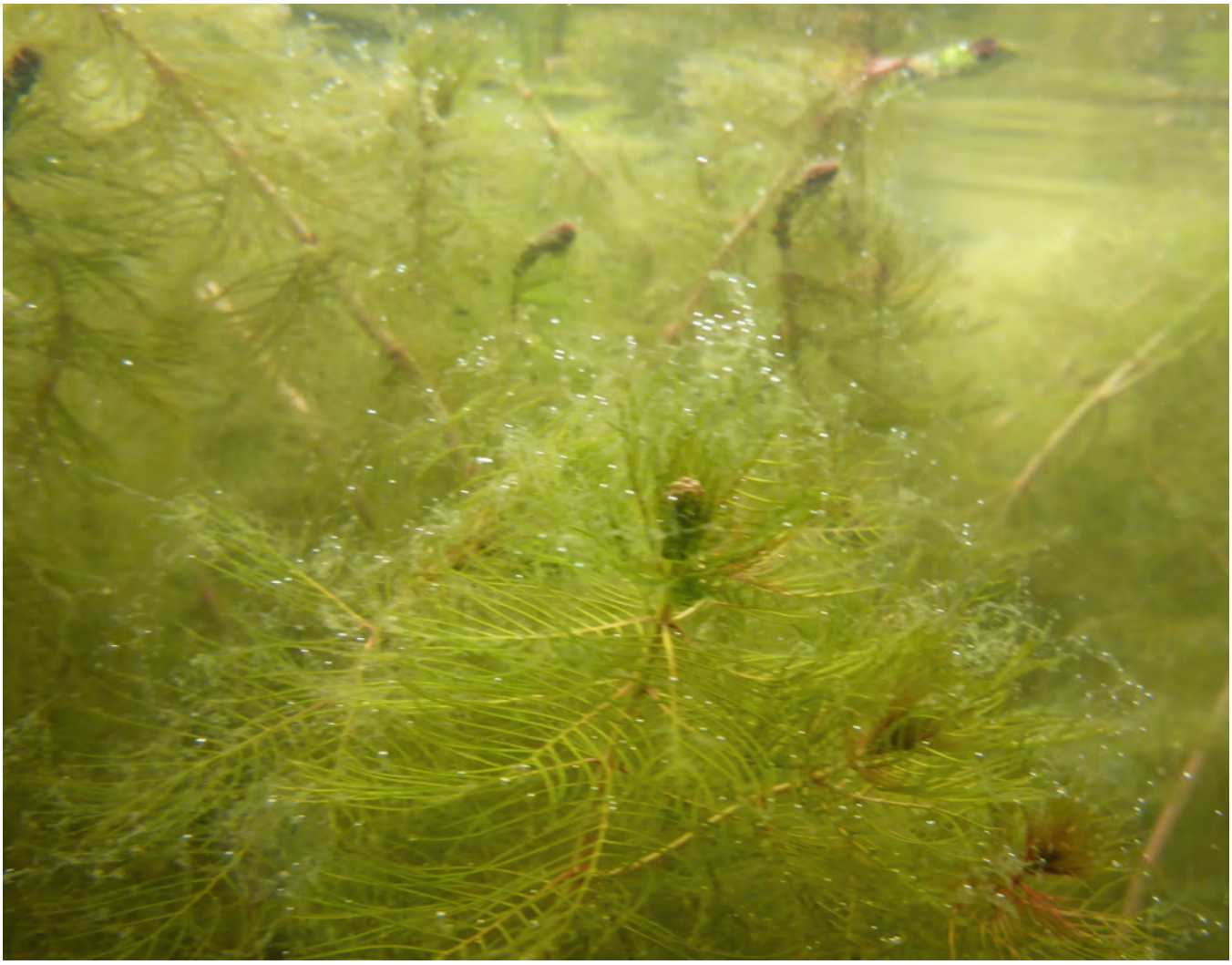


Underwater View of Eurasian Watermilfoil in Schmidt Lake on May 23, 2017

Aquatic Plant Point-Intercept Survey for Schmidt Lake, Plymouth, Minnesota, 2017

Aquatic Plant Point-Intercept Survey: May 23, 2017
Eurasian Watermilfoil Delineation: May 23, 2017

Prepared for:
Schmidt Lake Association
Plymouth, Minnesota

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

June 2017

Aquatic Plant Point-Intercept Survey for Schmidt Lake, Plymouth, Minnesota, 2017

Summary

Summary of Aquatic Plant Surveys from 2004 to 2008 and 2017: Summer plant diversity has been fair in Schmidt Lake from 2004 through 2008 and in 2017. The native plant community, has been dominated by coontail and elodea. In 2004, 2006, 2007, and 2017, curlyleaf distribution was widespread but not a nuisance. Eurasian watermilfoil was first reported in 1990 (based on MnDNR records). On May 23, 2017, the hybrid milfoil was abundant and wide spread in 45 acre Schmidt Lake (Table S1).

Table S1. Comparison of Schmidt Lake aquatic plant occurrences and densities for the plant surv eys from 2004 through 2017. Percent occurrence is the top number and densities are the bottom numbers show n in parenthesis. Density ratings are 1 - 5 with 1 being low and 5 being most dense.

