Acres of non-native plants treated from 2009 through 2021.

	CLP (acres)	EWM (acres)
2009	98	
2010	155	
2011	168	
2012	155	
2013	60	
2014	101	
2015	88	30
2016	114	13.9
2017	169	33.35
2018	16.59	40.74
2019	99.11	49.34
2020	59.29	53.83
2021	120.33	5.86

Eurasian Watermilfoil Delineation on June 9, 2021

Eurasian watermilfoil growth was delineated on June 9, 2021 and 560 sites were sampled. EWM was found at 15 out of the 560 sites (3% occurrence with EWM found mostly in the first lake) Figure 5). No treatment was recommended at this time.

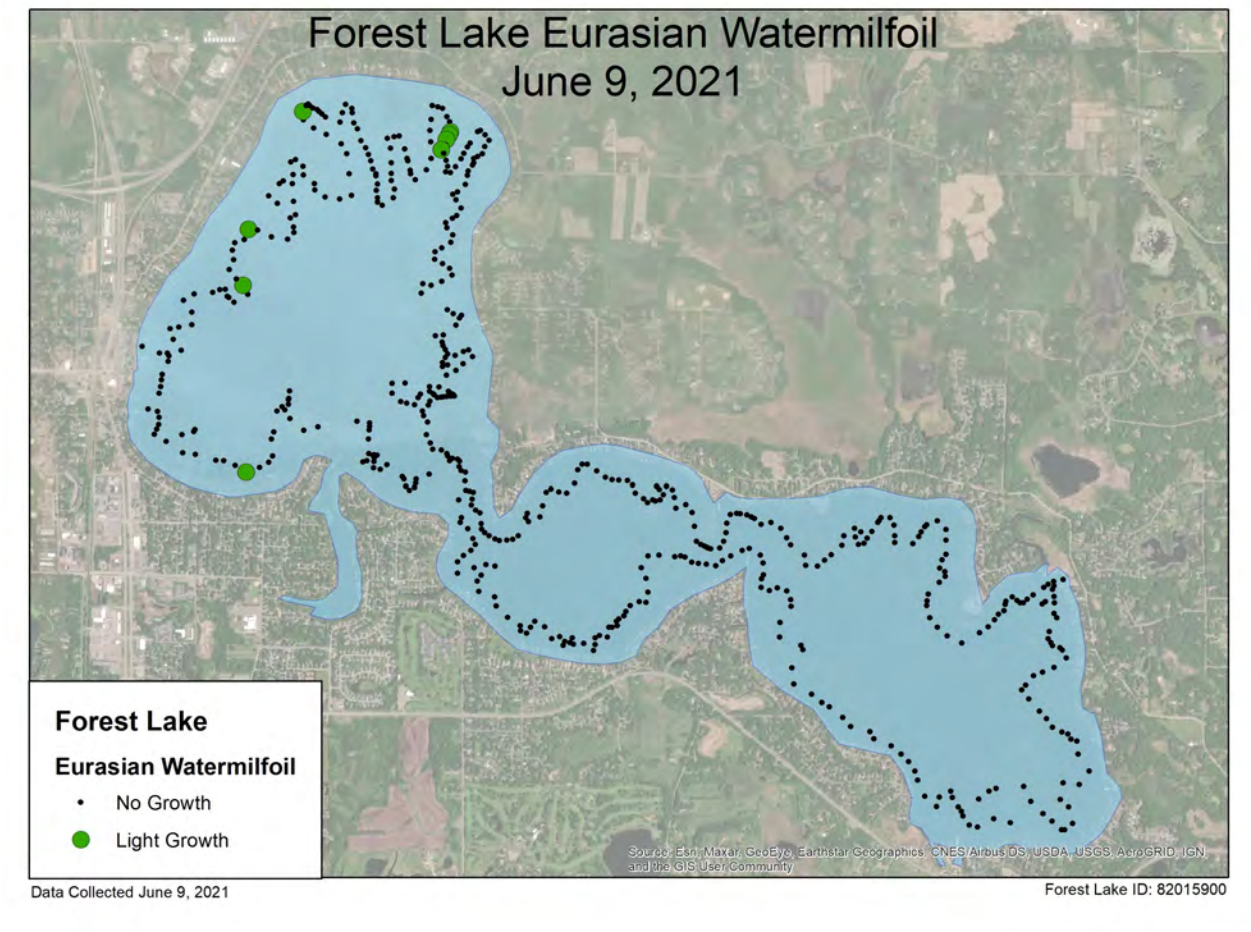


Figure 5. DELINEATION: Map of EWM distribution from the June 9, 2021 survey, no areas were delineated for treatment. 5.86 acres were delineated for EWM treatment.

