White Water Lilies in Bone Lake, July 20, 2023

Curlyleaf Pondweed and Eurasian Watermilfoil Management and Point Intercept Survey for Bone Lake, Washington County, Minnesota, 2023

	Delineation	Treatment	Assessment
CLP	May 1, 2023	No treatment	June 2, 2023
EWM	June 2, 2023	No treatment	July 20, 2023

Meander Surveys: May 1 and June 2, 2023
Point Intercept Survey: July 20, 2023

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

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Curlyleaf Pondweed and Eurasian Watermilfoil Management and Point Intercept Survey for Bone Lake, Washington County, Minnesota, 2023

Summary

Curlyleaf Pondweed Delineation and Assessment: Bone Lake (MnDNR ID #82-0054) is a 221 acre lake located in Washington County, Minnesota. On May 1, 2023 the curlyleaf pondweed (CLP) delineation survey sampled 117 sites. Curlyleaf pondweed growth was light and sparse and was found at 5 sample sites (Figure 1). No CLP treatment is necessary at this time.

No treatment of curlyleaf pondweed was conducted in 2023.

A CLP assessment was conducted on June 2, 2023, during the peak growth of CLP. Curlyleaf was sampled at 10 sites at light to moderate growth conditions on June 2, 2023 (Figure 1). One area in the southwest corner of the lake had one site of moderate CLP growth.

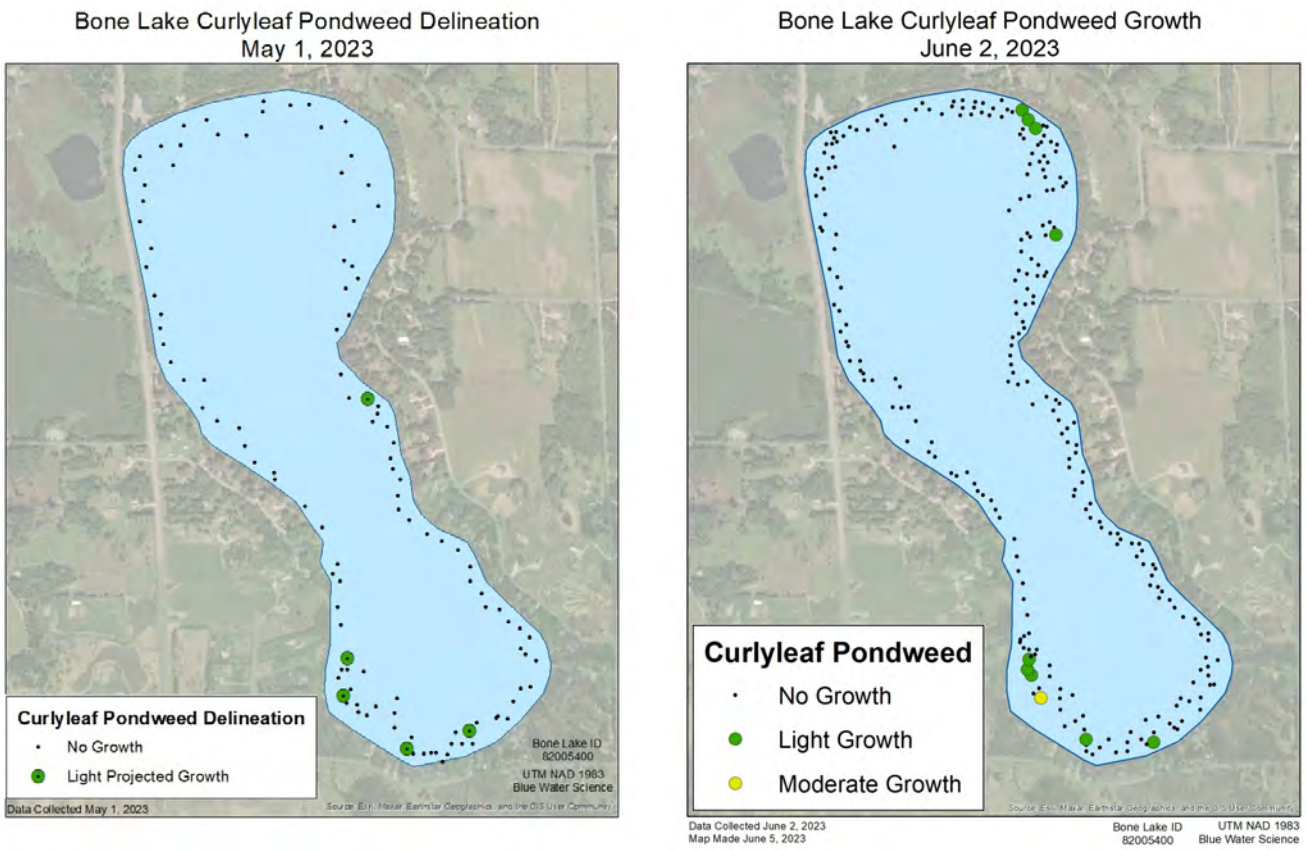


Figure 1. [left] CLP was found at 5 out of 117 sample sites in Bone Lake on May 1, 2023. [right] CLP was found at 10 out of 261 sample sites on June 2, 2023. Key: green = light growth potential and yellow = moderate growth potential.

Eurasian Watermilfoil Delineation and Assessment: Eurasian watermilfoil (EWM) was verified in Bone Lake in 2006. On May 1, 2023 the Eurasian watermilfoil (EWM) delineation survey sampled 117 sites. Eurasian watermilfoil growth was light and sparse and was found at 6 sample sites (Figure 2).

No treatment was conducted in 2023.

An assessment combined with a point intercept survey was conducted on July 20, 2023. Eurasian watermilfoil was sampled at 3 sites out of 163 sample locations out to 9 feet (depth of plant growth). EWM density was mostly light in 2023 (Figure 2).

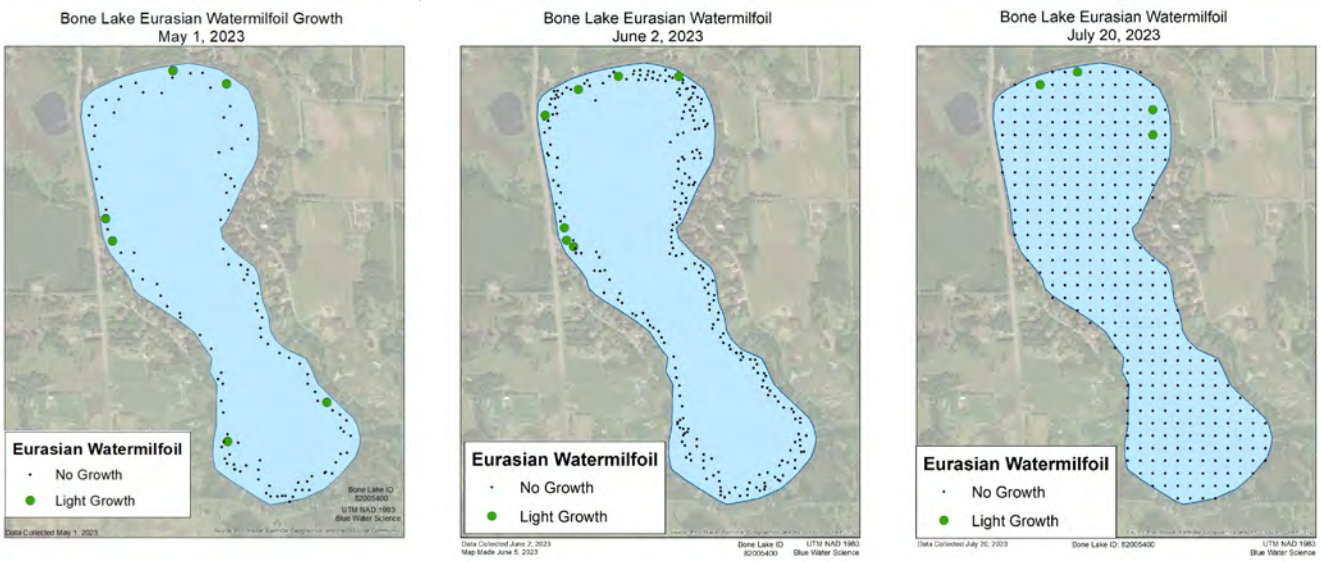


Figure 2. [left] EWM coverage for Bone Lake on May 1, 2023.
[middle] EWM coverage for Bone Lake on June 2, 2023.
[right] EWM coverage on for Bone Lake on July 20, 2023.

Summary of CLP and EWM Bone Lake Treatments: CLP has been treated in 5 out of the last 10 years. EWM has been treated in 3 out of the last 10 years. However, no CLP or EWM was treated tin 2023 (Figure 3).