	2004	2005	2006	2007	2008	2017	2004	2005	2006	2007	2008
	Jun 2	Jun 14	May 19	May 16	Jun 9	May 23	Sept 13	Sept 6	Aug 9	July 16	Aug 14
Duckweed (*Lemna sp*)	0	0	0	0	0	1 (1.0)	0	0	0	0	0
Spatterdock (*Nuphar variegatum*)	0	0	0	0	0	0	3 (0.5)	0	0	0	0
White waterlily (*Nymphaea sp*)	18 (1.2)	24 (1.2)	10 (1.5)	12 (0.8)	17 (1.7)	16 (1.9	23 (1.9)	17 (2.1)	21 (1.9)	21 (1.8)	10 (1.8)
Buttercup[(*Ranunculus sp*)	0	0	0	0	0	4 (1.0)	0	0	0	0	0
Coontail (*Ceratophyllum demersum*)	74 (1.3)	74 (1.7)	82 (2.2)	76 (1.9)	98 (3.0)	54 (1.6)	82 (1.7)	95 (1.7)	93 (2.0)	98 (2.5)	98 (3.0)
Chara (*Chara sp*)	5 (0.5)	8 (2.3)	18 (2.1)	12 (1.7)	2 (3.0)	1 (1.0)	10 (1.3)	15 (1.6)	5 (0.8)	7 (2.0)	5 (1.8)
Needle spikerush (*Eleocharis palustris*)	0	0	0	0	0	0	3 (0.5)	0	0	0	0
Elodea (*Elodea canadensis*)	64 (1.0)	53 (1.3)	28 (1.2)	0	10 (0.9)	75 (2.0)	36 (1.3)	37 (1.0)	17 (1.1)	19 (1.2)	10 (0.8)
Star duckweed (*Lemna trisulca*)	0	0	0	0	0	0	0	2 (2.0)	0	0	0
Northern watermilfoil (*Myriophyllum sibiricum*)	5 (0.5)	5 (0.8)	3 (1.0)	0	0	18 (1.1)	0	0	0	0	0
Hybrid milfoil (*M. sp*)	13 (1.1)	0	0	0	0	78 (2.7)	0	0	0	0	0
Eurasian watermilfoil (*M. spicatum*)	8 (0.8)	68 (2.5)	56 (1.7)	63 (2.3)	80 (3.2)	0	54 (1.0)	20 (1.0)	17 (1.5)	5 (0.5)	0
Naiads (*Najas flexilis*)	0	0	0	0	0	0	3 (0.5)	0	5 (1.0)	0	0
Nitella (*Nitella sp*)	13 (1.1)	0	0	0	0	9 (1.2)	0	0	0	0	0
Curlyleaf pondweed (*Potamogeton crispus*)	77 (1.8)	11 (0.4)	67 (1.7)	63 (1.4)	17 (1.5)	40 (1.4)	0	0	0	0	0
Stringy pondweed (*P. pusillus*)	3 (1.0)	0	0	0	0	1 (1.0)	8 (1.2)	0	0	0	0
Flatstem pondweed (*P. zosteriformis*)	41 (1.1)	18 (0.7)	0	2 (0.5)	0	9 (1.2)	74 (1.5)	0	0	0	2 (0.5)
Sago pondweed (*Stuckenia pectinata*)	0	0	0	0	0	0	3 (1.0)	0	2 (0.5)	2 (0.5)	0
Water celery (*Vallisneria americana*)	21 (0.6)	16 (0.9)	0	0	5 (1.0)	0	51 (2.6)	56 (2.4)	50 (2.6)	40 (1.9)	40 (2.4)
Water stargrass (*Zosterella dubia*)	0	3 (1.0)	0	0	0	1 (1.0)	3 (0.5)	0	0	0	0
Filamentous algae	21 (0.7)	16 (2.0)	0	46 (2.2)	5 (1.5)	13 (2.1)	3 (1.0)	2 (2.0)	2 (2.0)	2 (2.5)	0
Acres Covered by Plants (acres)	24	24	31	32	32	32	24	24	24	32	33
Percent Area Covered (%)	66	66	85	86	86	86	66	66	60	86	89
NUMBER OF SUBMERGED AQUATIC PLANTS	11	9	6	5	6	11	11	6	6	6	5

Aquatic Plant Point-Intercept Survey for Schmidt Lake, Plymouth, Minnesota, 2017

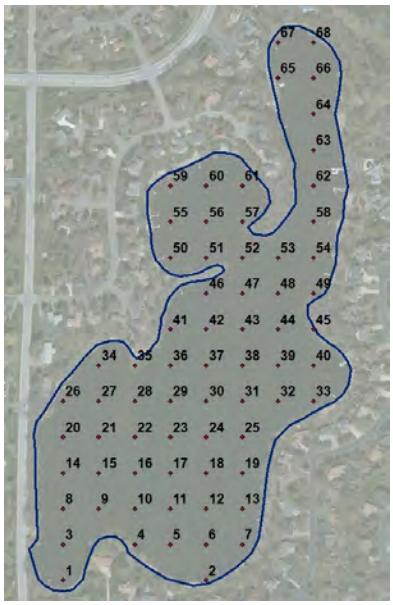
Introduction

Aquatic plants play a vital role in the water quality dynamics of moderately fertile lakes in the North Central Hardwood Forest Ecoregion like Schmidt Lake. Managing aquatic plants is a challenge that is multifold. The first challenge is to maintain a diverse native aquatic plant community. In the case of Schmidt Lake where native aquatic plants are present, a major emphasis will be on maintaining diversity of the native aquatic plant community. Another challenge is to maintain adequate active recreational opportunities which means managing excessive aquatic plant growth so it doesn't significantly hinder navigation. Lastly, the challenge is to manage non-native plants so they have a low impact on adversely effecting water quality or recreational lake use.