Eurasian Watermilfoil Delineation on July 27, 2021

Eurasian watermilfoil growth was delineated for a second time on July 27, 2021 and 206 sites were sampled. EWM was found at 22 out of the 206 sites (11% occurrence with EWM found mostly in the first lake)(Figure 6). Several areas were delineated for treatment.

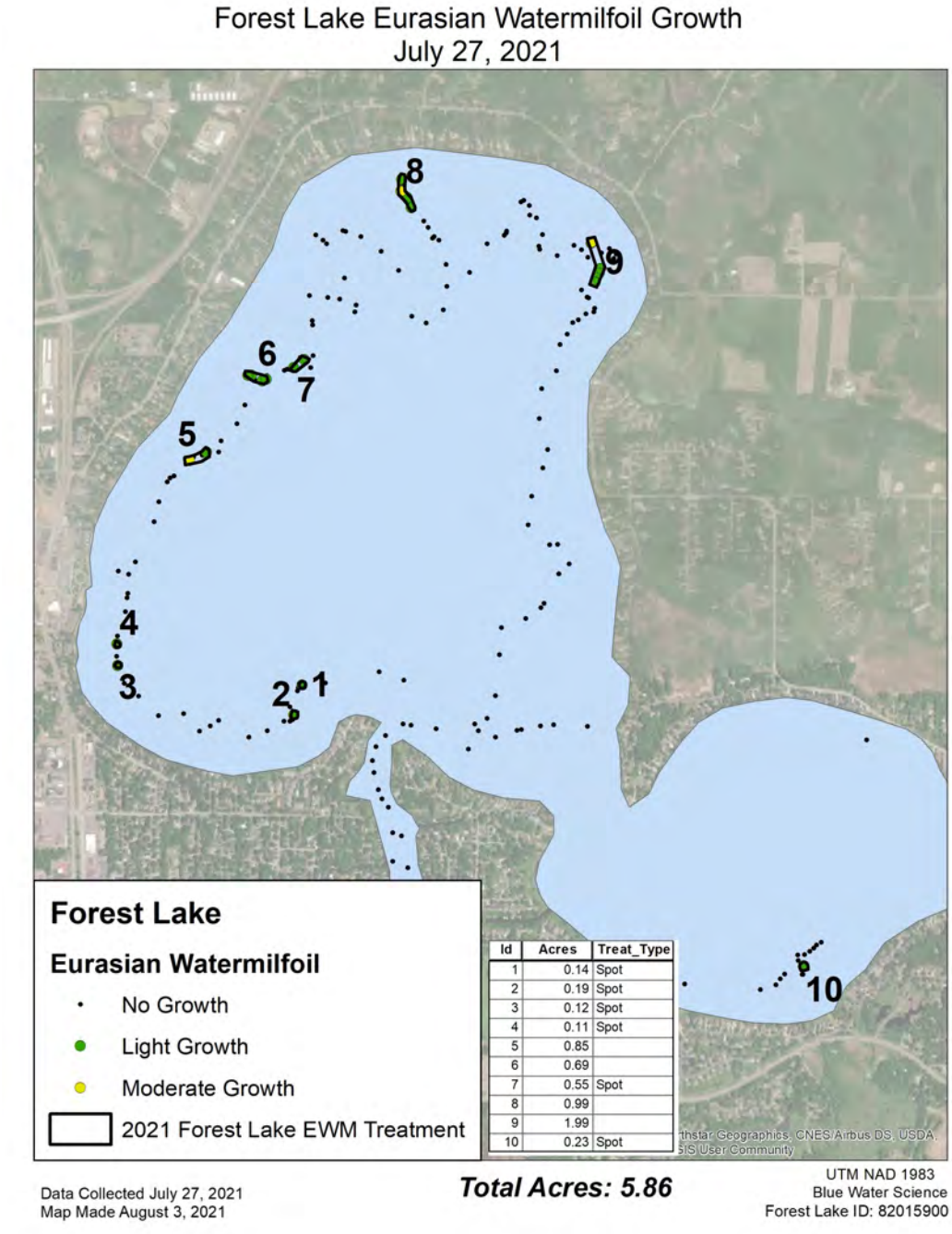


Figure 6. DELINEATION: Map of EWM distribution from the July 27, 2021 survey, 5.86 acres were delineated for EWM treatment.