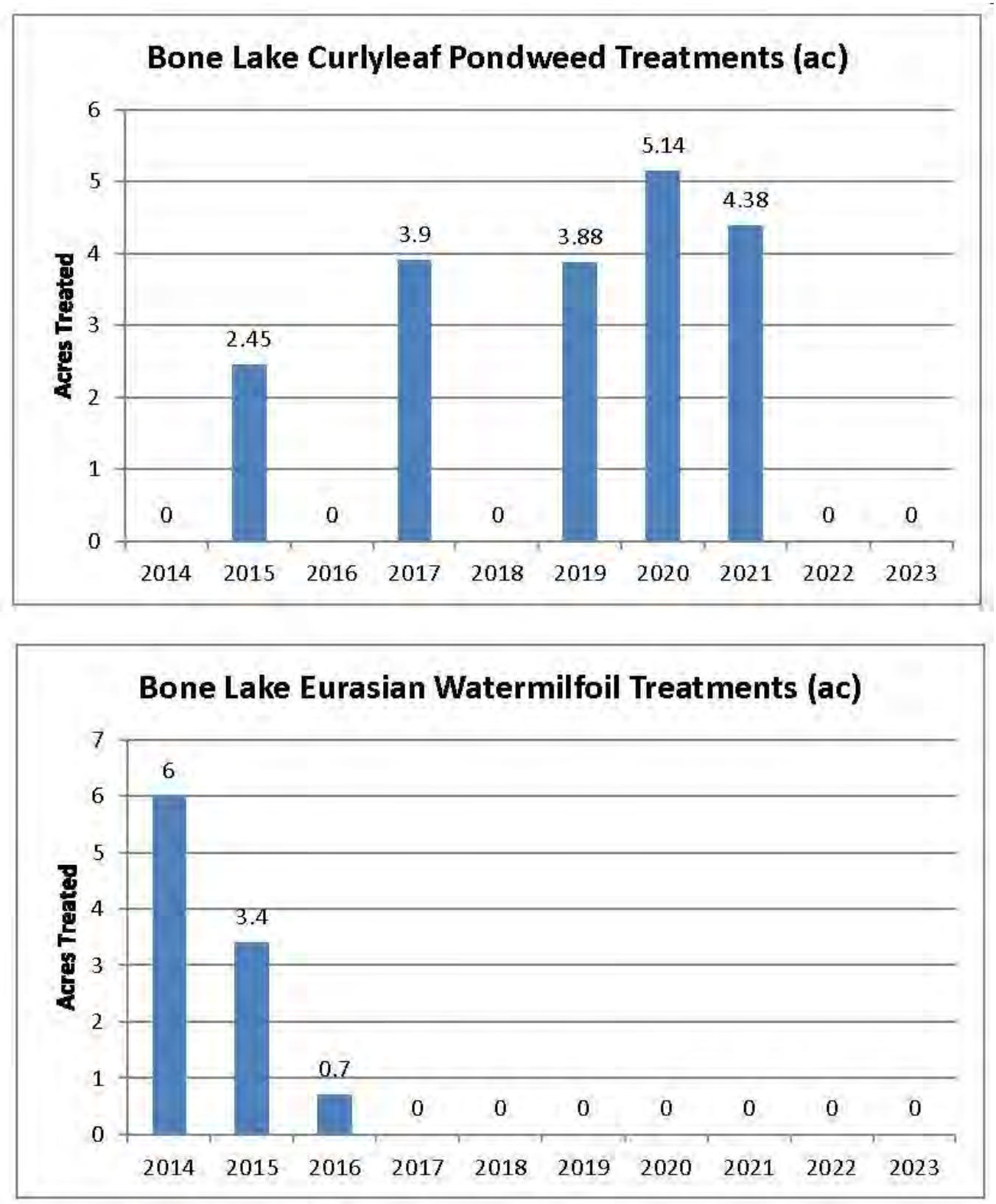


Figure 3. Summary of CLP and EWM treatment acreage for 2014-2023.

Curlyleaf and Milfoil Treatments from 2015-2023: A summary of CLP and EWM treatments from 2015 through 2023 is shown in Figure 4. Curlyleaf pondweed growth has fluctuated over the years. No treatment was conducted in 2022 and 2023. EWM treatment areas have decreased since 2014 with no treatment occurring 2017 through 2023 in Bone Lake.

A hotspot map of sites of CLP and EWM that show moderate and heavy growth for 2015 through 2023 is shown in Figure 4. CLP and EWM have typically grown to a water depth of 6 feet or less.

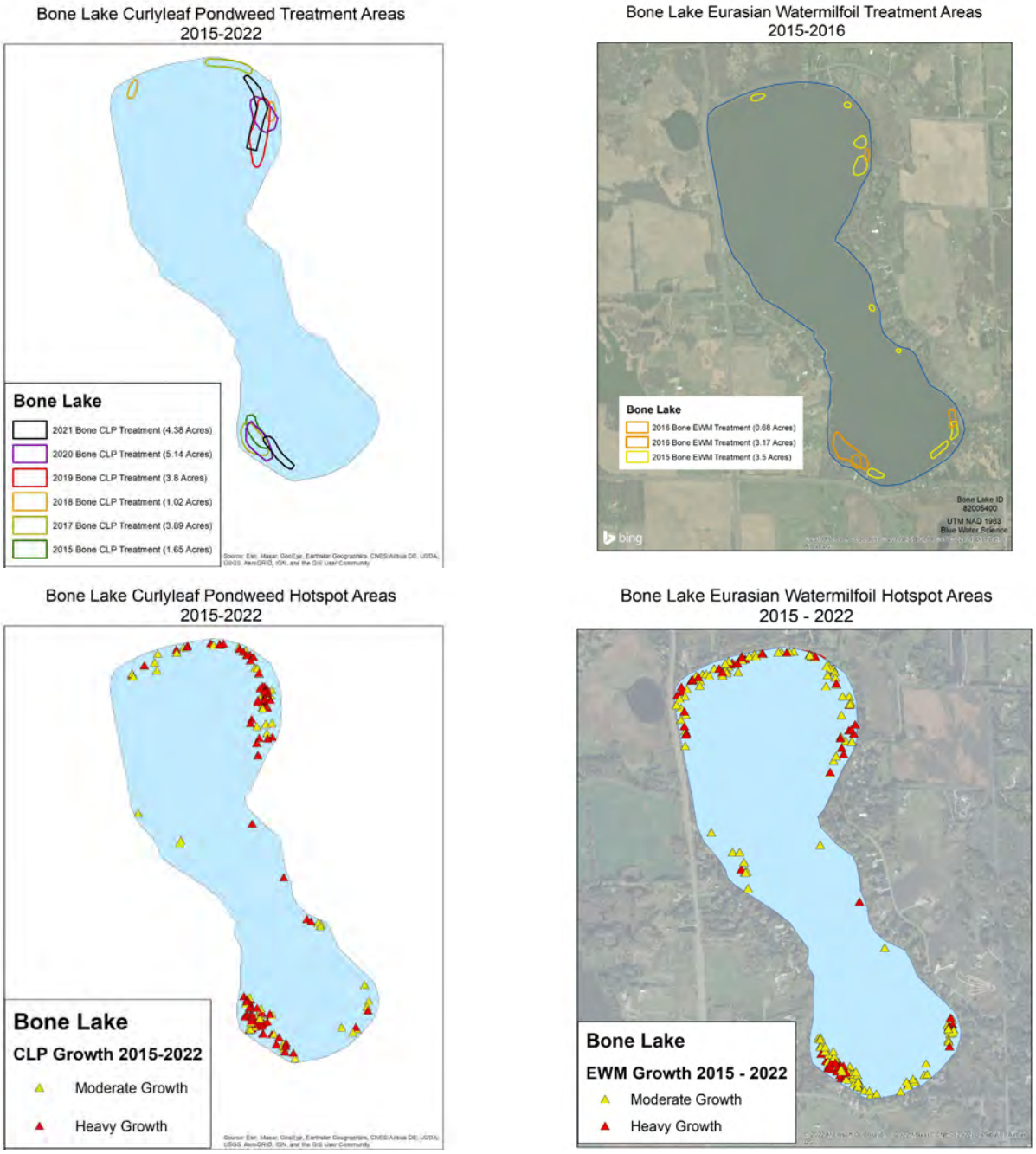


Figure 4. [top-left] Bone Lake CLP treatment map 2015-2022. [top-right] Bone Lake EWM treatment map 2015-2016. [bottom-left] Hotspot map of CLP growth over the years of 2015-2022 placed on a single map. [right] Hotspot map of EWM growth over the years of 2015-2022 placed on a single map Key: yellow = moderate growth, and red = heavy growth.

Aquatic Plant Point Intercept Survey: On July 20, 2023 an aquatic plant point intercept survey using 50 m spacing between sites was conducted on Bone Lake. During the survey non-native species including curlyleaf pondweed, Eurasian watermilfoil, starry stonewort, and zebra mussels as well as characterized all aquatic plants. Eight submerged aquatic plant species and 2 water lily species were sampled on July 20, 2023 in Bone Lake.

In July, the most abundant native aquatic plant species were naiads (found at 43% of the sites out to 9 feet) followed by coontail (found at 35% of the sites)(Table 1). Eurasian watermilfoil was found at 3 out of 163 sites (2%). Plants were found at 163 sites and grew out to 9 feet of water depth. Aquatic plants covered about 67 acres or 30% of the lake area.

Table 1. The percent occurrence of aquatic plants for Bone Lake. Percent occurrence is calculated based on the number of times a plant species occurs at a sampling station divided into the total number of stations for the survey. For example, if coontail was found in 25 out of 50 stations, its percent occurrence would be 50%.

