



Underwater Picture of Curlyleaf Pondweed in Prior Lake, June 7, 2021

Curlyleaf Pondweed Delineation and Assessment Surveys for Upper and Lower Prior Lake and Summer Point Intercept Survey for Upper Prior Lake, Scott County, 2021

Curlyleaf Pondweed Delineation: April 20, 2021

Herbicide Treatment: 24.15 acres May 17, 2021

Curlyleaf Pondweed Assessment Date: June 7, 2021

Point Intercept Survey for Upper Prior: August 19, 2021

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



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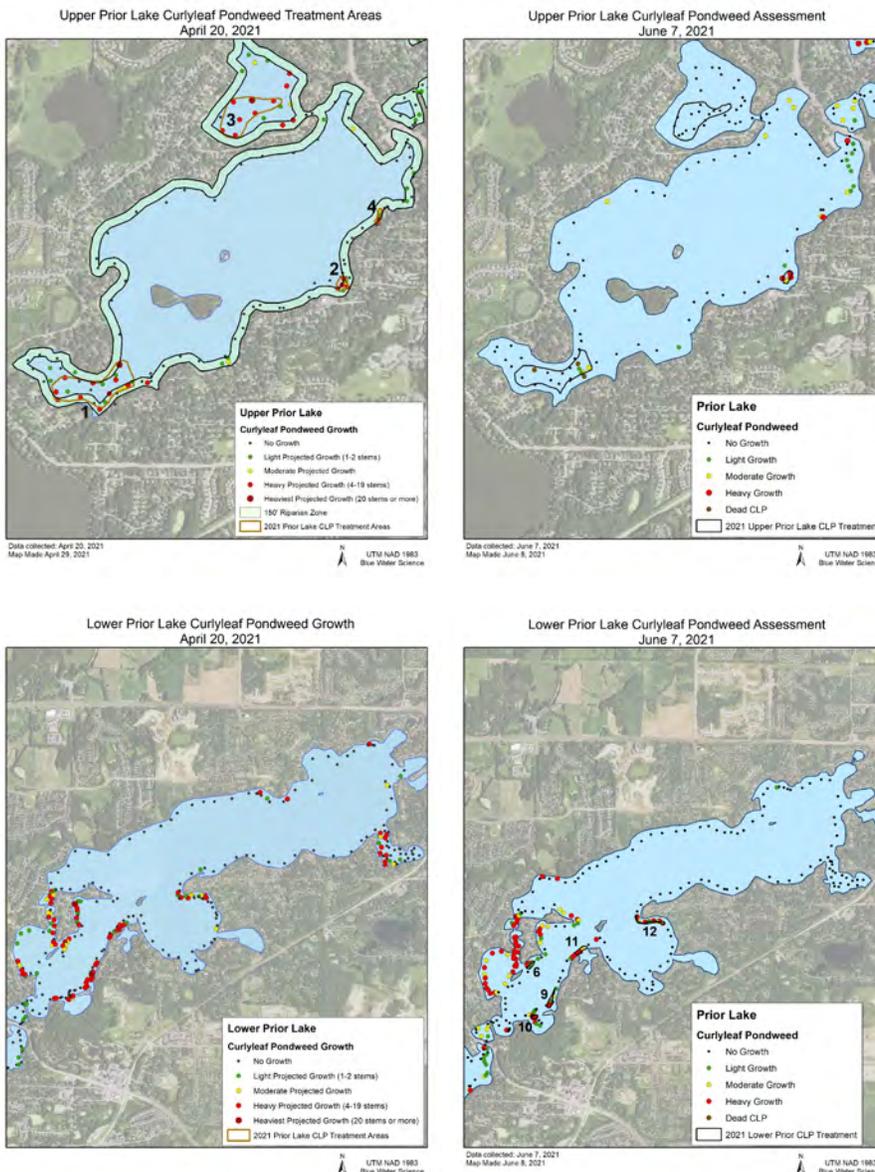
December 23, 2021

Curlyleaf Pondweed Delineation and Assessment Surveys for Upper and Lower Prior Lake and Summer Point Intercept Survey for Upper Prior Lake, Scott County, 2021

Summary

Early Season Curlyleaf Pondweed Delineation: Curlyleaf pondweed (CLP) distribution and abundance were delineated in Upper and Lower Prior Lakes on April 20, 2021. Based on the curlyleaf pondweed densities in both Upper and Lower Prior, several areas were delineated as having the potential for heavy curlyleaf growth by June (Figure S1).

Curlyleaf density was mostly light in April but there was the potential for heavy curlyleaf growth in some areas and 43.54 acres were delineated for a herbicide treatment.



The curlyleaf pondweed treatment was conducted on May 17, 2021 using diquat on a total of 24.15 acres in Upper and Lower Prior Lake.

Post Treatment Assessment: A follow-up curlyleaf assessment was conducted on June 7, 2021. The June 7 curlyleaf assessment found curlyleaf in the treatment areas was mostly well controlled. Outside of the treatment areas, there were a few spots where heavy curlyleaf pondweed growth was present, however most heavy growth was patchy.

Figure S1. [left-top] Curlyleaf pondweed delineation survey conducted in Upper Prior Lake on April 20, 2021. [right-top] Curlyleaf pondweed assessment survey in Upper Prior Lake on June 7, 2021. [left-bottom] Curlyleaf pondweed delineation survey conducted in Lower Prior Lake on April 20, 2021. [right-bottom] Curlyleaf pondweed assessment survey in Lower Prior Lake on June 7, 2021.

Curlyleaf Planning for 2021: Treating heavy growth of curlyleaf pondweed based on early season curlyleaf distribution is a challenge. Curlyleaf in April and 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 late May and 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 Upper and Lower Prior Lake, the method has been to use past CLP growth history (Figure S2) combined with early season scouting. Then if curlyleaf growth has indications of producing potential heavy growth, those areas are delineated and treatment is considered. That is the approach to be considered for 2022.