Eurasian Watermilfoil Treatment on August 13, 2021

A total of 8.37 acres were treated using a combination of ProcellaCOR and diquat.

Figure 7. EWM treatment was conducted on August 13, 2021.

Eurasian Watermilfoil Assessment on September 9, 2021

After the herbicide treatments of EWM, an EWM assessment was conducted on September 9, 2021. EWM was controlled in the treatment areas (Figure 8). No EWM was observed in 2nd and 3rd lakes.

The combination of diquat along with ProcellaCOR was very effective for controlling EWM in Forest Lake.

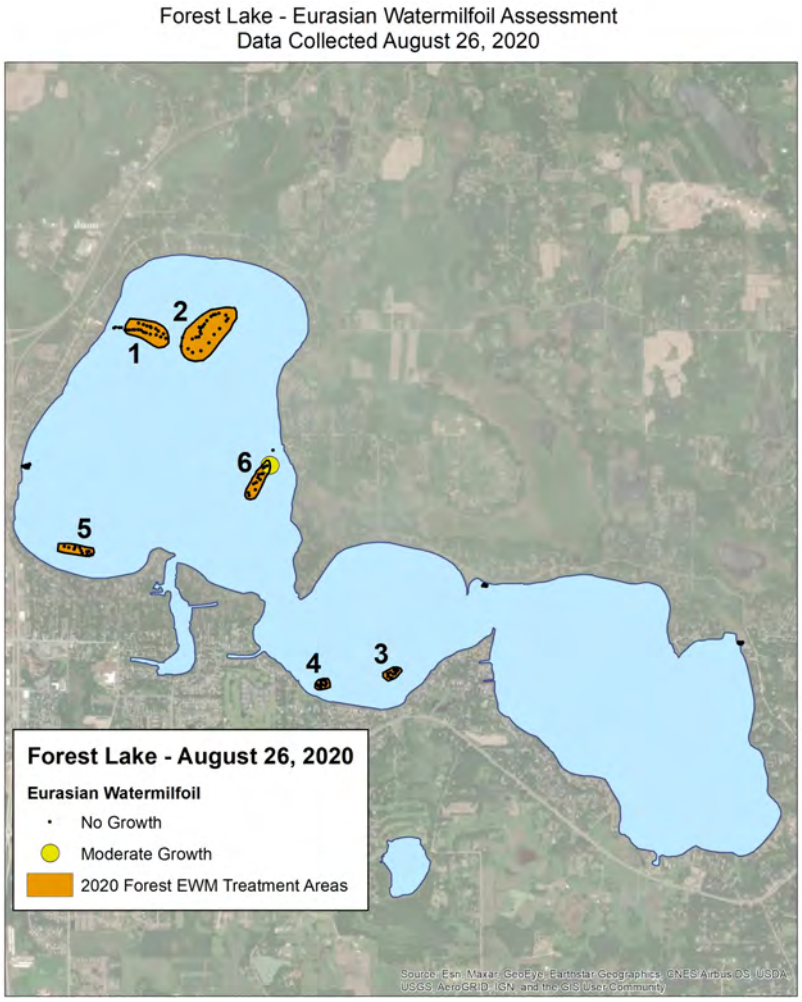


Figure 8. ASSESSMENT: Map of EWM distribution from the August 26, 2020 survey.

Table 3. Forest Lake, 2021 Eurasian watermilfoil herbicide treatment

Treatment Area	Acres	EWM Control
Lake 1		
	1	Excellent
	0.72	Excellent
	1	Excellent
	2	Excellent
	1	Excellent
	2	Excellent
Total for Lake 1	7.72	
Lake 2		
	0.65	Excellent
Total for Lake 2	0.65	
Lake 3		
Total for Lake 3	0	No treatment
Total for Forest Lake	8.37	

Eurasian Watermilfoil Treatments from 2015-2021

Eurasian watermilfoil was first observed in Forest Lake in 2015. EWM treatments have occurred in 2015 through 2021. All areas that have been treated are shown in Figure 9. EWM is found primarily in the first lake with a couple of small areas in second lake at the end of 2021.