An aquatic plant point-intercept survey was conducted on Schmidt Lake on May 23, 2017. The objectives of the survey was to evaluate the distribution of curlyleaf pondweed and Eurasian watermilfoil as well as other native plant species in Schmidt Lake.

Methods

An aquatic plant survey of Schmidt Lake using a point intercept sampling method was conducted by Blue Water Science on May 23, 2017. A map and sampling grid were prepared by Blue Water Science and a consisted of a total of 68 points that were distributed throughout the 45 acre lake (34 acre littoral zone)(Figure 2). Points were spaced 50 meters apart and each point represented an average of 0.67 acres of lake surface area.



For the survey, all 68 sites were sampled. 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 4. A density of a "1" indicated sparse growth with one or two stems present on the rake sampler. A 4 rating indicated heavy growth or surface matting plant growth. Visual observations of surface growth were mapped in the field using a hand held GPS to verify locations.

Growth characteristics of Eurasian watermilfoil or the hybrid milfoil are defined on the next page.

Figure 1. Point locations for the aquatic plant surveys. Lake map with UTM coordinates using the WGS84 datum.

Eurasian Watermilfoil Growth Characteristics

(source: Steve McComas, Blue Water Science)

Light Growth Conditions

Plants rarely reach the surface.

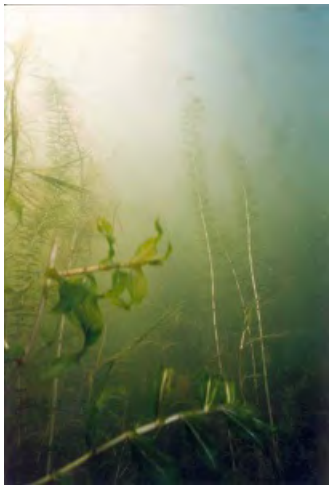
Plants are in scattered patches*.

Navigation and recreational activities generally are not hindered.

Stem density: 1 - 90 stems/m^2
Biomass: 0 - 70 g-dry wt/m^2

MnDNR rake sample density equivalent for light growth conditions: 1 or 2.

**patch = EWM stems arising from a single root crown. Generally 5 to 10+ stems sprout from a root crown.*



Moderate Growth Conditions

Broken surface canopy conditions. However, stems are usually unbranched.

Plants are in beds* with some patches.

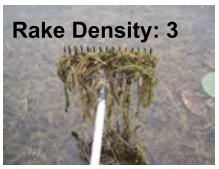
Navigation and recreational activities may be hindered.

Lake users may opt for control.

Stem density: 90 - 180 stems/m^2
Biomass: 70 - 200 g-dry wt/m^2

MnDNR rake sample density equivalent for moderate growth conditions: 3.

**beds = EWM patches close together forming an area of dominant EWM growth.*



Heavy Growth Conditions

Solid or near solid surface canopy conditions. Stems typically are branched near the surface.

Plants grow in continuous beds.

Navigation and recreational activities are limited.

Control is necessary for navigation and/or recreation.

Stem density: 180+ stems/m^2
Biomass: >200 g-dry wt/m^2

MnDNR rake sample density equivalent for heavy growth conditions: 4.

Results

Results of the summer aquatic plant survey conducted on May 23, 2017 found a total of 11 submerged plants and that hybrid watermilfoil was the dominant plant in the lake (Tables 1 and 2).

Results from the point-intercept plant survey found that plants grew out to depth of 10 feet (Table 2). Hybrid watermilfoil was found at 53 sites and covered approximately 32 acres. A map of hybrid milfoil distribution and abundance are shown in Figure 2.

Individual point intercept data for Schmidt Lake plants are listed in Table 2. Other aquatic plant maps are shown in Figure 3.

Table 1. Comparison of Schmidt Lake aquatic plant occurrences and densities for the plant surv eys from 2004 through 2017. Percent occurrence is the top number and densities are the bottom numbers show n in parenthesis. Density ratings are 1 - 5 with 1 being low and 5 being most dense.