Prior Lakes Curlyleaf Pondweed Hotspot Map

CLP Treatment Areas 2014-2021

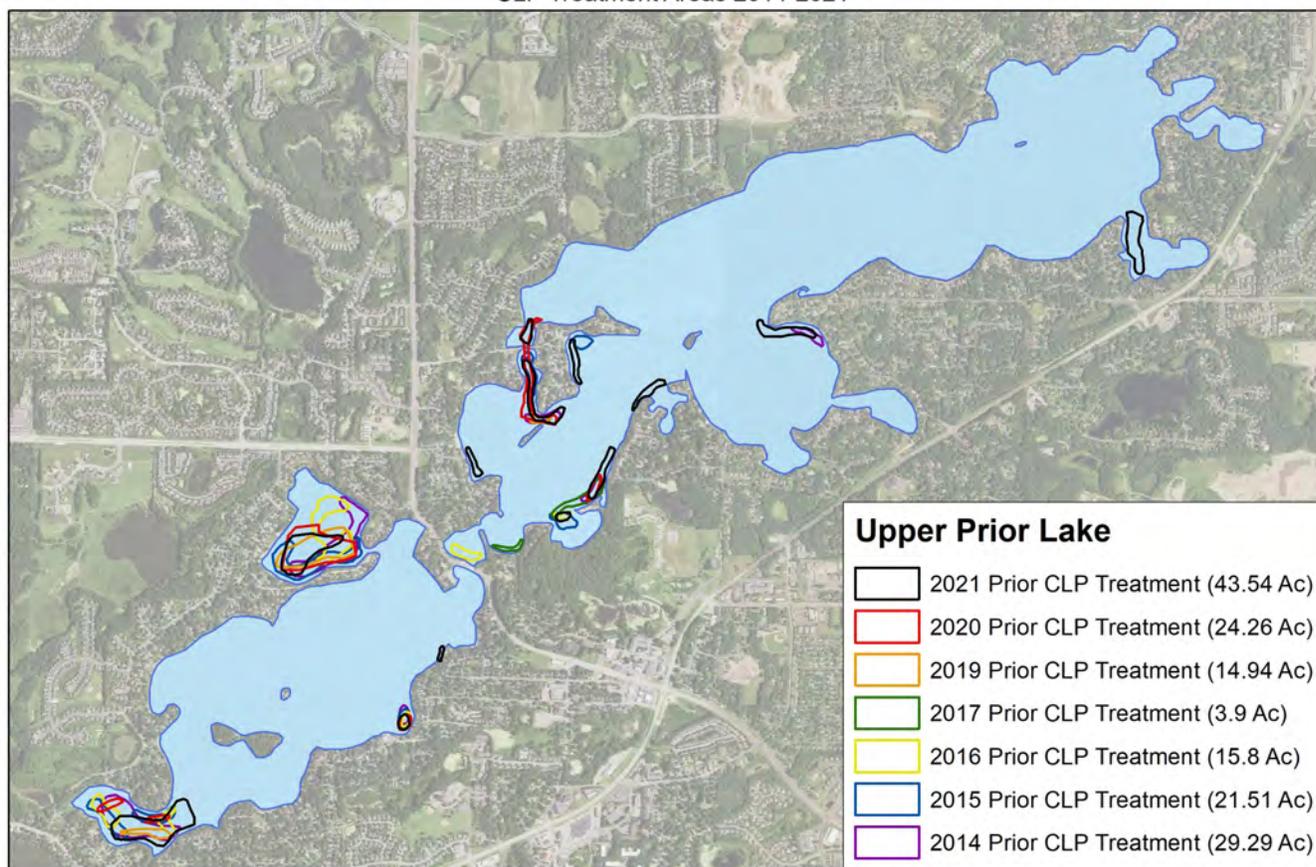


Table S1. Treatment summary from 2009-2021.

Year	Treatment
2009	No treatment
2010	No treatment
2011	No treatment
2012	No treatment
2013	23 acres
2014	29.3 acres
2015	21.5 acres
2016	15.8 acres
2017	2.55 acres
2018	No treatment
2019	14.9 acres
2020	24.3 acres
2021	24.15 acres

Figure S2. Prior Lake hot spot map for curlyleaf pondweed treatment areas from 2014-2021.

Point Intercept Survey: For Upper Prior Lake, a grid with points spaced 100 meters apart were sampled throughout the growing zone. A total of 163 sites were sampled, plants were observed growing to a depth of 8 feet. Results of the summer aquatic plant point intercept survey found 15 submerged aquatic plant species in Lower Prior and 6 species in Upper Prior including CLP. Native plants were found around the perimeter of the basin of Prior Lake (Figure S3).

Native aquatic plants were estimated to cover 27% of the lake bottom (358 acres). Coontail was the dominant aquatic plant. The 10 aquatic plant species found in this survey represents a fair to good diversity for Prior Lake in late summer.

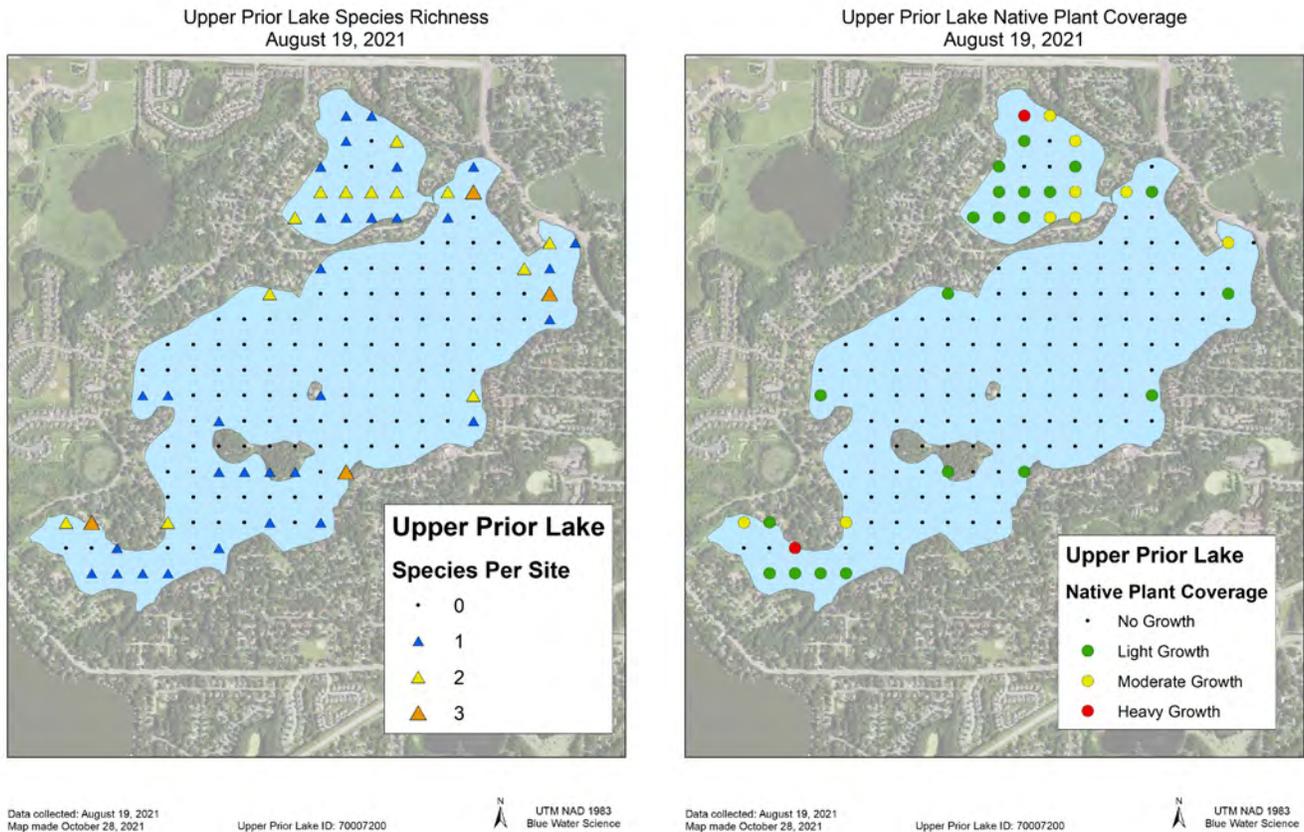


Figure S3. Point intercept survey results for species richness (left) and native plant coverage (right).