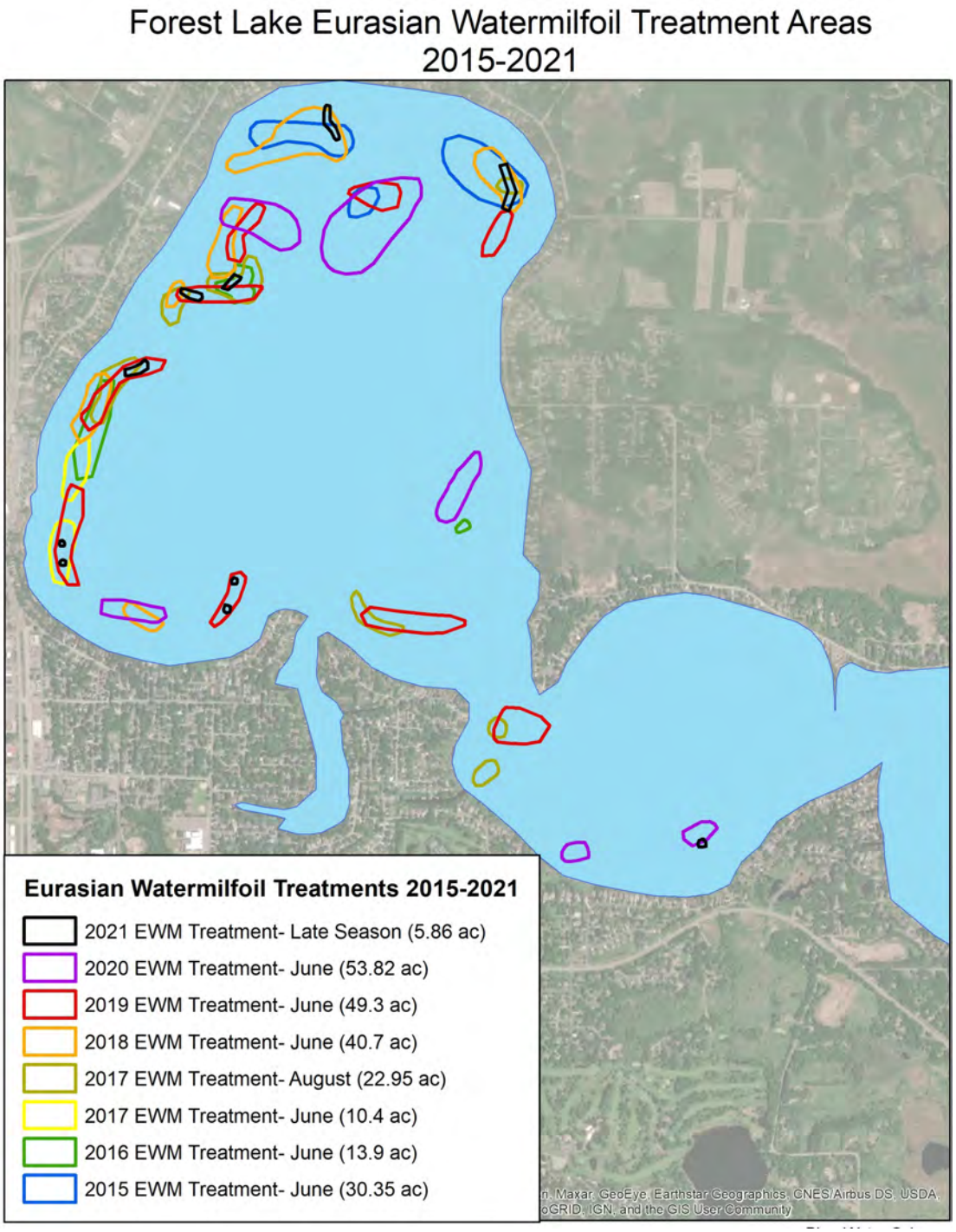


Figure 9. Map of Eurasian watermilfoil treatment areas in Forest Lake, 2015-2021.