	July 20, 2023 % Occur (0-9 feet, 163 sites)
Spatterdock (*Nuphar variegatum*)	6
White water lily (*Nymphaea odorata*)	19
Coontail (*Ceratophyllum demersum*)	35
Chara (*Chara spp*)	1
Northern watermilfoil (*Myriophyllum sibiricum*)	2
Eurasian watermilfoil (*Myriophyllum spicatum*)	2
Naiads (*Najas flexilis*)	43
Stringy pondweed (*Potamogeton sp*)	16
Sago pondweed (*Stuckenia pectinata*)	1
Water celery (*Vallisneria americana*)	1
Number of submerged aquatic plant species	8

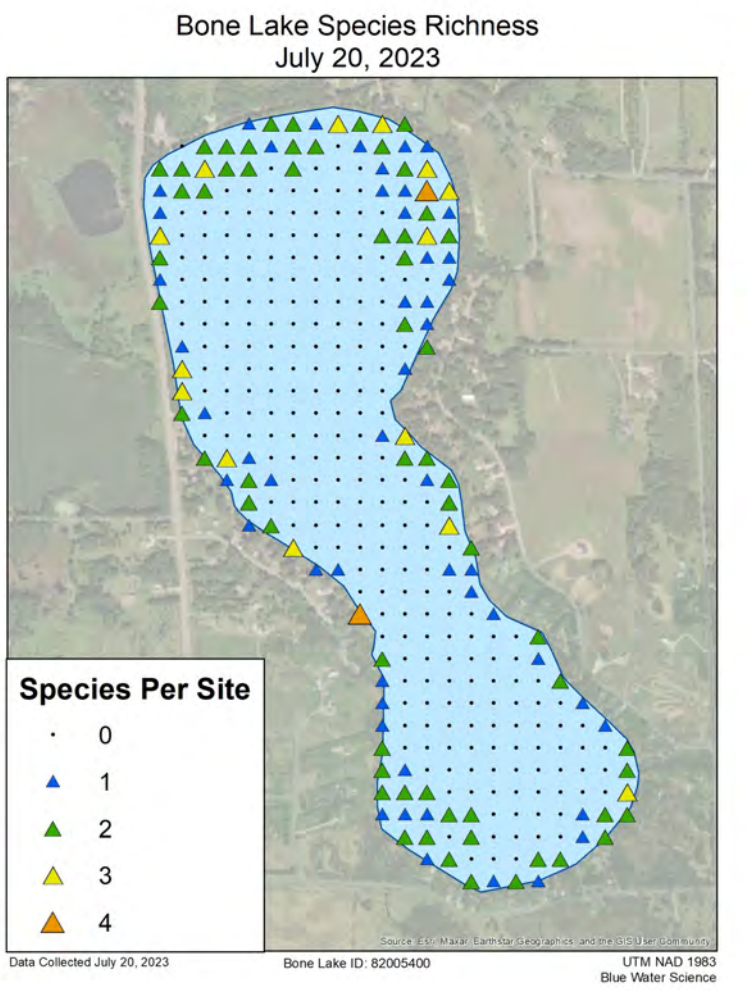


Figure 5. Species richness coverage on July 20, 2023.

Curlyleaf Pondweed and Eurasian Watermilfoil Management and Point Intercept Survey for Bone Lake, Washington County, Minnesota, 2023

Bone Lake, Washington County (ID: 82-0054)
Size: 221 acres (MnDNR) Littoral area: 124 acres (MnDNR)
Maximum depth: 30 ft (MnDNR)

Introduction

Curlyleaf pondweed (CLP) and Eurasian watermilfoil (EWM) are non-native species and both are present in Bone Lake. Curyleaf pondweed and Eurasian watermilfoil delineations and assessments were conducted in Bone Lake in 2023. The objectives of the delineations were to locate areas of nuisance invasive species and recommend areas for potential treatments. The purpose of the assessments were to determine if any nuisance growth of CLP or EWM were missed during the delineations. In addition, an aquatic plant point intercept survey was conducted on July 20, 2023 to characterize the entire plant communty.

Methods

Curlyleaf Pondweed Delineation Method: At the time of the spring curlyleaf delineation on May 1 only a fraction of the peak curlyleaf biomass is present compared to what could be present in June, at its peak. For spot treatments, the areas to be treated are delineated prior to curlyleaf developing peak biomass. The CLP delineation survey is conducted using a meandering path around the nearshore area of the entire lake. Curlyleaf is sampled using a fixed 14 tine rakehead on a pole. Curlyleaf stem counts on a rake sampler were used to identify areas that had a potential to produce curlyleaf growth at its June peak. After a short sweep of about 1-foot (which samples about 0.1 m^2), if one or two stems (10-20 stems/m^2) were collected on the rake sweep, it was predicted that this area would produce only future light growth at its peak and was not delineated for treatment. Alternatively, sites where 3 stems (30 stems/m^2) were collected per rake sample future potential growth was considered to be moderate. However if 4 curlyleaf stems (40 stems/m^2) or more per rake sample generally indicated some plants had developed runners and would likely produce heavy growth in the next few weeks and this site would be marked for potential treatment. This survey method used for determining curlyleaf pondweed spot herbicide treatments was similar to the methodology published in a peer reviewed journal (McComas et al, 2015)*.

*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.* https://doi.org10.1080/10402381.2015.1014583

Curlyleaf Assessment and Eurasian Watermilfoil Delineation and Assessment Sampling: An EWM initial delineation along with a CLP assessment were conducted on June 2 and 261 sites were sampled. On July 20 an EWM assessment was conducted and the entire perimeter of the lake was checked for CLP and EWM. A point intercept survey was also conducted at this time.

Point Intercept Survey: An aquatic plant survey of Bone Lake using a point intercept sampling method was conducted by Blue Water Science on July 20, 2023. A map and sampling grid were prepared by Blue Water Science and a consisted of a total of 368 points that were distributed throughout the lake (Figure 6). Points were spaced 50 meters apart. Each point represented about 0.6 acres. At each sample point, plants were sampled with a rake sampler. A plant density rating was assigned to each plant species on a scale from 1 to 3 (Figure 7). A density of a "1" indicated sparse growth with one or two stems present on the rake sampler. A 3 rating indicated matting surface plant growth.

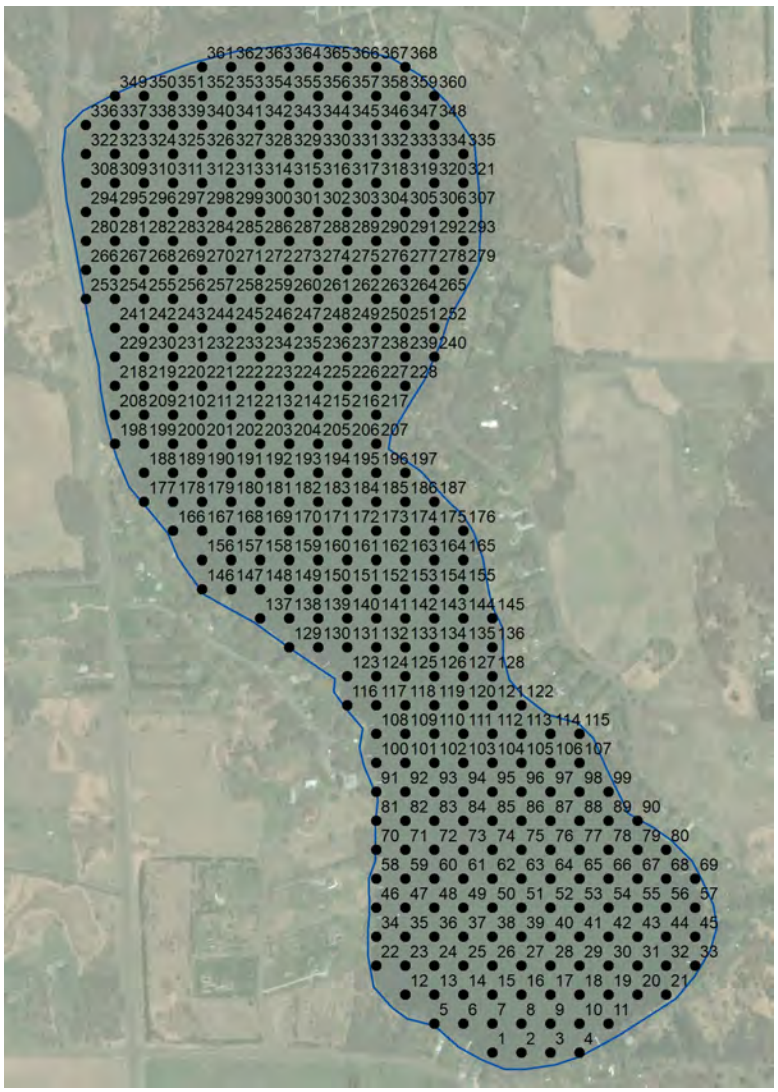


Figure 6. Point locations for the aquatic plant surveys.

Chart of Aquatic Plant Density Ratings

Figure 7. Aquatic plant density ratings from 1 to 3.

Curlyleaf Pondweed Delineation on May 1, 2023

A CLP delineation conducted on May 1, 2023 and found CLP was present at 5 sample sites out to a total of 117 sampled sites. No CLP treatment was not recommend in 2023 (Figure 8).