Summary of Aquatic Plant Point Intercept Surveys

Three point intercept surveys have been recently conducted in Lower Prior and 4 point intercept surveys have been conducted in Upper Prior Lake (Table S2).

In Upper Prior, the number of aquatic plant species and the coverage have increased since 2015 (Table S2).

Table S2. Prior Lake aquatic plant number of sites where a species was sampled for 2015, 2018, 2020, and 2021 point intercept surveys.

Lower Prior	Occurrence of Plants		
	2015	2018	2020
Duckweed (<i>Lemna sp</i>)		1	
Coontail (<i>Ceratophyllum demersum</i>)	62	129	63
Chara (<i>Chara sp</i>)	9		8
Elodea (<i>Elodea canadensis</i>)	5	2	1
Water stargrass (<i>Heteranthera dubia</i>)	3	22	7
Star duckweed (<i>Lemna trisulca</i>)		4	3
Northern watermilfoil (<i>Myriophyllum sibiricum</i>)	10	52	4
hybrid watermilfoil (<i>M. sp</i>)		2	
Eurasian watermilfoil (<i>M. spicatum</i>)	38	16	32
Naiads (<i>Najas flexilis</i>)		4	2
Nitella (<i>Nitella sp</i>)		2	1
Cabbage (<i>Potamogeton amplifolius</i>)	4	2	4
Curlyleaf pondweed (<i>P. crispus</i>)		10	7
Illinois Pondweed (<i>P. illinoensis</i>)	6	11	
Whitestem pondweed (<i>P. praelongus</i>)	7	4	
Claspingleaf (<i>P. Richardsonii</i>)	6	10	9
Stringy pondweed (<i>P. sp</i>)		1	3
Flatstem pondweed (<i>P. zosteriformis</i>)	10	26	32
Sago (<i>Stuckenia pectinata</i>)		1	1
Water celery (<i>Vallisneria americana</i>)	37	46	46
Number of submerged species	12	18	16
Estimated aquatic plant coverage (ac)	220 ac	375 ac	262 ac
Max depth of vegetation (ft)	15 ft	20 ft	19 ft
Percent coverage of plants (%)	23%	39%	27%

Upper Prior	Occurrence of Plants			
	2015	2018	2020	2021
Coontail (<i>Ceratophyllum demersum</i>)	5	29	33	25
Elodea (<i>Elodea canadensis</i>)	2	17	3	2
Bearded stonewort (<i>Lychnothamnus barbatus</i>)				1
Northern Watermilfoil (<i>Myriophyllum sibiricum</i>)			6	1
Eurasian watermilfoil (<i>M. spicatum</i>)	11	17	5	25
Naiads (<i>Najas flexilis</i>)		4		2
Curlyleaf pondweed (<i>Potamogeton crispus</i>)			3	3
Stringy pondweed (<i>P. filiformis</i>)				9
Stringy pondweed (<i>P. sp</i>)		2	2	
Sago pondweed (<i>Stuckenia pectinata</i>)	2	1		2
Number of submerged species	4	6	6	9
Estimated aquatic plant coverage (ac)	33 ac	74 ac	82 ac	116 ac
Max depth of vegetation (ft)	6 ft	8 ft	10 ft	11 ft
Percent coverage of plants (%)	9%	19%	21%	30%

Curlyleaf Pondweed Delineation and Assessment Surveys for Upper and Lower Prior Lake and Summer Point Intercept Survey for Upper Prior Lake, Scott County, 2021

Introduction

Upper and Lower Prior Lakes combined have an area of 1,343 acres with a total littoral area of 732 acres (MnDNR). An initial curlyleaf pondweed delineation was conducted on April 20, 2021 including both Upper and Lower Prior. Curlyleaf was then treated on May 17, 2021 and a follow-up curlyleaf pondweed assessment was conducted on June 7, 2021 to characterize the status of curlyleaf pondweed at its peak growing period. Sample sites were selected based on areas where curlyleaf had been found over the years.

A summer point intercept aquatic plant survey was conducted in August to evaluate the entire plant community in Upper Prior Lake (Figure 1).