What's Next for 2022?

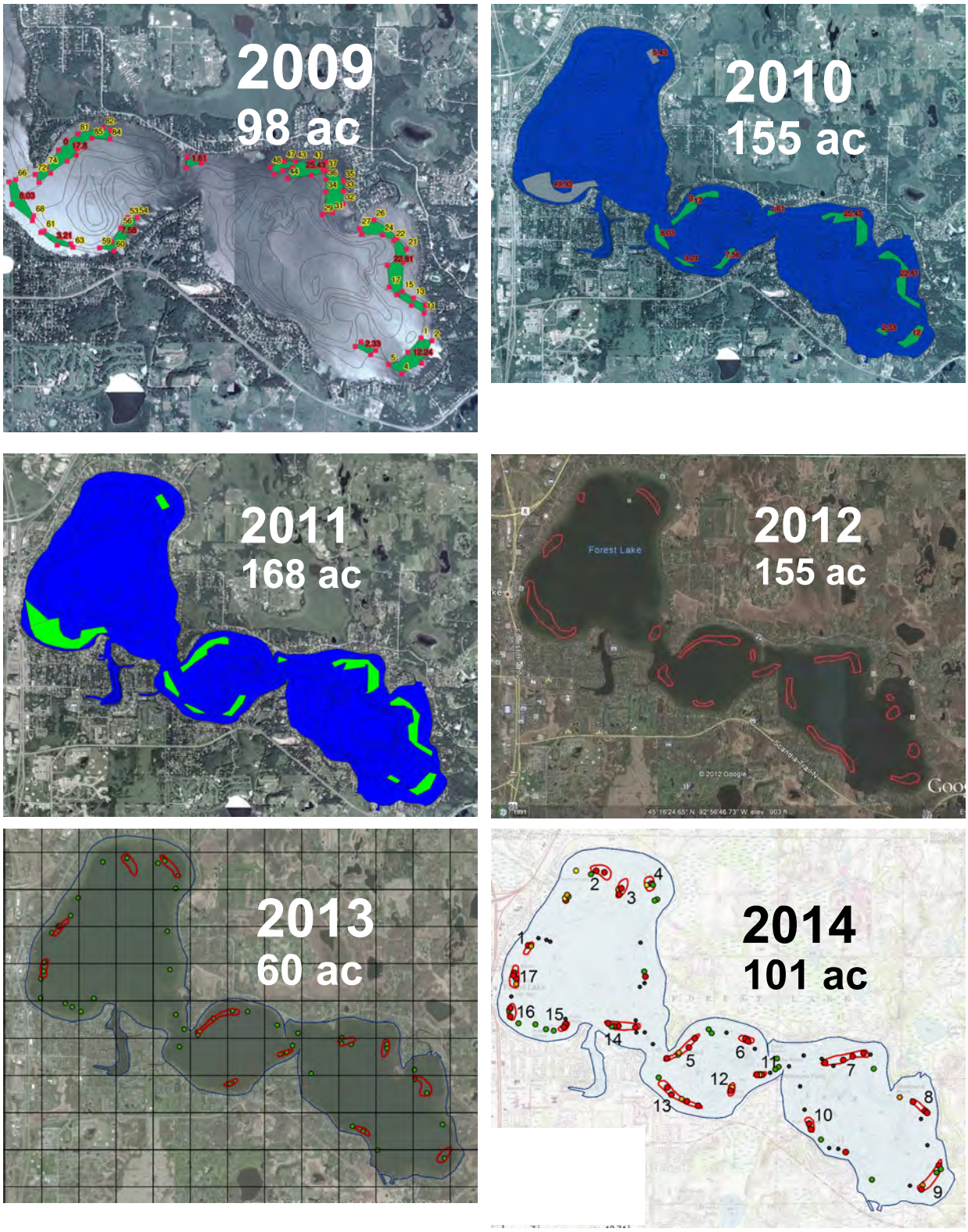
Curlyleaf Pondweed: Treating heavy growth of curlyleaf pondweed based on early season curlyleaf distribution is a challenge. Curlyleaf in early May has just started to go into a rapid growth phase. However, not all early season curlyleaf growth will result in heavy curlyleaf growth in June. It appears 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 potential heavy growth of curlyleaf pondweed was controlled in 2021.