	May 23, 2017		
	Occurrence	% Occurrence	Density
Duckweed (*Lemna sp*)	1	1	1.0
White waterlily (*Nymphaea sp*)	11	16	1.9
Buttercup[(*Ranunculus sp*)	3	4	1.0
Chara (*Chara sp*)	1	1	1.0
Coontail (*Ceratophyllum demersum*)	37	54	1.96
Elodea (*Elodea canadensis*)	51	75	2.0
Northern watermilfoil (*Myriophyllum sibiricum*)	12	18	1.1
Hybrid milfoil (*M. sp*)	53	78	2.7
Nitella (*Nitella sp*)	6	9	1.2
Curlyleaf pondweed (*Potamogeton crispus*)	27	40	1.4
Stringy pondweed (*P. pusillus*)	1	1	1.0
Flatstem pondweed (*P. zosteriformis*)	6	9	1.2
Water stargrass (*Zosterella dubia*)	1	1	1.0
Filamentous algae	9	13	2.1
Acres Covered by Plants (acres)	32		
Percent Area Covered (%)	86		
NUMBER OF SUBMERGED AQUATIC PLANTS	11		

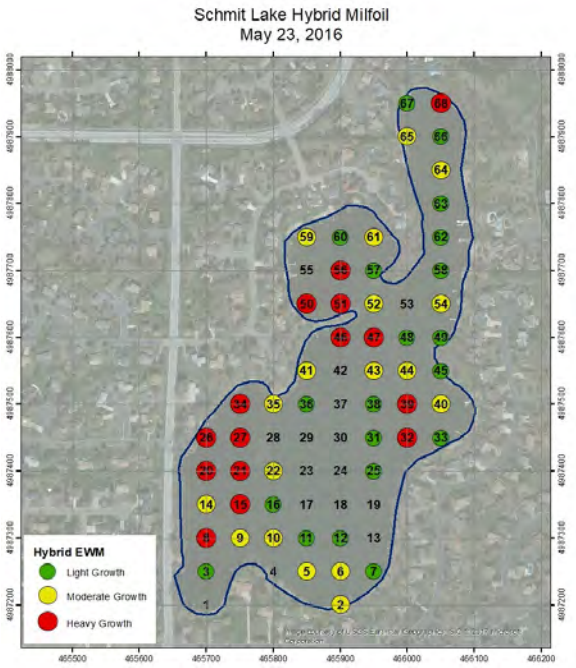


Figure 2. Sample site location map showing the distribution and abundance of hybrid Eurasian watermilfoil.