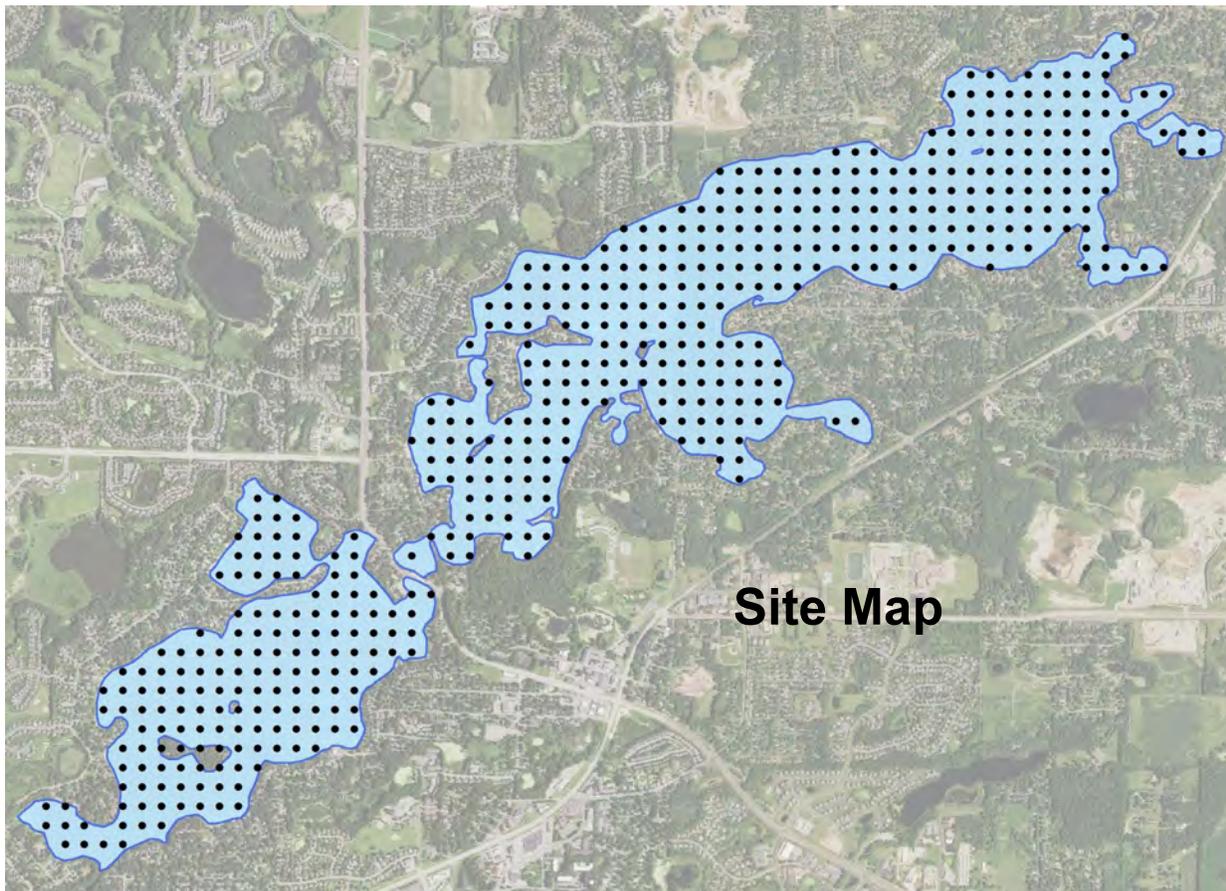


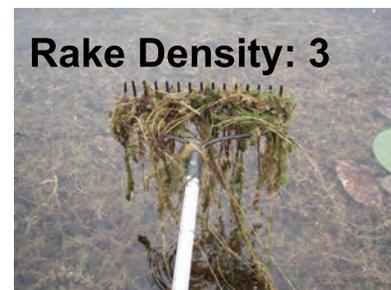
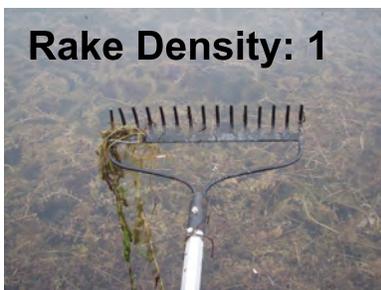
Figure 1. Point intercept 100 meter grid on Upper and Lower Prior Lake.

Methods

Curlyleaf Pondweed Delineation: 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 targeted for treatment. This delineation method was used for spot lake treatments in Gleason Lake and has worked for other lakes as well (McComas et al, 2015*).

Curlyleaf Pondweed Assessment: A CLP assessment was conducted by Blue Water Science on June 7, 2021. The assessment is a post-treatment evaluation, it involved surveying the entire lake nearshore area, observing CLP growth, and sampling aquatic plants with rakes. The plant species were recorded and the density of each species was assigned. Densities were based on the coverage on the teeth of the rake. Density ratings were from 1 to 3 with 1 being sparse and 3 being a nuisance. Plant density chart is shown on the next page (Figure 2). Based on these sample sites, plant distribution maps were constructed.

Survey Methods for the Point Intercept Survey An aquatic plant point intercept survey of Upper Prior Lake was conducted by Blue Water Science on August 19, 2021. Sample points were spaced 100 meters apart on a grid that covered the lake (Figure 1). At each sample point, a sampling rake was lowered into the water and a plant sample was taken. The plant species were recorded and the density of each species was assigned. Densities were based on the coverage on the teeth of the rake. Density ratings ranged from 1 to 3 with 1 being sparse and 3 being heavy growth. Based on these sample sites, a plant distribution map was constructed.



*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 20, 2021 and Assessment on June 7, 2021 in Upper and Lower Prior Lake

Results: A delineation survey on April 20, 2021, sampled a total of 413 sites around Upper and Lower Prior Lake with rake sampling. Curlyleaf was found at 166 out of 413 sample sites including 88 sites with curlyleaf growth projected to be abundant in June. A total of 43.54 acres in Upper and Lower Prior Lake areas were delineated as having the potential to develop moderate to heavy growth conditions by June (Figure 2). A total area of 24.15 acres of CLP in Prior Lake was permitted for treatment based on criteria where treatment was either 150 feet or more from shore or treatment was in front of public property. On June 7, 2021, a curlyleaf assessment was conducted. A total of 185 sites were sampled (Figure 2). Control was good in the treated areas. A few spots of moderate to heavy growth were observed in untreated areas (Figure 2). CLP conditions on June 7, 2021 are shown in Figure 2.