For 2022, it is proposed to delineate CLP later in April to capture late sprouting CLP. Also the herbicide diquat could be considered for CLP treatments as well.

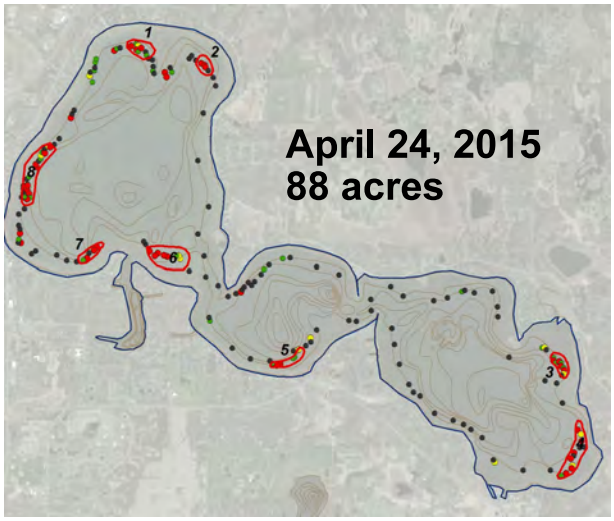
Eurasian Watermilfoil: Two passes with a liquid 2,4-D herbicide for EWM control prevented the occurrence of heavy EWM growth in 2016. The first pass treated half the area and the second pass treated the other half of the area. The same basic approach for EWM control was using in 2017 through 2019. In 2020 and 2021, a combination of 2 herbicides (diquat and ProcellaCPR) were applied and control was very good. This treatment approach could be considered by 2022, if treatment is needed.

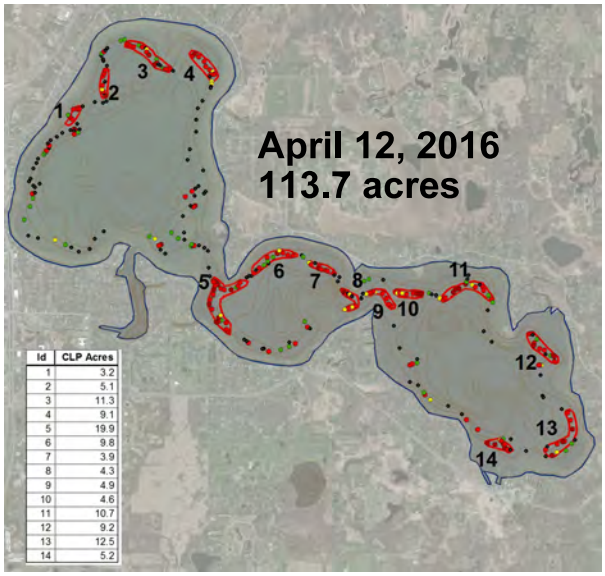
APPENDIX

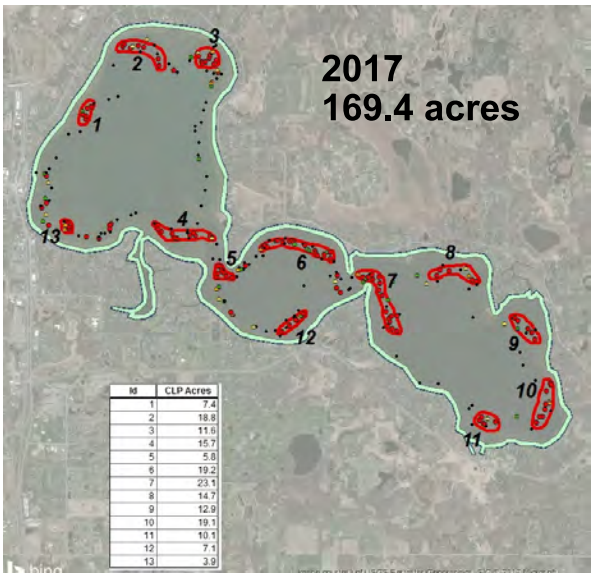
Forest Lake Curlyleaf Treatment Areas for 2009-2020