Aquatic Plant Maps for May 23, 2017

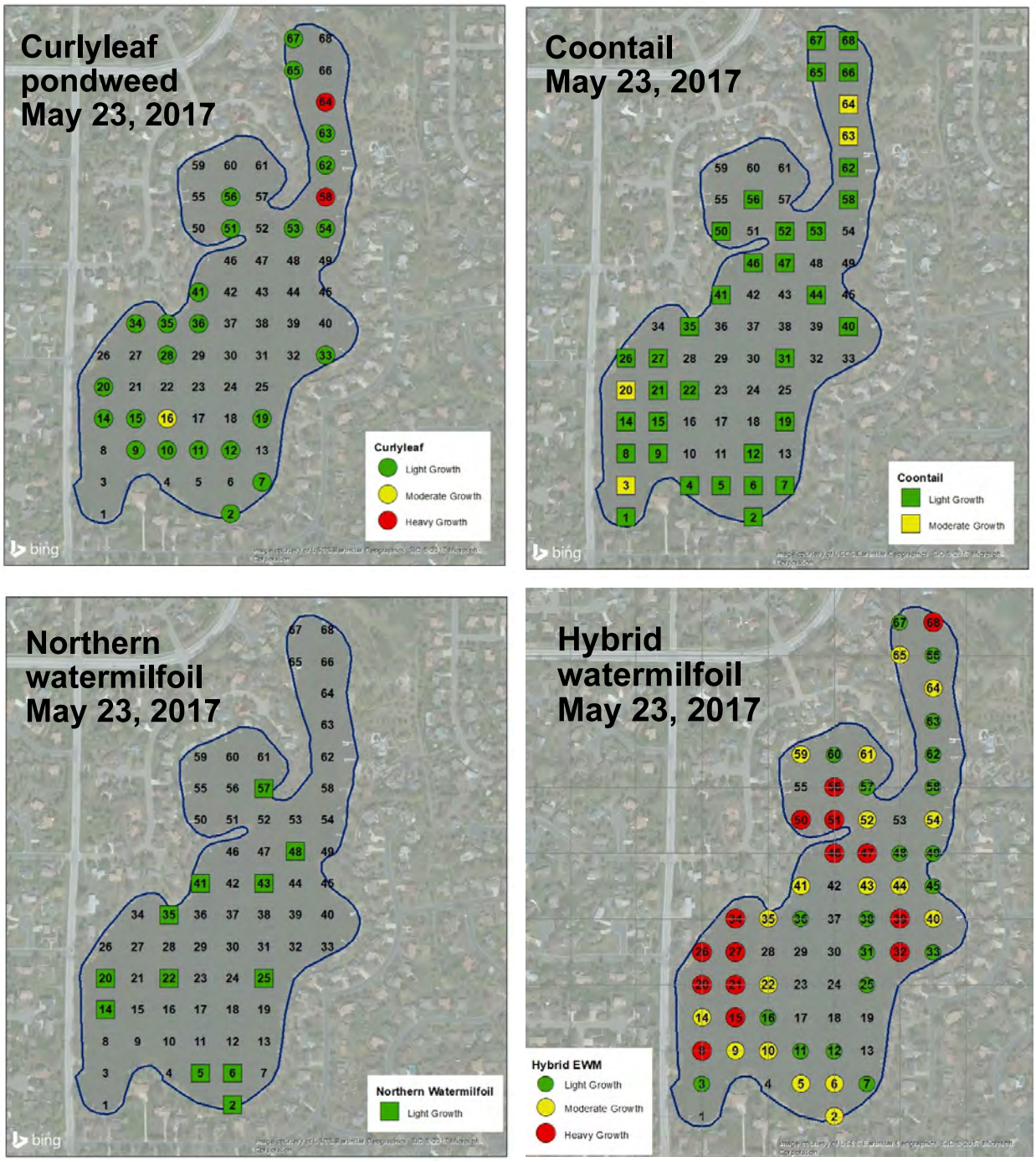


Figure 3. Distribution and abundance of 4 aquatic plant species sampled in Schmidt Lake on May 23, 2017. [top-left] Curlyleaf pondweed (non-native). [top-right] Coontail (native). [bottom-left] Northern watermilfoil (native). [bottom-right] Hybrid watermilfoil (non-native).

Table 2. Individual sample site data for May 23, 2017.

Site	Depth (ft)	White lily	Duck-weed	Butter-cup	Chara	Coontail	Curlyleaf	Elodea	Flatstem	Hybrid EWM	Nitella	NWM	Stringy	Water star-grass	FA	Treat
1	4	1				1		3							2	
2	4					2	2	1		3		1				?
3	5					3		1		1					3	
4	4	1				1		1					1			
5	7					1		2		3		1				
6	8					2				3		1				?
7	6					2	1	2		1						
8	6					2				4					2	T
9	7					2	1	2		3						T
10	9						1	1		3						
11	10						2	2		1						
12	10					2	1	2		2						
13																
14	6					1	1	1		3		1				T
15	7					1	1	1		4						T
16	10						3	2		2	1					T
17	23															
18	15															
19	7					1	1	3	1		1					
20	5					3	1			4		1			1	T
21	6			1		2		1		4					2	T
22	8					1		2	1	3		1				
23	19															
24	26															
25	9							1		2		2				
26	4					2		1		4				1		T
27	6					1		2		4						T
28	6						2	2	2							
29	18															
30	27															
31	9					1		2		1						
32	6							2		4						?
33	5						1	2		1						
34	4						2	3		4						T
35	5					1	1	1		3		1				T
36	9						1	2		2						
37	27															
38	10									1						
39	7							1		4						T
40	5					1		3		3						?
41	6					1	1	1		3		1				
42	17															
43	9							1		3		1				?
44	7					1		3		3	1					T
45	4							2		1	1					
46	7					1				4						?
47	7					1		2		4						T
48	6							3		2		1				
49	3				1			2		1						
50	4					1		3		4						T
51	4			1			1	2		4						T
52	5					2		2		3						
53	5					1	1	3	1							
54	5						1	2	1	3						
55	4							3								
56	6					1	1	3		4	2					?
57	4	1						3	1	2		1				
58	5					1	4	3		1						
59	4	1		1				3		3						
60	5							3		2	1					
61	4	2						3		3						?
62	4					2	1	1		2					3	
63	4	3				3	1			2					2	
64	4	1	1			3	4			3					2	
65	2	3				2	1	1		3						
66	4	3				2				2					2	
67	3	4				2	1	1		1						
68	3	1				1		1		4						
Average		1.9	1.0	1.0	1.0	1.6	1.4	2.0	1.2	2.7	1.2	1.1	1.0	1.0	2.1	
Occurrence (68 sites)		11	1	3	1	37	27	51	6	53	6	12	1	1	9	
% occur		16	1	4	1	54	40	75	9	78	9	18	1	1	13	