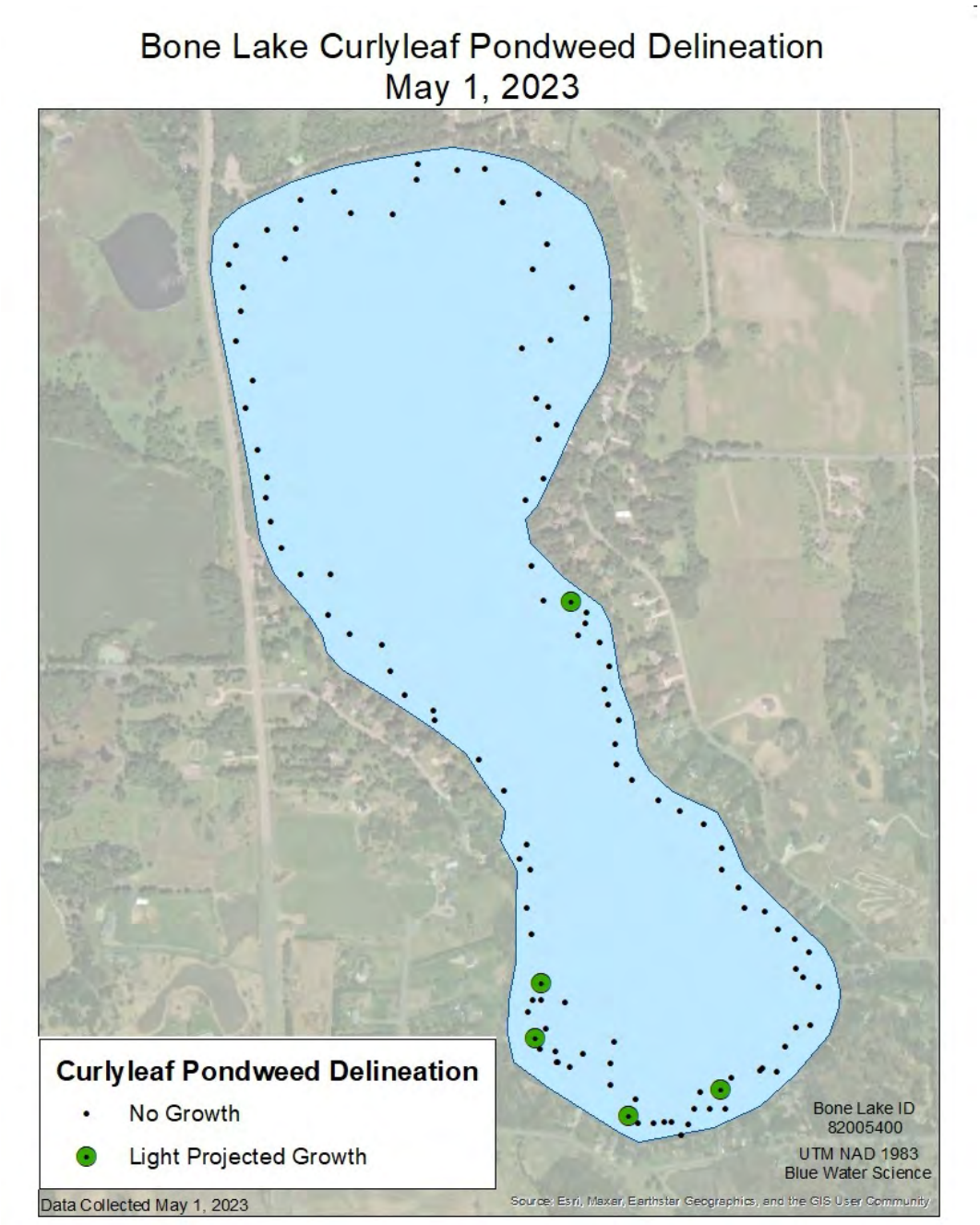


Figure 8. Curlyleaf coverage for Bone Lake on May 1, 2023. Key: black dot = no growth and green dots = light growth.

Curlyleaf Pondweed Assessment on June 2, 2023

An assessment was conducted on June 2, 2023 and found CLP was present at 10 sites out of the 261 sample sites (Figure 9). Curlyleaf growth had increased slightly since May 1, 2023. Moderate growth of CLP was found at 1 site in the lower southwest corner of Bone Lake.

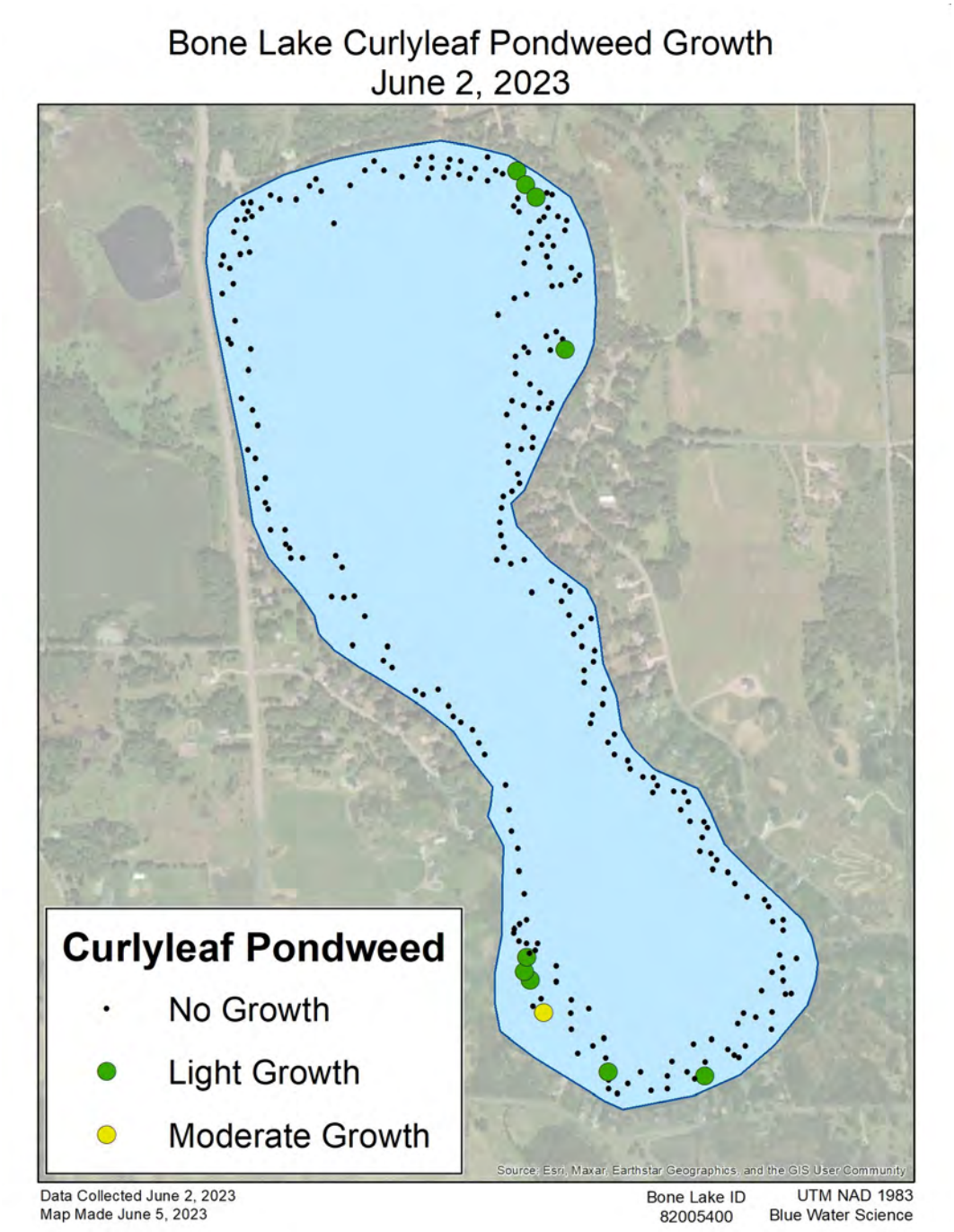


Figure 9. Curlyleaf growth in Bone Lake on June 2, 2023.
Key: black dot = no curlyleaf growth, green dot = light growth, and yellow dot = moderate growth.

Eurasian Watermilfoil Delineation on June 2, 2023

An EWM delineation was conducted on June 2, 2023. Eurasian watermilfoil was sampled at 7 sites out of 261 sites sampled and all sites had light growth (Figure 10).

No treatment areas were delineated for 2023.