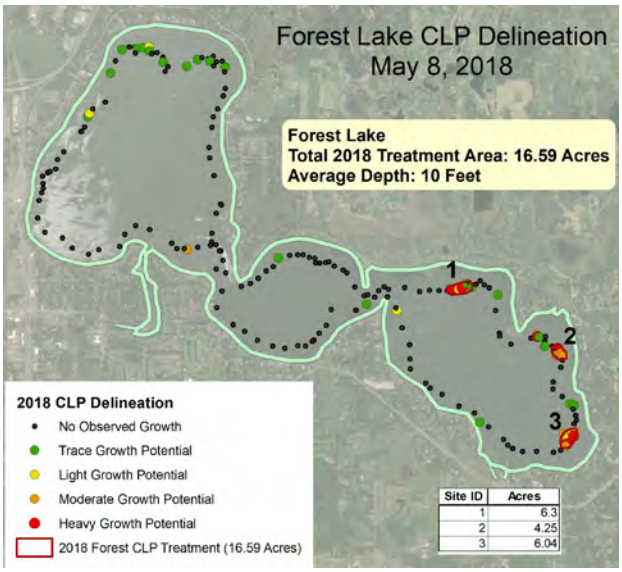


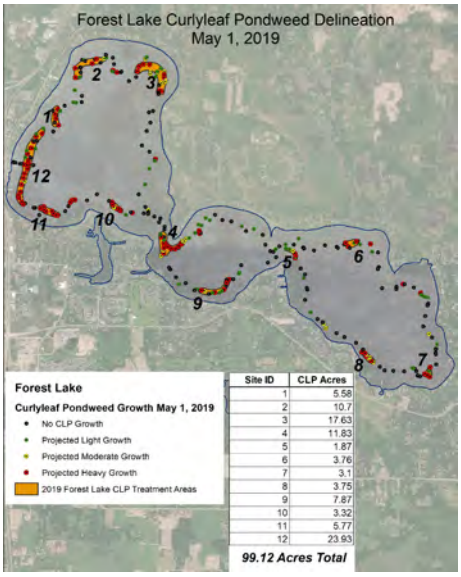
Curlyleaf treatment areas in 2009 through 2014.