Hybrid Watermilfoil Map for Schmidt Lake on May 23, 2017

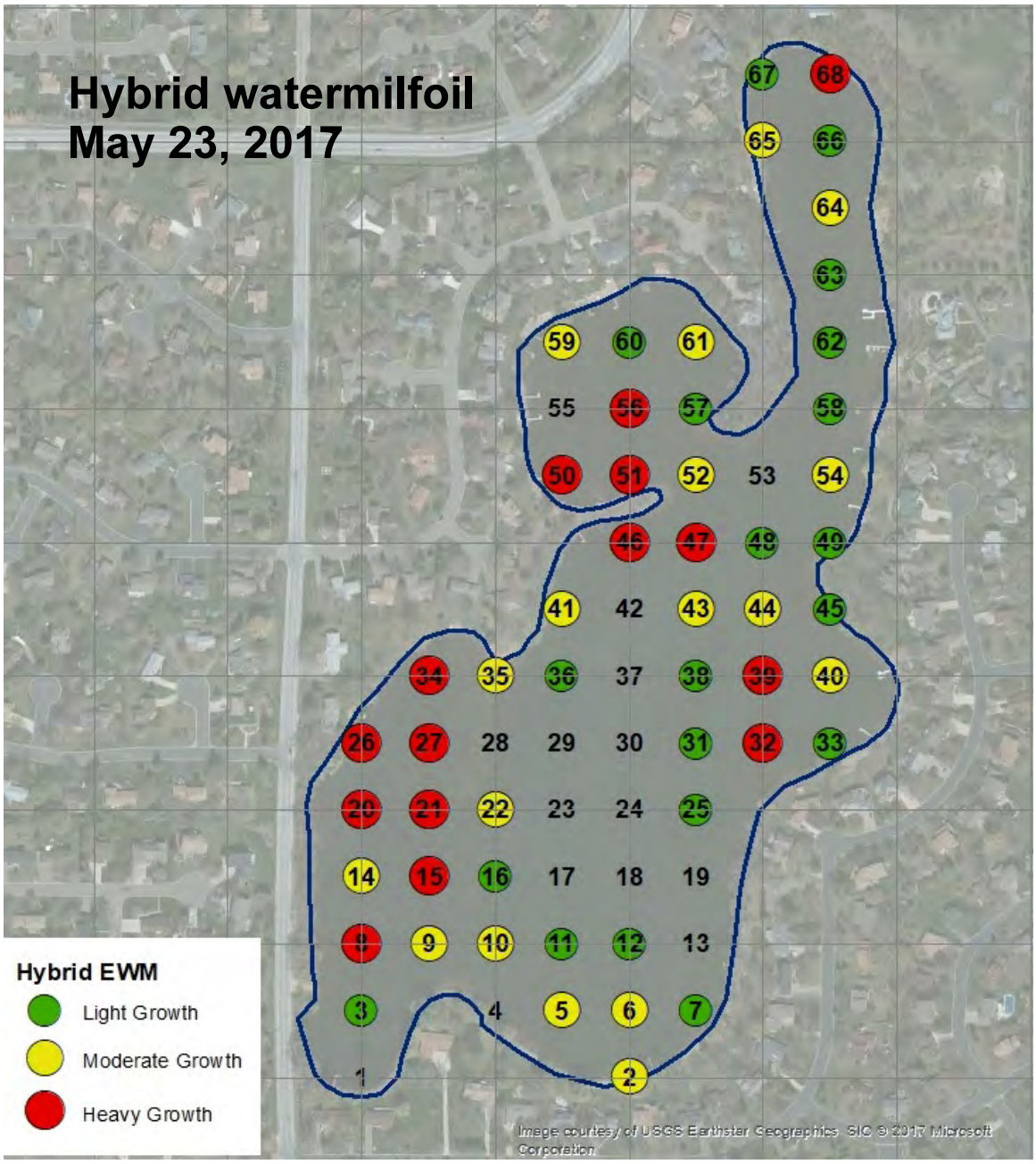


Figure 4. Distribution and abundance of the hybrid watermilfoil in Schmidt Lake on May 23, 2017.

Aquatic Plant Conditions in Schmidt Lake on May 23, 2017: Hybrid milfoil (cross between Eurasian and northern watermilfoil) was the dominant milfoil and was widespread in Schmidt Lake.

Figure 5. Lake conditions on May 23, 2017.

Figure 6. Hybrid Eurasian watermilfoil from May 23, 2017. These pictures were taken in the lab.