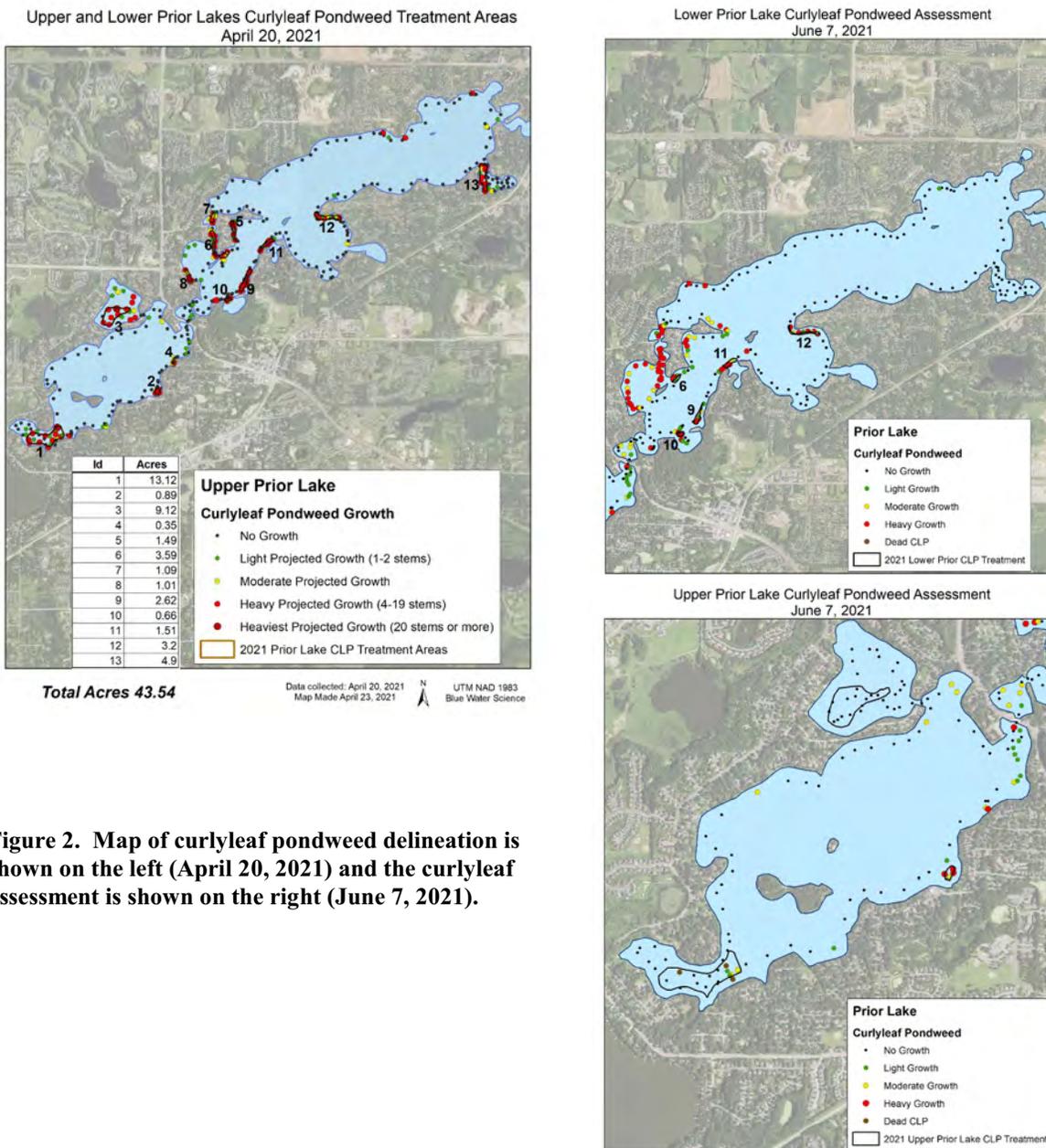
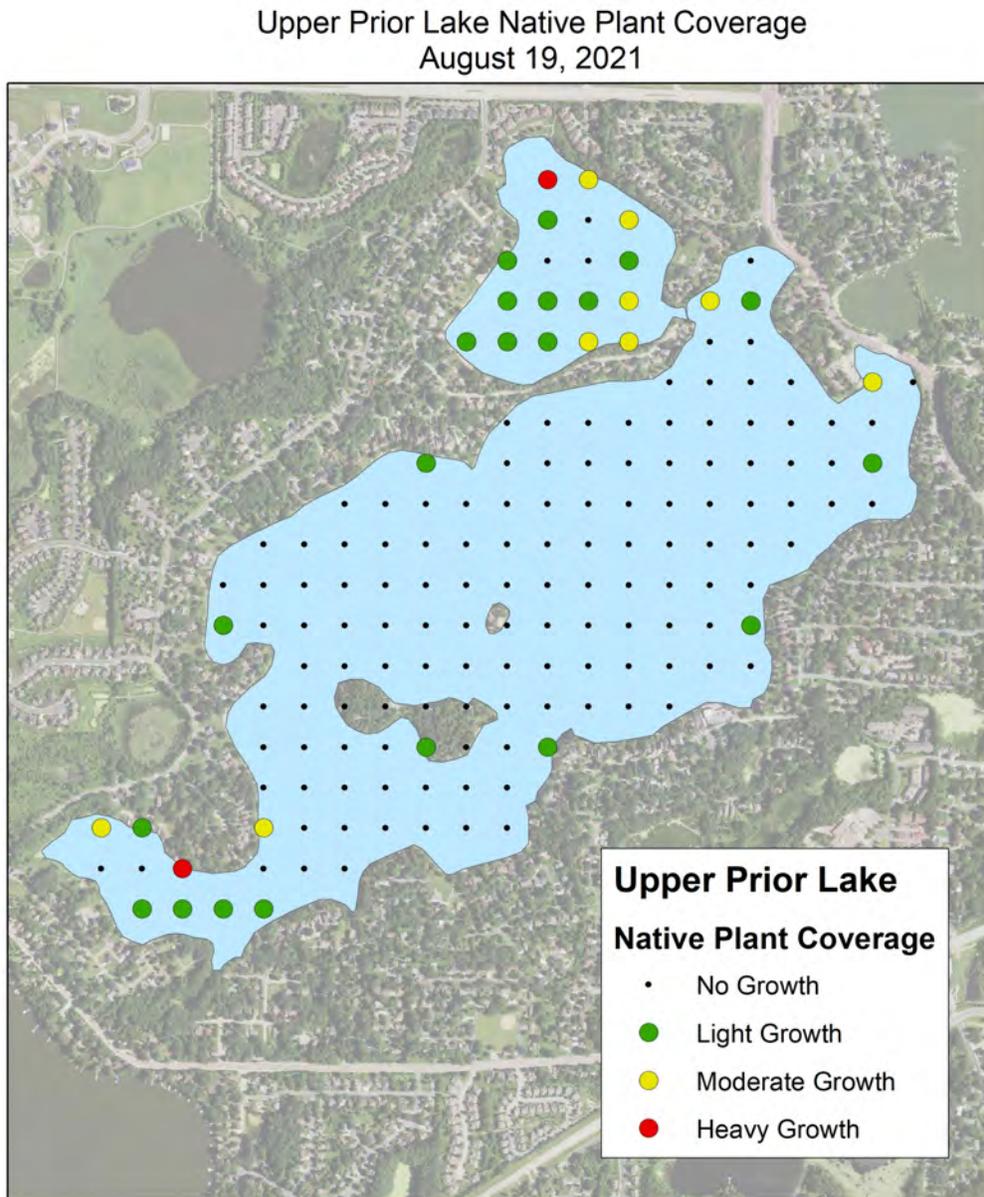


Figure 2. Map of curlyleaf pondweed delineation is shown on the left (April 20, 2021) and the curlyleaf assessment is shown on the right (June 7, 2021).

Point Intercept Aquatic Plant Survey for Upper Prior Lake

Results: A point intercept aquatic plant survey was conducted on Upper Prior Lake on August 19, 2021 (Figure 3). Aquatic plants grew to a water depth of 11 feet in Upper Prior. Aquatic plants covered approximately 116 acres in Upper Prior in 2021 compared to approximately 96 acres in 2020 and to approximately 69 acres in 2018.



Data collected: August 19, 2021
Map made October 28, 2021

Upper Prior Lake ID: 70007200

N
UTM NAD 1983
Blue Water Science

Figure 3. Native Plant Coverage in Prior lakes in late summer 2021.

Table 1. Upper Prior Lake aquatic plant data for August 19, 2021 point intercept survey.