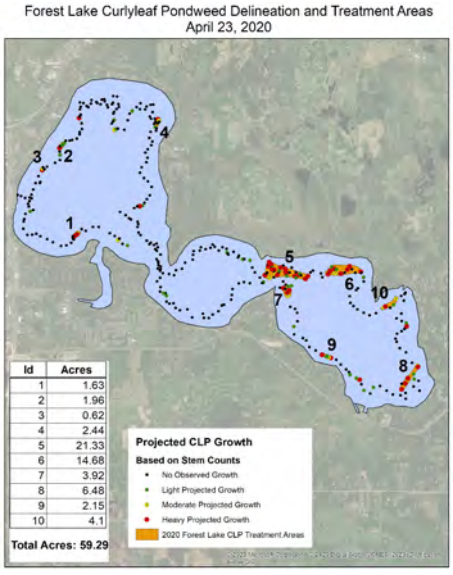






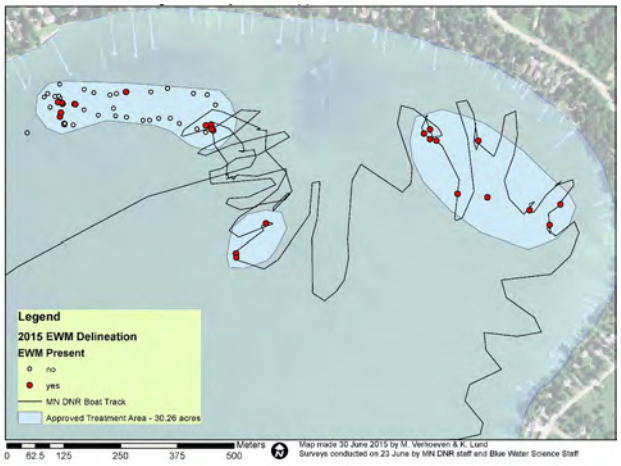


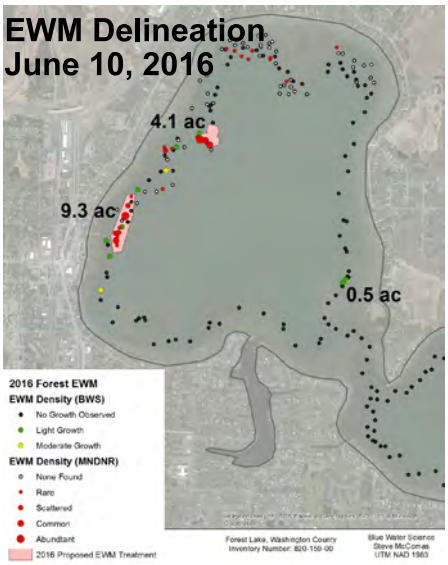


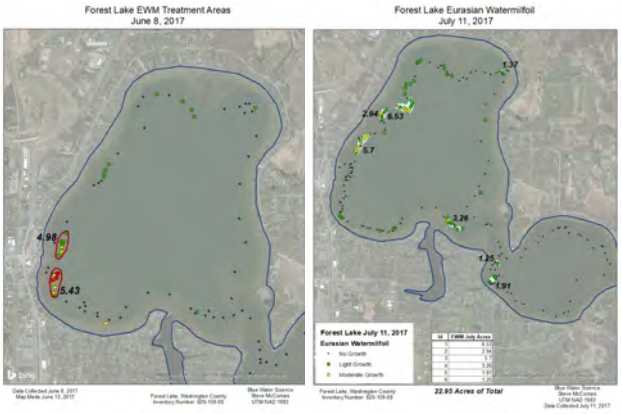


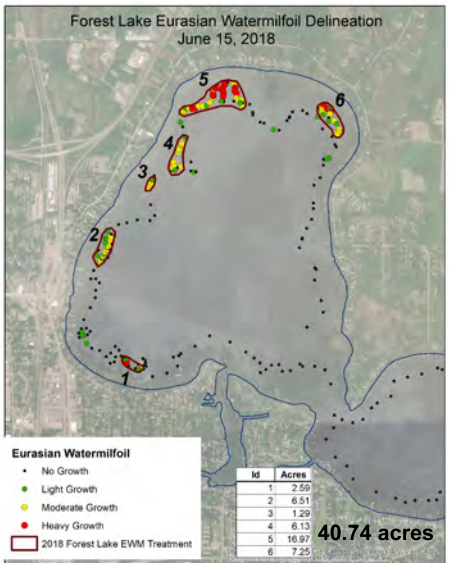
Curlyleaf treatment areas in 2015 through 2020.

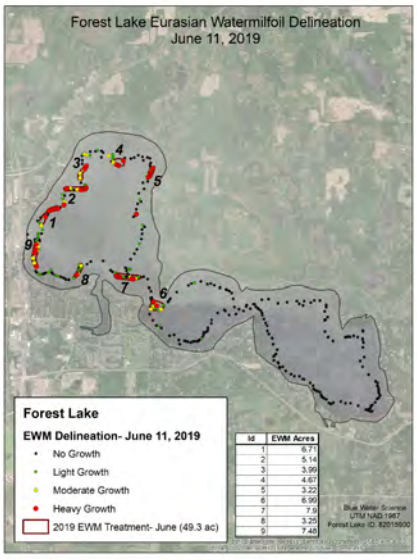
Forest Lake EWM Treatment Areas for 2015-2020

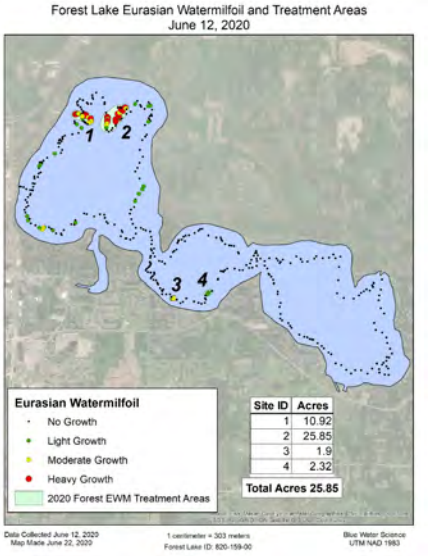












Eurasian watermilfoil treatment areas in 2015 through 2020.