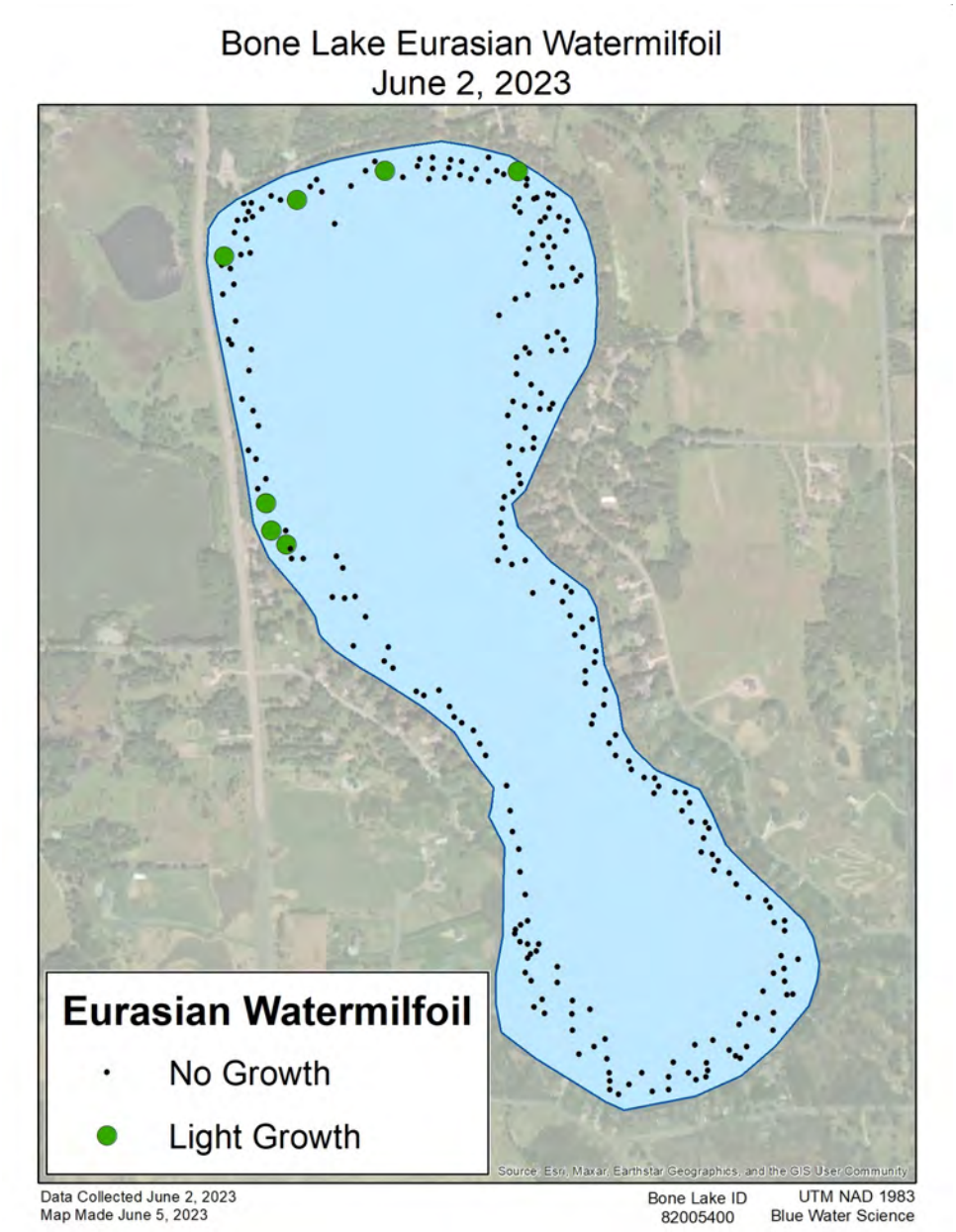


Figure 10. Eurasian watermilfoil coverage for Bone Lake on June 2, 2023.
Key: black dot = no growth and green dots = light growth.

Point Intercept Survey Conducted on July 20, 2023

Bone Lake Point Intercept Survey Statistics: A summary of plant statistics from the point intercept survey is shown in Tables 2 and 3 and Figure 11. A total of 177 points were sampled. A total of 163 points were sampled in the depths out to 9 feet which was the maximum depth of plant growth. (Table 3). The mean number of native plant species identified at each sample point was 1.0 species per point (Table 2).

Table 2. MnDNR Template Statistics

Total # Points Sampled	**177**
Depth Range of Rooted Veg	**1-9 feet**
Maximum Depth of Growth (95%) in feet	**8**
# Points in Max Depth Range	**163**
# Points in Littoral Zone (0-15 feet)	**176**
% Points w/ Submersed Native Taxa	**63**
Mean Submersed Native Taxa/Point	**1.0**
# Submersed Native Taxa	**8**
# Submersed Invasive Taxa	**1**
Max Depth of EWM in feet	**4**
% Frequency of EWM	**2**
Mode Rake Abundance of EWM	**1**
Max Depth of CLP in feet	**0**
% Frequency of CLP	**0**
Mode Rake Abundance of CLP	NA

Table 3. Aquatic plants sampled by depth.

Depth (feet)	Number of Points Sampled	Percent of Sampling Points with Submerged Species Observed
1	6	0%
2	31	77%
3	38	87%
4	18	100%
5	21	62%
6	14	71%
7	7	57%
8	15	47%
9	13	8%
10	9	0%
11	2	0%
12	0	0%
13	0	0%
14	2	0%
15	0	0%
16	0	0%
17	0	0%
18	0	0%
19	1	0%
20	0	0%
All sites	177	

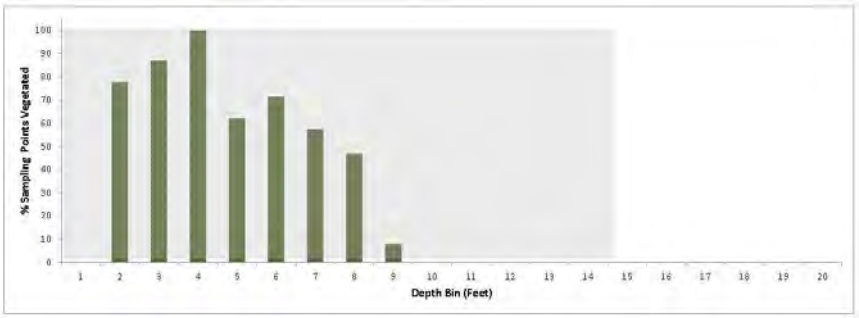


Figure 11. Depth of plant colonization (in feet).

Aquatic Plant Occurrence and Density

The most common plant in the point intercept plant survey was the native naiad followed by coontail (Table 4). A total of 8 submerged species were observed. Native plant coverage is shown in Figure 12 and covered approximately 30% of the lake bottom.

Table 4. The percent occurrence and density of aquatic plants for Bone Lake. Percent occurrence is calculated based on the number of times a plant species occurs at a sampling station div ided into the total number of stations for the survey. For example, if coontail was found in 25 out of 50 stations, its percent occurrence would be 50%. Density is a rating scale from 1 to 3 with 3 being the densest.

	July 20, 2023	
	% Occur (163 sites)	Density
Spatterdock (*Nuphar variegatum*)	6	1.8
White water lily (*Nymphaea odorata*)	19	1.9
Coontail (*Ceratophyllum demersum*)	35	1.3
Chara (*Chara spp*)	1	1.5
Northern watermilfoil (*Myriophyllum sibiricum*)	2	1.0
Eurasian watermilfoil (*Myriophyllum spicatum*)	2	1.0
Naiads (*Najas flexilis*)	43	1.5
Stringy pondweed (*Potamogeton sp*)	16	1.1
Sago pondweed (*Stuckenia pectinata*)	1	1.0
Water celery (*Vallisneria americana*)	1	1.0
Number of submerged aquatic plant species	8	

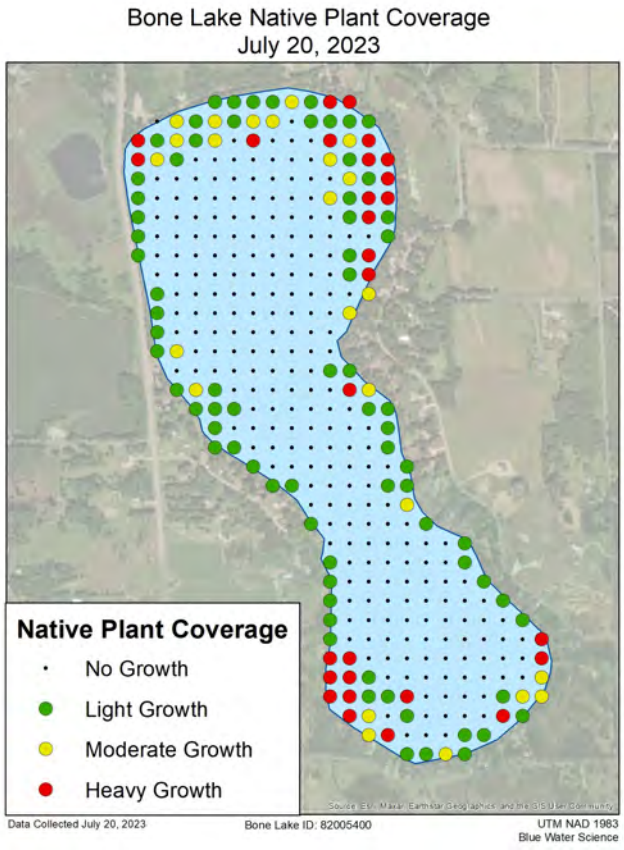


Figure 12. Native plant coverage on July 20, 2023. Key: green = light growth, yellow = moderate growth, and red = heavy growth.

Aquatic Plant Maps

The most abundant native plant on the July 20, 2023 point intercept plant survey for Bone Lake was naiads, found at 70 out of 163 sites sampled out to 9 feet (43%)(Figure 13). The other submerged plant species observed were also found to be growing at light to moderate conditions (Figure 13).