	All Stations (n=77)(11 feet)		
	Occurrence	% Occur out to 11 ft	Average Density
Coontail (<i>Ceratophyllum demersum</i>)	25	32%	1.5
Elodea (<i>Elodea canadensis</i>)	2	3%	1.0
Bearded stonewort (<i>Lychnothamnus barbatus</i>)	1	1%	1.0
Northern watermilfoil (<i>Myriophyllum sibiricum</i>)	1	1%	1.0
Eurasian watermilfoil (<i>M. spicatum</i>)	25	32%	1.5
Naiads (<i>Najas flexilis</i>)	2	3%	1.0
Curlyleaf pondweed (<i>Potamogeton crispus</i>)	3	4%	1.0
Stringy pondweed (<i>P. filiformis</i>)	9	12%	1.1
Sago (<i>Stuckenia pectinata</i>)	2	3%	1.0

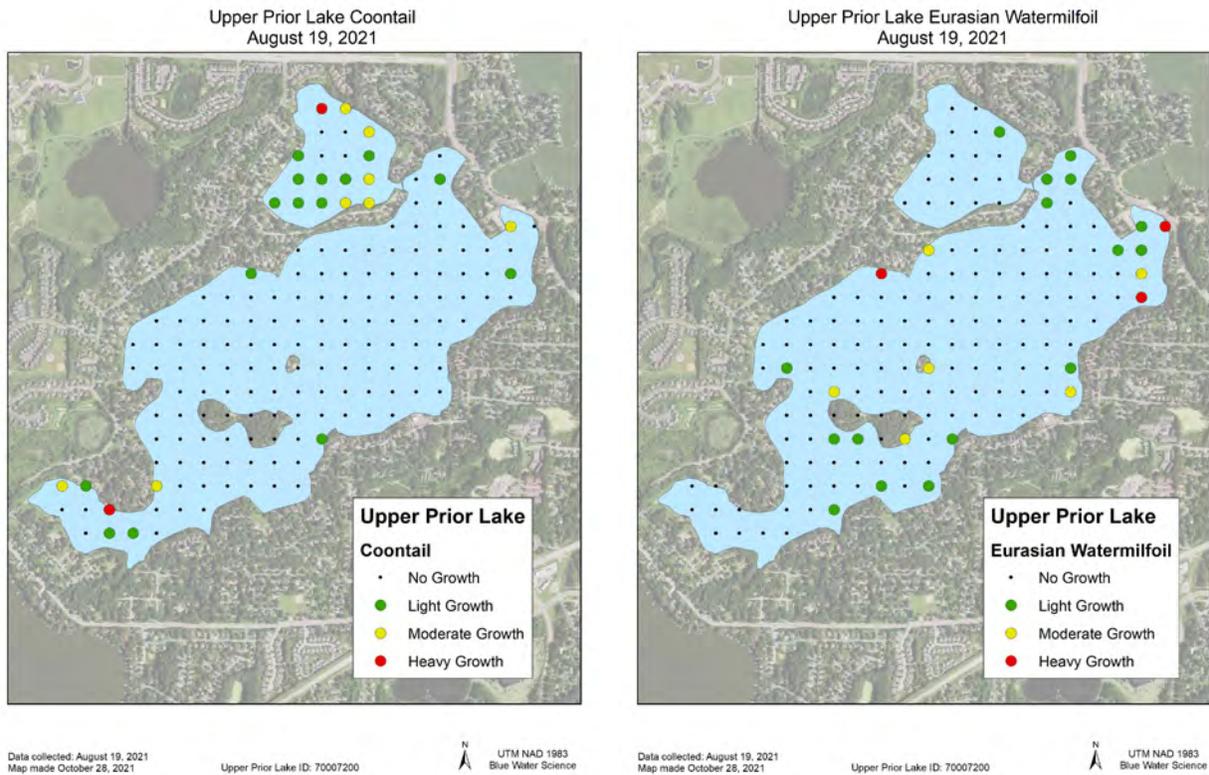


Figure 4. Map of coontail coverage and density is shown on the left (August 19, 2021) and EWM coverage and density is shown on the right (August 19, 2021).

Upper Prior Lake Point Intercept Survey Statistics: A summary of plant statistics from the point intercept survey is shown in Tables 2 and 3 and Figure 5. A total of 102 points were sampled and plants were found out to 11 feet of water which included 77 sample points out to 11 feet. Plant occurrence and abundance for individual sites are shown in the Appendix.

Table 2. MnDNR Template Statistics

Total # Points Sampled	102
Depth Range of Rooted Veg	1-11 feet
Maximum Depth of Growth (95%) in feet	11.0
# Points in Max Depth Range	77
# Points in Littoral Zone (0-11 feet)	99
% Points w/ Submersed Native Taxa	32
Mean Submersed Native Taxa/Point	0.4
Mean Density of Submersed Native Taxa	1.1
# Submersed Native Taxa	7

Table 3. Aquatic plants sampled by depth.

Depth Bin (Feet)	# points sampled (0-11 ft)	% Sampling points with submersed species observed
0	0	0
1	2	100%
2	1	100%
3	1	100%
4	17	82%
5	8	100%
6	5	80%
7	5	60%
8	5	40%
9	6	83%
10	12	42%
11	15	27%
	77	

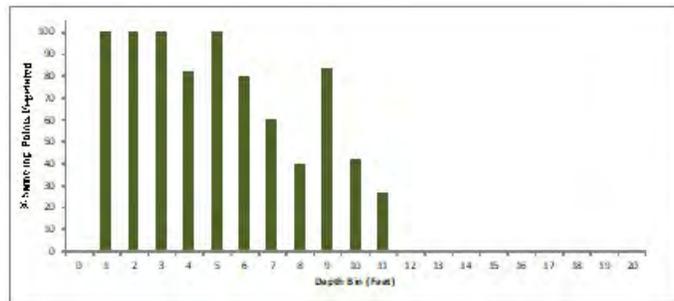


Figure 5. Depth of plant colonization (in feet).

Point Intercept aquatic plant survey comparisons for 2015, 2018, 2020, and 2021

Table 4. Prior Lake aquatic plant number of sites where a species was sampled for 2015, 2018, 2020, and 2021 point intercept surveys.