Milfoil in Schmidt Lake from 2004-2008 and 2017

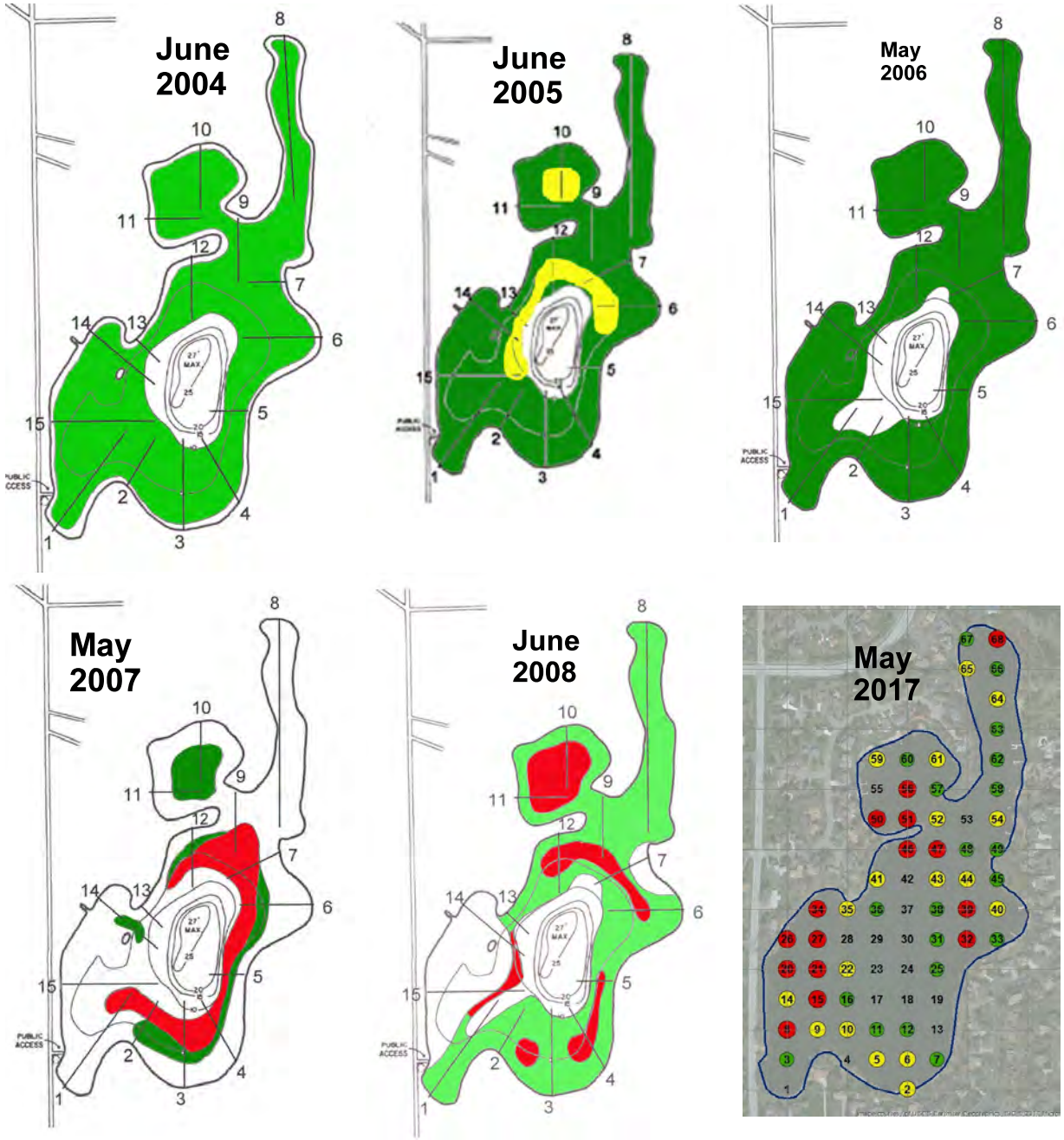


Figure 5. [top-left] Aquatic plant coverage in Schmidt Lake on June 2, 2004. Plants grew out to a depth of 12 feet. EWM percent occurrence was 8%.
[top-middle] Aquatic plant distribution on Schmidt Lake in June, 2005. Yellow shading indicates areas where EWM was growing up to the surface or was matting on the surface. EWM percent occurrence was 68%. Both Aquathol K and 2, 4-D herbicides were used in early summer.
[top-right] Aquatic plant distribution on Schmidt Lake in May is shown with green shading. EWM grew to the surface in several areas in May, 2006. EWM percent occurrence was 56%.
[bottom-left] Eurasian watermilfoil grew to the surface in several areas in May 2007. Non-nuisance coverage of Eurasian watermilfoil is shown in green (4 acres) and nuisance coverage is shown in red (5 acres). Percent occurrence was 63%.
[bottom-middle] Eurasian watermilfoil grew to the surface in several areas in June 2008. Non-nuisance coverage of Eurasian watermilfoil is shown in green and nuisance coverage is shown in red (7 acres). Percent occurrence was 80%.
[bottom-right] Hybrid watermilfoil grew to the surface in several areas in May 2017. It's percent occurrence was 78%. Key: green dot = light growth, yellow dot = moderate growth, and red dot = heavy growth.

APPENDIX

Lake Sediment Survey Results for 2004

Lake Areas that Could Support Nuisance Curlyleaf Growth Based on Lake Sediment Characteristics: Lake sediment sampling results from 2004 have been used to predict lake bottom areas that have the potential to support nuisance curlyleaf pondweed plant growth. Based on the key sediment parameters of sediment bulk density, organic matter, pH, and the Mn:Fe ratio, a table and map were prepared to indicate what type of curlyleaf pondweed growth could be expected in the future (Table A1, Figure A1).

Curlyleaf pondweed growth is predicted to produce widespread light to moderate growth in the future. Soil data indicate that nuisance growth, where plants top out in a solid canopy, is not expected.

Table A1. Schmidt Lake sediment data and ratings for potential nuisance curlyleaf pondweed growth.

Site	Bulk Density (g/cm^3 dry)	Organic Matter (%)	pH (su)	Mn:Fe Ratio	Potential for Nuisance Curlyleaf Pondweed Growth
Non-Nuisance	1.04	5	6.8	0.22	Low (green)
Light Nuisance	0.94	11	6.2	0.17	Medium (yellow)
Heavy Nuisance	<0.51	>20	>7.7	>0.64	High (red)
1	0.87	7.6	6.6	0.06	Low
2	0.67	33.4	6.2	0.06	Medium
3	0.68	35.8	6.3	0.07	Medium
4	0.74	17.2	6.7	0.06	Low
5	0.90	4.4	6.8	0.08	Low
6	0.93	5.6	7.1	0.10	Low
7	0.75	18.6	7.1	0.10	Medium
8	0.62	18.6	5.9	0.09	Medium
9	0.52	25.4	6.3	0.09	Medium
10	0.81	8.4	5.7	0.20	Medium
11	0.77	9.6	5.8	0.12	Medium
12	0.70	19.1	6.1	0.06	Medium
13	0.80	17.3	6.7	0.09	Low
14	0.80	12.1	6.8	0.08	Low
15	0.85	7.9	6.5	0.06	Low
1D	0.84	10.5	6.0	0.07	Medium