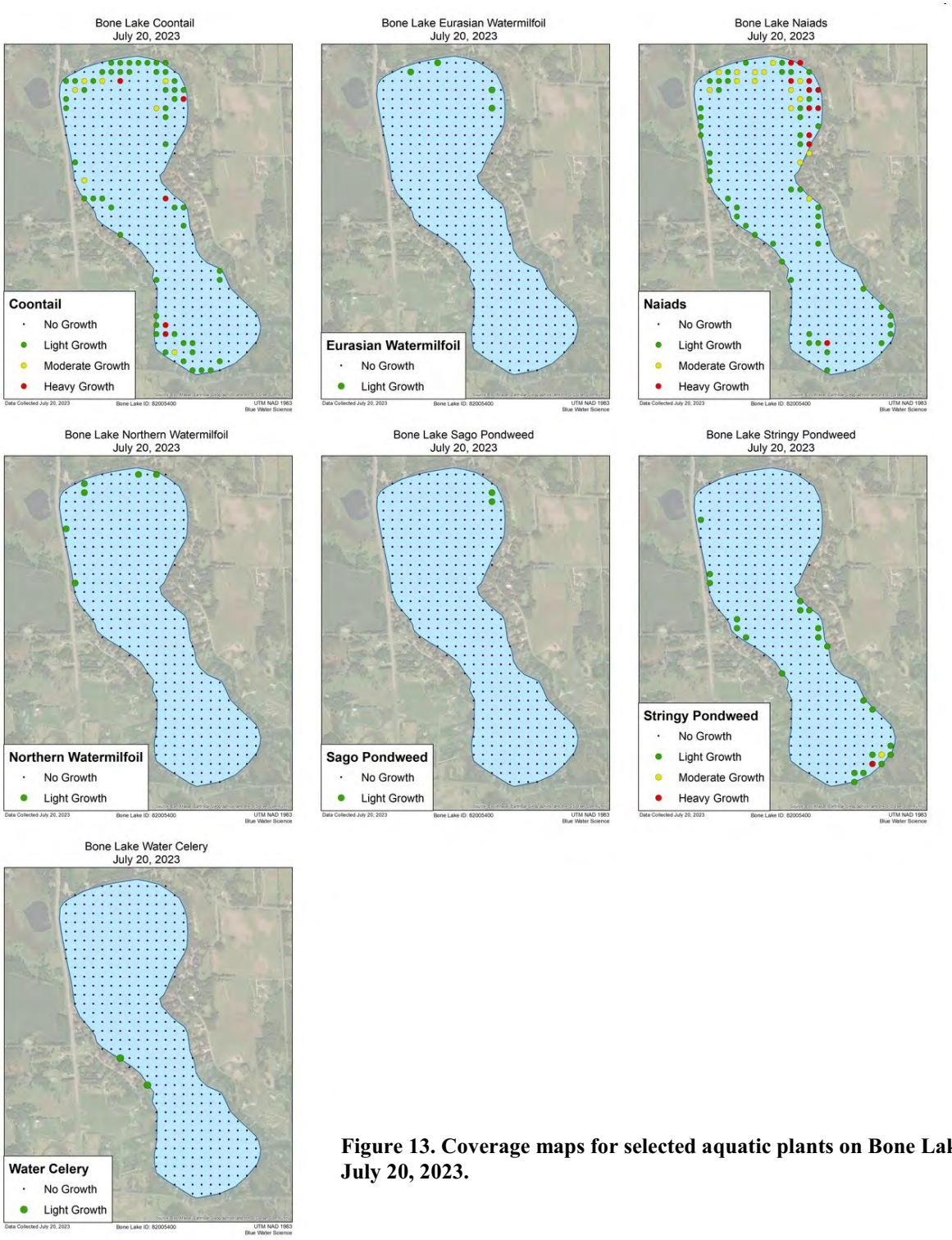


Figure 13. Coverage maps for selected aquatic plants on Bone Lake on July 20, 2023.

A summary of plant density and occurrence at each sample site is shown in Table 5.

Table 5. Individual site data for August 2, 2018. Numbers indicate plant density.

Site	Depth (ft)	Spatterdock	White lilies	Chara	Coontail	EWM	Naiads	NWM	Sago	Stringy	Water celery	No Plants
1	3				1		1					
2	3				1							
3	3	2			1							
4	2									1		
5	1		2									
6	2		3		1							
7	5											1
8	10											1
9	9											1
10	3				1					1		
11	2	1								1		
12	2		3		1							
13	3		2		2							
14	2											1
15	5				1		1					
18	9											1
19	5											1
20	3									3		
21	2		1							1		
22	1		3									
23	3		3									
24	4						1					
25	5				1		1					
26	7				1		3					
30	8											1
31	6									1		
32	3						1			2		
33	2		2							1		
34	2		3		1							
35	4		2		3							
36	5				1		1					
37	9											1
42	14											1
43	11											1
44	5											1
45	3		2				1			1		
46	2		3		1							
47	6				3							
56	6											1
57	2		3				1					
58	1		1		1							
59	8											1
68	9											1
69	3		3				1					
70	2	1										
71	10											1
79	11											1
80	4						1					
81	1	1										
89	9											1
90	3									1		
91	2		1									
98	9											1
99	3						1			1		
100	5				1		1					
107	5				1							
108	7											1
114	6											1

Table 5. Individual site data for August 2, 2018. Numbers indicate plant density.

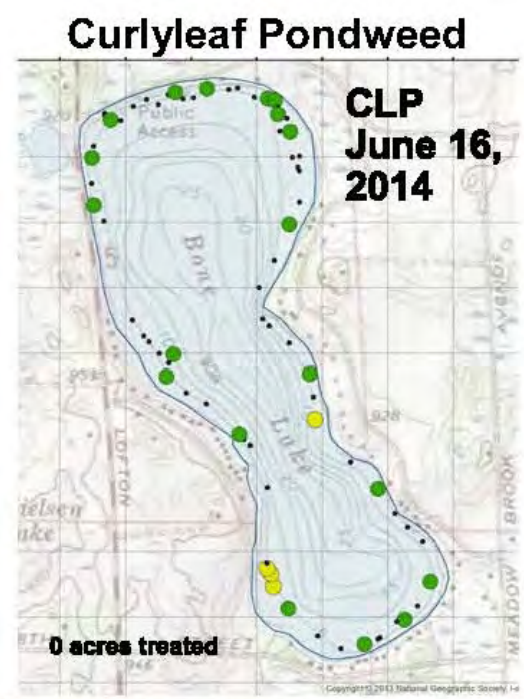
Site	Depth (ft)	Spatterdock	White lilies	Chara	Coontail	EWM	Naiads	NWM	Sago	Stringy	Water celery	No Plants
115	3		1		1							
116	3		1				1			1	1	
121	19											1
122	5		1									
123	5											1
127	10											1
128	2			2								
129	1		1									
130	3						1					
135	3						1					
136	2		1									
137	3				1		1				1	
138	6											1
144	7											1
145	2		1							1		
146	2		1									
147	3						1			1		
148	7											1
155	6				1		1			1		
156	2						1			1		
157	5											1
158	9											1
164	10											1
165	5						1			1		
166	1		1									
167	2						1			1		
168	4				1							
169	9											1
175	6				1							
176	3				1		1					
177	2		1		1							
178	4	2			1		1					
179	6				1							
180	9											1
186	5				3					1		
187	3						2			1		
188	5											1
189	6											1
196	2						1					
197	2			1			1			1		
198	3		1				1					
199	6				2							
200	9											1
208	3						1	1		1		
209	9											1
218	4				1		1			1		
227	14											1
228	5						2					
229	5						1					
239	5											1
240	2	2					2					
241	8											1
251	6				1		1					
252	3						3					
253	2		1				1					
254	8											1
264	5						1					
265	2						3					
266	2						1					
267	8											1
276	8											1
277	3											1
278	3											1

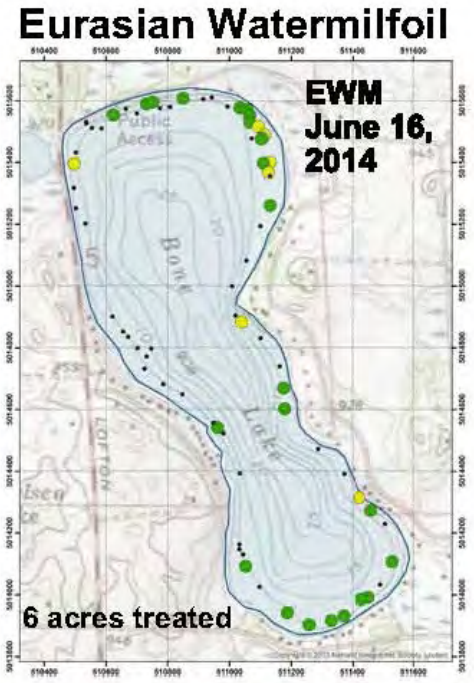
Table 5. Individual site data for August 2, 2018. Numbers indicate plant density.

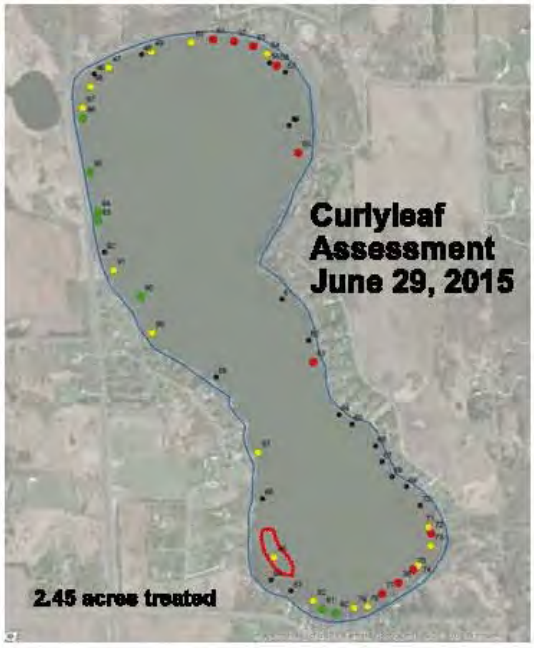
Site	Depth (ft)	Spatterdock	White lilies	Chara	Coontail	EWM	Naiads	NWM	Sago	Stringy	Water celery	No Plants
279	2						1					
280	3						1	1				
290	10											1
291	3				1		1					
292	2		3									
293	2	1										
294	3				1		1			1		
295	8											1
304	8				2		2					
305	4				1		1					
306	3	3				1	3					
307	3		3				3					
308	4				1							
309	8											1
318	10											1
319	5						2					
320	4				1		1					
321	4				3							
322	3	3										
323	6				2		2					
324	8				1		1					
325	10											1
332	8						2					
333	7				1							
334	3				1	1	3		1			
335	3		2		1		3					
336	3		3		1							
337	4				1		1					
338	5				2		1	1				
339	6				1		1					
340	8				2		2					
341	9											1
342	8				3		2					
345	10											1
346	8						3					
347	5				2		2					
348	4				1		3		1			
350	2						2	1				
351	3					1	1					
352	4				1		2					
353	6				1							
354	7				1		2					
355	8				1		2					
356	10											1
357	9						1					
358	7				1		1					
359	4				1							
360	2						1					
361	3		1									
362	3				1		1					
363	4				1	1						
364	4				1							
365	4				1		2	1				
366	4				1		1					
367	3				1		3	1				
368	2				1		3					
Average		1.8	1.9	1.5	1.3	1.0	1.5	1.0	1.0	1.1	1.0	
Occur to 9 ft	163	9	31	2	57	3	70	4	2	24	2	51
% Occur		6	19	1	35	2	43	2	1	15	1	