Lower Prior	Occurrence of Plants			Upper Prior	Occurrence of Plants			
	2015	2018	2020		2015	2018	2020	2021
Duckweed (<i>Lemna sp</i>)		1		Coontail (<i>Ceratophyllum demersum</i>)	5	29	33	25
Coontail (<i>Ceratophyllum demersum</i>)	62	129	63	Elodea (<i>Elodea canadensis</i>)	2	17	3	2
Chara (<i>Chara sp</i>)	9		8	Bearded stonewort (<i>Lychnothamnus barbatus</i>)				1
Elodea (<i>Elodea canadensis</i>)	5	2	1	Northern Watermilfoil (<i>Myriophyllum sibiricum</i>)			6	1
Water stargrass (<i>Heteranthera dubia</i>)	3	22	7	Eurasian watermilfoil (<i>M. spicatum</i>)	11	17	5	25
Star duckweed (<i>Lemna trisulca</i>)		4	3	Naiads (<i>Najas flexilis</i>)		4		2
Northern watermilfoil (<i>Myriophyllum sibiricum</i>)	10	52	4	Curlyleaf pondweed (<i>Potamogeton crispus</i>)			3	3
hybrid watermilfoil (<i>M. sp</i>)		2		Stringy pondweed (<i>P. filiformis</i>)				9
Eurasian watermilfoil (<i>M. spicatum</i>)	38	16	32	Stringy pondweed (<i>P. sp</i>)		2	2	
Naiads (<i>Najas flexilis</i>)		4	2	Sago pondweed (<i>Stuckenia pectinata</i>)	2	1		2
Nitella (<i>Nitella sp</i>)		2	1	Number of submerged species	4	6	6	9
Cabbage (<i>Potamogeton amplifolius</i>)	4	2	4	Estimated aquatic plant coverage (ac)	33 ac	74 ac	82 ac	116 ac
Curlyleaf pondweed (<i>P. crispus</i>)		10	7	Max depth of vegetation (ft)	6 ft	8 ft	10 ft	11 ft
Illinois Pondweed (<i>P. illinoensis</i>)	6	11		Percent coverage of plants (%)	9%	19%	21%	30%
Whitestem pondweed (<i>P. praelongus</i>)	7	4						
Claspingleaf (<i>P. Richardsonii</i>)	6	10	9					
Stringy pondweed (<i>P. sp</i>)		1	3					
Flatstem pondweed (<i>P. zosteriformis</i>)	10	26	32					
Sago (<i>Stuckenia pectinata</i>)		1	1					
Water celery (<i>Vallisneria americana</i>)	37	46	46					
Number of submerged species	12	18	16					
Estimated aquatic plant coverage (ac)	220 ac	375 ac	262 ac					
Max depth of vegetation (ft)	15 ft	20 ft	19 ft					
Percent coverage of plants (%)	23%	39%	27%					

Aquatic Plant Distribution and Abundance for 2015, 2018, 2020, and 2021

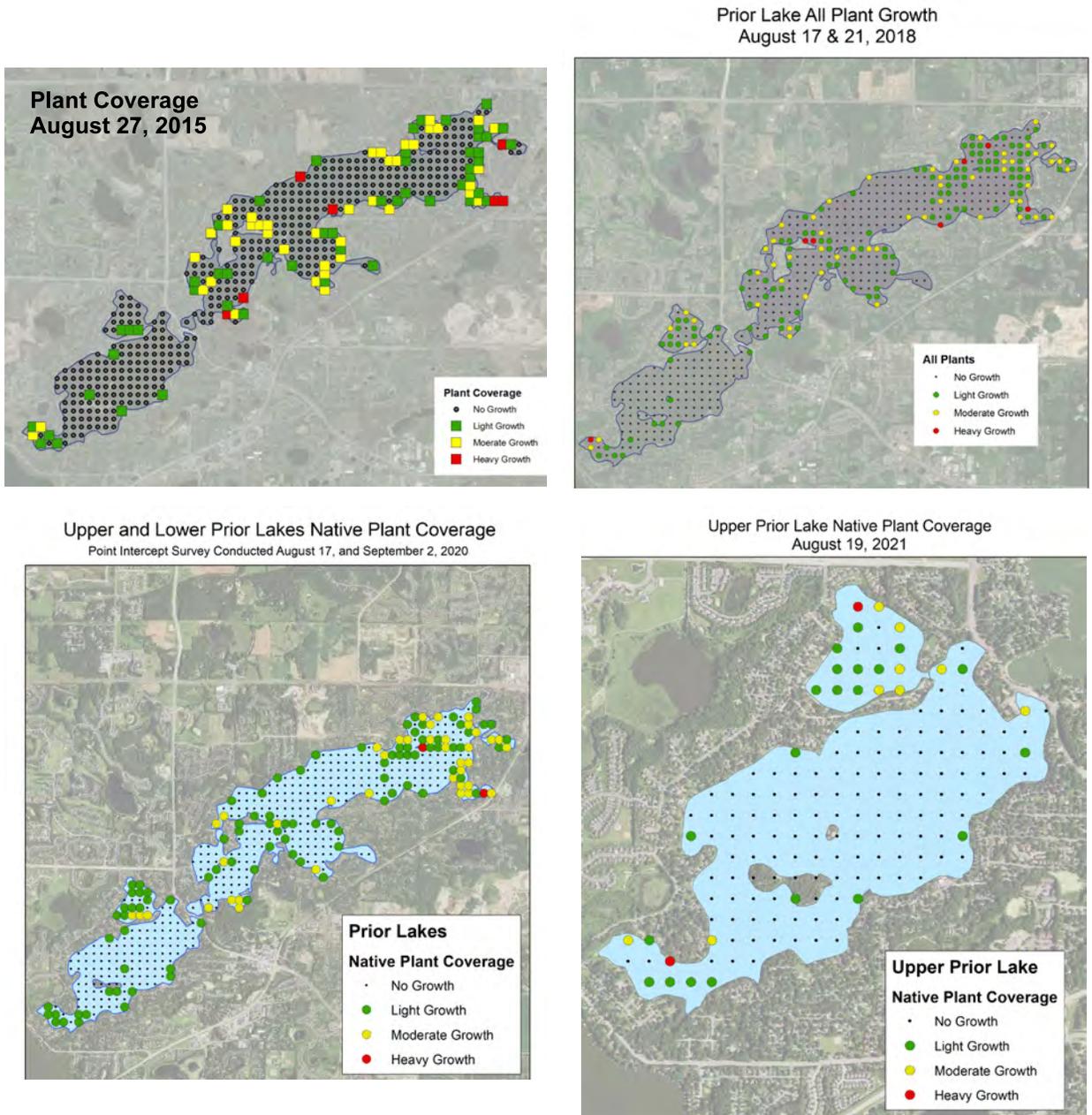


Figure 6. Maps of plant coverage for 2015, 2018, 2020, and 2021.