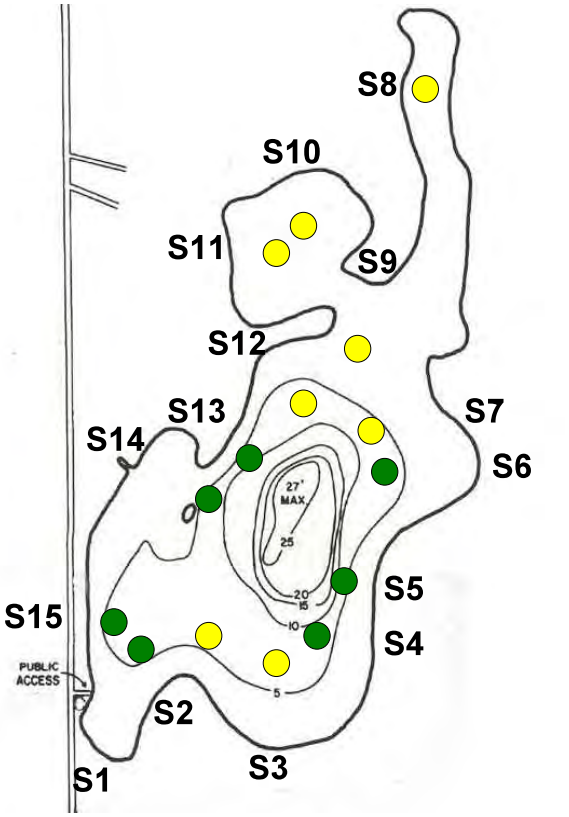


Figure A1. Sediment sample locations are shown with dots. The dot color indicates the potential for nuisance curlyleaf pondweed to occur at that site. Key: green dot = light growth and yellow dot = moderate growth.

Lake Areas that Could Support Nuisance Eurasian Watermilfoil Growth Based on Lake Sediment Characteristics: Lake sediment sampling results from 2004 have been used to predict lake bottom areas that have the potential to support nuisance EWM growth. Based on the key sediment parameters of NH_4 and organic matter, a table and map were prepared to indicate what type of growth could be expected in the future (Table A2 and Figure A2).

Except for Station 3, the sediment nitrogen conditions in Schmidt Lake are low to moderate. Although Eurasian watermilfoil will grow widely through Schmidt Lake, it is predicted that it will not produce perennial nuisance matting conditions (which are defined as heavy nuisance condition).

Table A2. Schmidt Lake sediment data and ratings for potential nuisance EWM growth.

Site	NH_4 Conc (ppm)	Organic Matter (%)	Potential for Nuisance EWM Growth
Non-Nuisance or Light Nuisance	<10	>20	Low (green) to Medium (yellow)
Heavy Nuisance	>10	<20	High (red)
1	7.5	7.6	Medium
2	3.7	33.4	Medium
3	33.9	35.8	Medium
4	3.5	17.2	Medium
5	3.1	4.4	Medium
6	7.1	5.6	Medium
7	6.5	18.6	Medium
8	4.4	18.6	Medium
9	2.8	25.4	Medium
10	7.7	8.4	Medium
11	6.3	9.6	Medium
12	3.9	19.1	Medium
13	6.0	17.3	Medium
14	6.8	12.1	Medium
15	8.1	7.9	Medium
1D	6.1	10.5	Medium

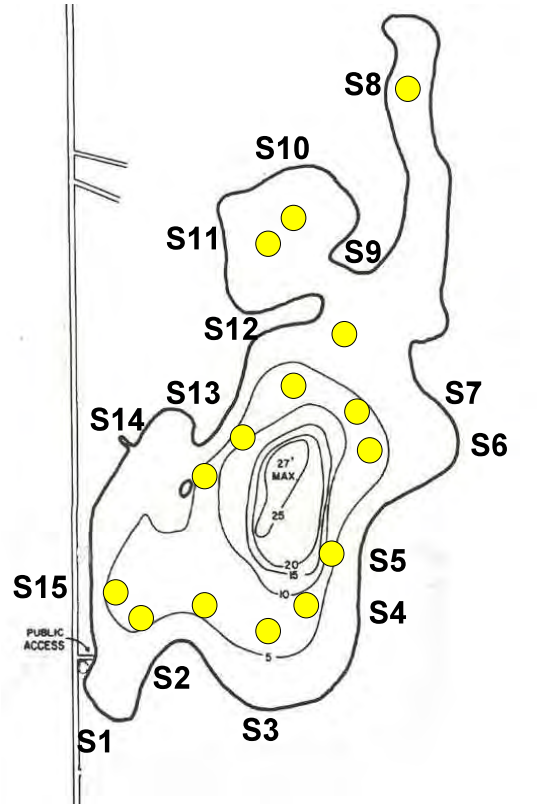


Figure A2. Sediment sample locations are shown with dots. The dot color indicates the potential for nuisance Eurasian milfoil to occur at that site.
Key: yellow dot = medium potential.