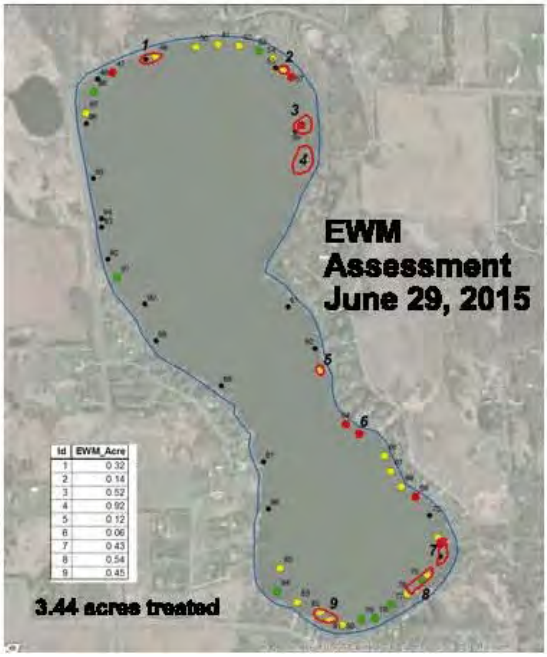
APPENDIX

Curlyleaf Pondweed and Eurasian Watermilfoil Assessments from 2014 - 2022

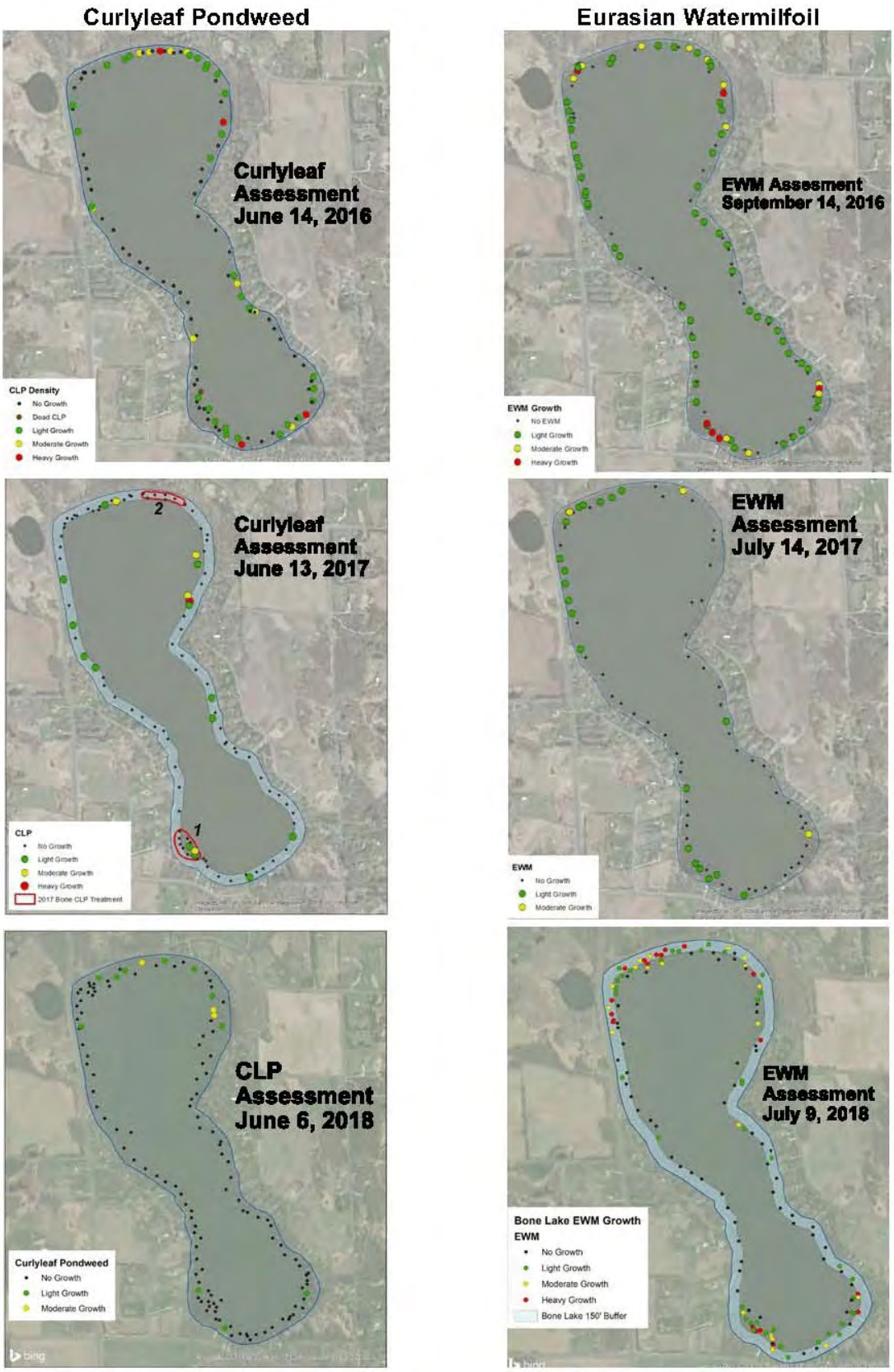




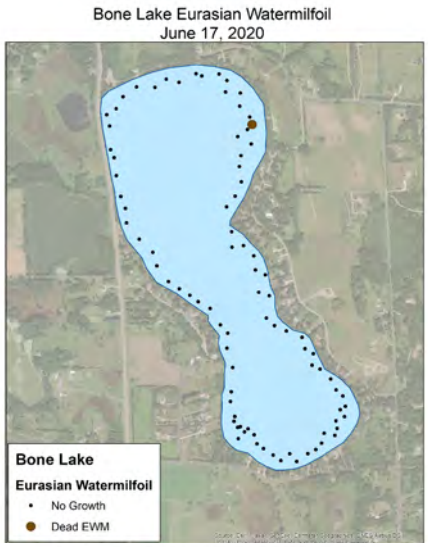


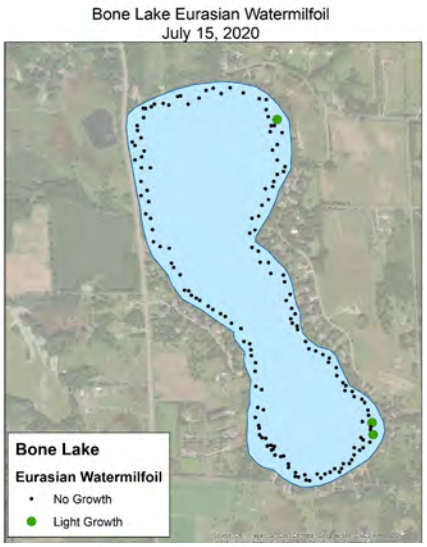


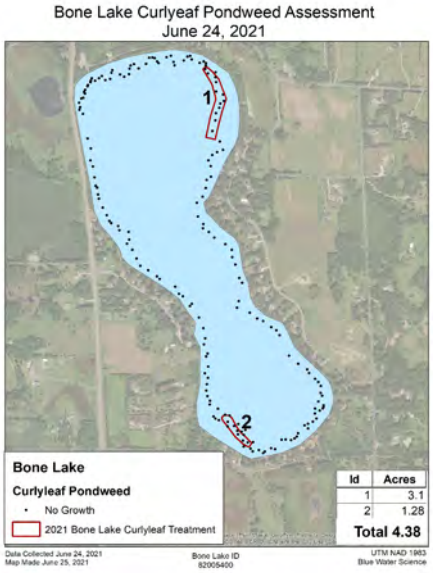
CLP and EWM maps for 2014 through 2022 (continued on the next 2 pages).

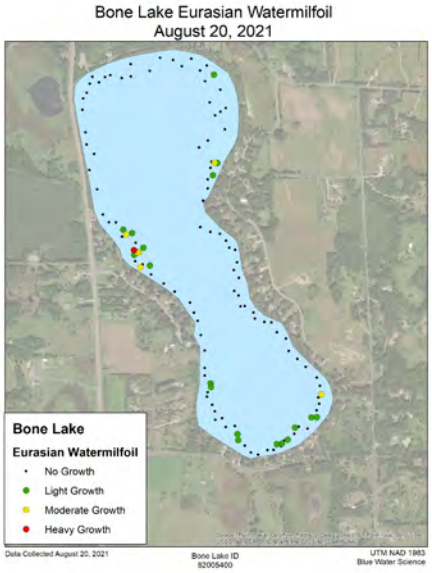


CLP and EWM maps for 2014 through 2022.