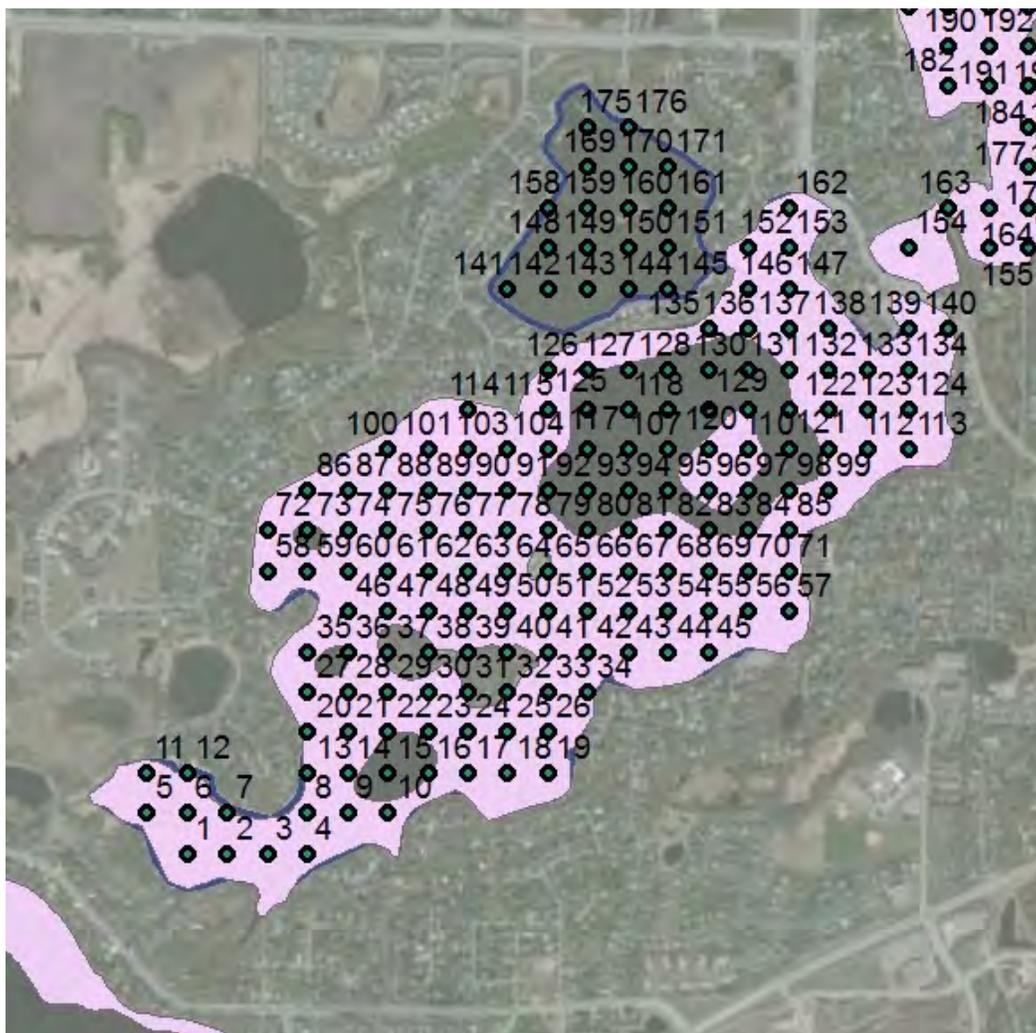
APPENDIX

Upper Prior Lake aquatic plant occurrence for the point intercept survey conducted on August 19, 2021.

Site	Depth (ft)	Coontail	CLP	Elodea	EWM	Filiformis	Naiads	NWM	Sago	Bearded stonewort	Benthic algae	No plants	ZM on plants
1	5							1					
2	5	1									1		
3	4	1									1		
4	6						1						
5	4										1	1	
6	6										1	1	
7	4	3									1		
8	7											1	
9	10											1	
10	9				1								
11	3	2								1			
12	2	1					1		1				
13	5	2	1								1		
14	31											1	
16	14											1	
17	10				1								
18	10											1	
19	9				1								
20	7											1	
24	11											1	
25	12											1	
26	10											1	
27	11											1	
29	11				1								
30	10				1								
31	1								1				
32	1				2								
33	10											1	
34	5	1			1	1							
35	12											1	
41	9										1	1	
42	13											1	
43	14											1	
44	13											1	
45	10											1	
46	13											1	
47	10				2								
48	10											1	
49	11											1	
50	12											1	
51	13											1	
55	16											1	
56	14											1	
57	8				2								
58	9					1							1
59	11				1								
60	11											1	
62	11											1	
63	10											1	
64	8											1	
65	7				2								
70	15											1	
71	9				1	1							
72	8											1	
75	11											1	
76	11											1	
77	13											1	
78	14											1	
79	16											1	
85	14											1	
86	8											1	
87	13											1	
88	13											1	
89	11											1	
99	15											1	
100	11											1	
101	12											1	
102	12											1	
103	11											1	
112	14											1	
113	9				3								
114	6	1			3								
123	14											1	
124	10	1	1		2								
125	6				2								
133	6		1		1								
134	11				1								
138	13											1	
139	11	2			1								

Upper Prior Lake aquatic plant occurrence for the point intercept survey conducted on August 19, 2021.

Site	Depth (ft)	Coontail	CLP	Elodea	EWM	Filiformis	Naiads	NWM	Sago	Bearded stonewort	Benthic algae	No plants	ZM on plants
140	5				3								
141	4	1				1							
142	4	1											
143	4	1											
144	4	2											
145	4	2											
146	10				1								
147	11											1	
148	4	1				1							
149	5	1				1							
150	4	1		1									
151	5	2		1									
152	7				1	2							
153	8	1			1	1							
158	5	1											
159	4											1	
161	4	1											
162	7				1								
169	4					1							
170	4											1	
171	4	2			1								
175	4	3											
176	4	2											
Average		1.5	1.0	1.0	1.5	1.1	1.0	1.0	1.0	1.0	1.0		
Occurrence of plants out to 11 feet (77 sites)		25	3	2	25	9	2	1	2	1	7	53	1
% occurrence		32	4	3	32	12	3	1	3	1	9		



Point intercept sites for Upper Prior Lake, August 19, 2021

Common Aquatic Plants in Prior Lake

Chara (*Chara sp*)



Claspingleaf pondweed (*Potamogeton richardsonii*)



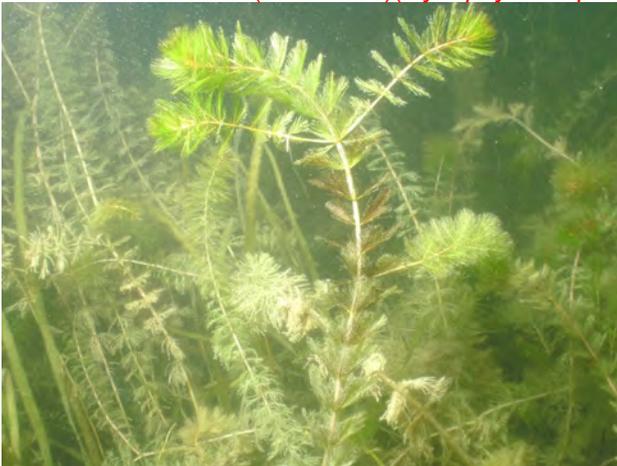
Coontail (*Ceratophyllum demersum*)



Curlyleaf Pondweed (non-native)(*Potamogeton crispus*)



Eurasian watermilfoil (non-native)(*Myriophyllum spicatum*)



Flatstem pondweed (*Potamogeton zosteriformis*)



Naiad (*Najas* sp)



Northern watermilfoil (*Myriophyllum sibiricum*)



Sago pondweed (*Stuckenia pectinata*)



Stringy pondweed (*Potamogeton pusillus*)



Water celery (*Vallisneria americana*)



Water stargrass (*Heteranthera dubia*)