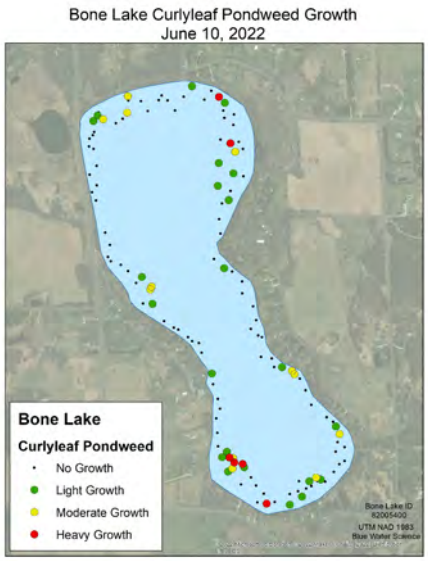




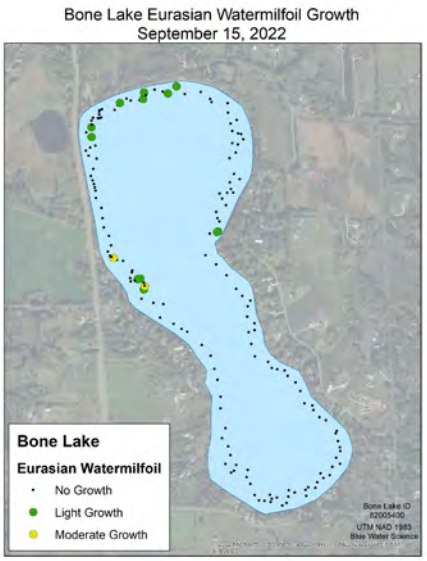


CLP and EWM maps for 2014 through 2022.

Curlyleaf Pondweed



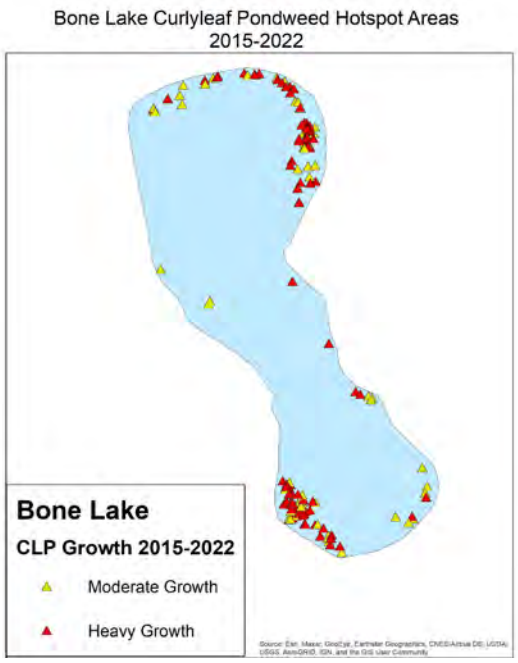
Eurasian Watermilfoil

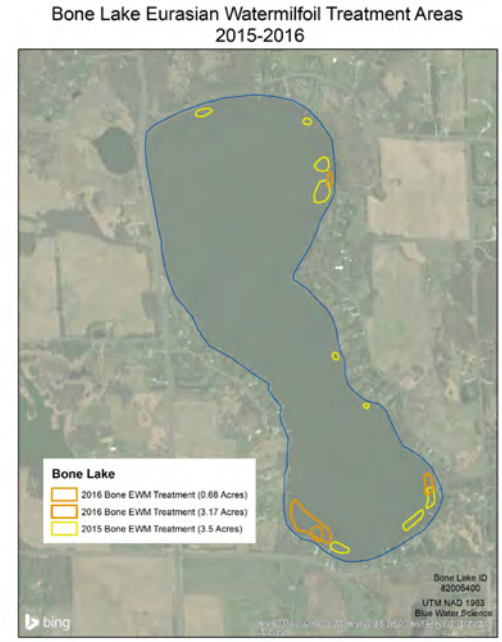


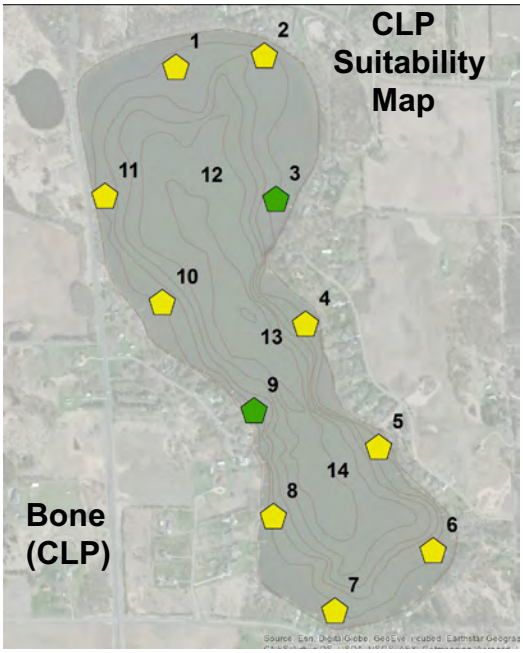
CLP and EWM maps for 2014 through 2022.

Curlyleaf Pondweed from 2015 - 2022

A summary of CLP treatments from 2015 through 2022 is shown below. CLP growth has been variable for the last couple of years. Lake ice, snow cover, and even cloudy days can limit curlyleaf growth. A hotspot map of sites of CLP moderate and heavy growth for 2015 through 2022 is shown in Figure 8. In the last 5 years CLP growth has been most evident in the northern and southern ends of Bone Lake where growing conditions are conducive to heavy plant growth. CLP has typically grown to a water depth of 6 feet or less.







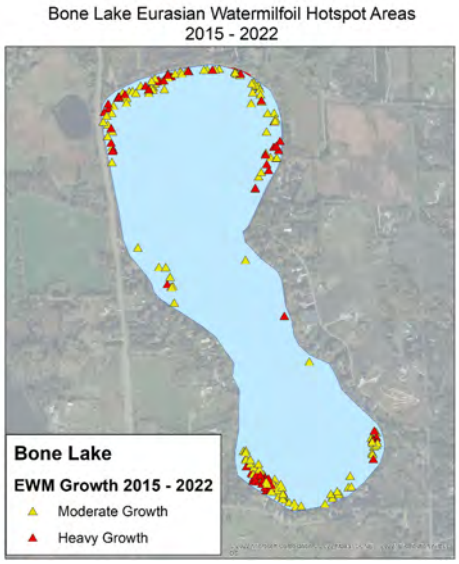
[top-left] Bone Lake CLP hotspot map 2015-2022. [top-right] Treatment map of CLP growth over the years of 2015-2022 placed on a single map.
[bottom-left] Curlyleaf pondweed potential growth based on lake sediment analyses for Bone Lake.
Key for Potential Growth: green = light growth, yellow = moderate growth, red = heavy growth (shown with octagons).

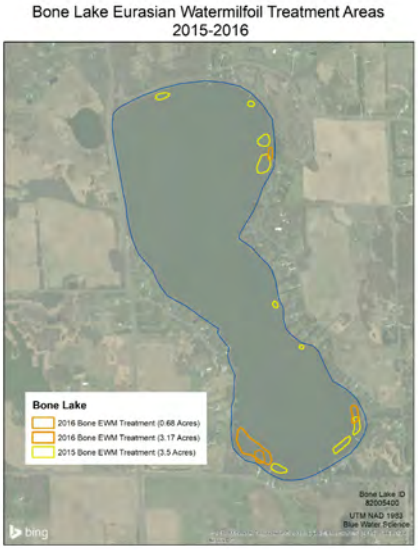
Eurasian Watermilfoil from 2015 - 2022

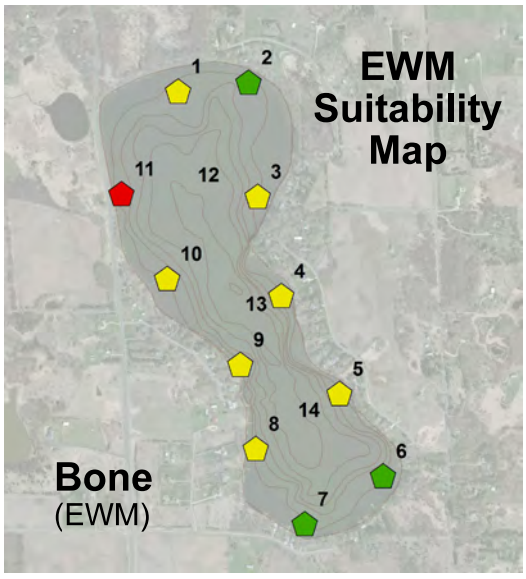
EWM has been in Bone Lake since 2006. Although control of EWM has been ongoing since 2006, EWM continued to expand around the lake. A map showing the occurrence of moderate to heavy growth of EWM in Bone Lake from 2015 through 2022 is shown below. Some nearshore areas in the north and south ends of Bone Lake support consistently significant growth. These “hotspot” areas are shown below.

Heavy milfoil growth has been correlated with high sediment nitrogen conditions and from a soils survey conducted in 2014, Bone Lake has at least 1 area with high lake sediment nitrogen conditions. The potential for long term milfoil growth, based on lake sediment sampling, predicts mostly moderate growth with the potential for annual heavy growth limited to the northwest side of Bone Lake.

For Bone Lake, it is estimated the plants have the potential to grow down to at least 7 feet of water depth based on low Secchi transparencies, restricting milfoil growth to nearshore areas. Results of the sediment survey indicate growth would be primarily light on a long term basis.







[top-left] Hotspot map of EWM growth over the years of 2015 to 2022 placed on a single map.
[top-right] Treatment map of EWM growth over the years of 2015-2022 placed on a single map.
[bottom-left] Suitability map for EWM growth in Bone Lake.
Key: green = light growth, yellow = moderate growth, and red = heavy growth.