Moody Lake, Chisago County, Minnesota, June 2, 2015

Curlyleaf Pondweed Delineation and Assessment And a Point Intercept Survey for Moody Lake, Chisago County, Minnesota, 2015

Curlyleaf Pondweed Delineation: April 18, 2015
Curlyleaf Pondweed Assessment: June 2, 2015
Point Intercept Survey: September 1, 2015

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Summary

Curlyleaf Pondweed Delineation: Moody Lake (MnDNR ID #13-0023) is a 45 acre lake located in Chisago County, Minnesota. Water clarity has a summer average of 0.75 meters in 2012 (source: Comfort Lake/Forest Lake Watershed District). A curlyleaf pondweed delineation was conducted on April 18, 2015 by Blue Water Science to characterize conditions of curlyleaf pondweed and to look for Eurasian watermilfoil. Results of the curlyleaf delineation indicated that the heaviest seasonal growth predicted for 2015 was located in 3 areas totaling 2 acres.

Curlyleaf Pondweed Assessment: Curlyleaf was not treated in Moody Lake in 2015. A curlyleaf pondweed assessment was conducted on June 2, 2015 by Blue Water Science. Curlyleaf pondweed had reached heavy growth conditions in areas that were delineated in April (Figure S1). Results of the curlyleaf pondweed assessment indicated Moody Lake has a low diversity of aquatic plants, with elodea the only other submerged aquatic plant species observed. Eurasian watermilfoil was not observed on June 2, 2015. The most common plant in the lake was curlyleaf pondweed. The April delineation effectively predicted areas of heavy curlyleaf in June.

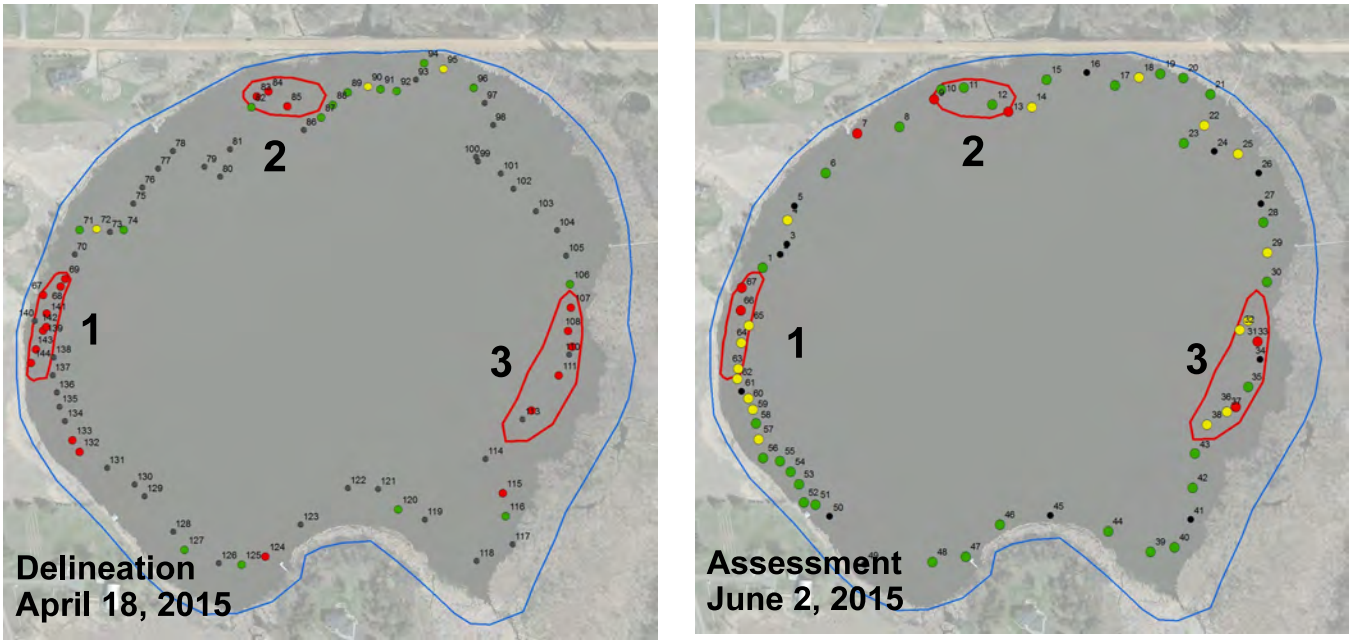


Figure S1. [left] Curlyleaf pondweed potential treatment areas Moody Lake that were delineated on April 18, 2015. In the delineation, red outlined areas are potential treatment sites which totaled about 2 acres. [right] Curlyleaf pondweed coverage for Moody Lake on June 2, 2015. The April delineation predicted areas of heavy growth in June.
Key: green dots = light growth, yellow dots = moderate growth, red dots = heavy growth, and black dots = no growth.

Aquatic Plant Point Intercept Survey: On September 1, 2015 an aquatic plant point-intercept survey was conducted on Moody Lake. The survey looked for non-native species such as curlyleaf pondweed and Eurasian watermilfoil and characterized all aquatic plants.

In September, curlyleaf pondweed was found at 1 out of 83 sites (1%) and no Eurasian watermilfoil was observed. Coontail and elodea were the only native submerged plants found. Coontail was observed at 1 site (1% of the sites) and elodea was found at 10 sites (12% of the sites)(Table S1). Plants grew out to about 5 feet of water depth (Figure S2)(Table S1).

Table S1. The percent occurrence of aquatic plants for Moody 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%.

	September 1, 2015 % Occur (83 sites)
Cattails (*Typha sp*)	2
Duckweed (*Lemna sp*)	5
Coontail (*Ceratophyllum demersum*)	1
Elodea (*Elodea canadensis*)	12
Curlyleaf pondweed (*Potamogeton crispus*)	1
Aquatic Plant Coverage (acres)	5.9

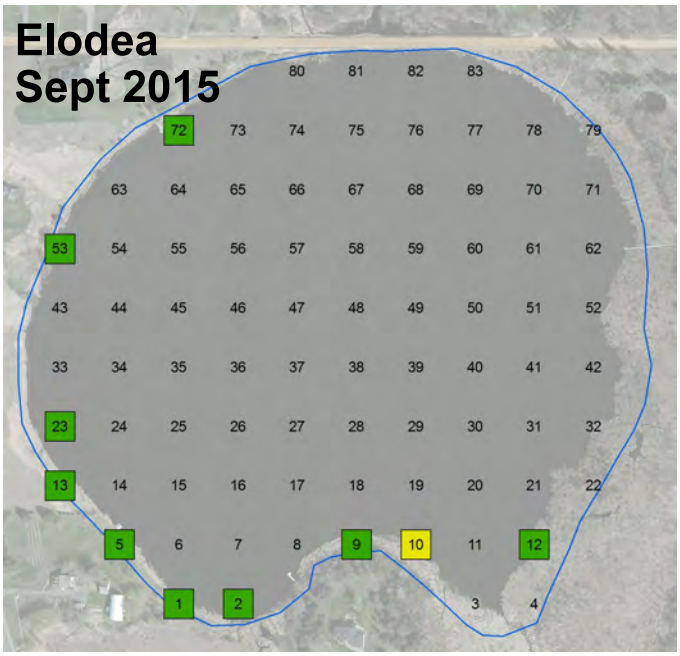


Figure S2. Elodea coverage on September 1, 2015. Key: Green shading = light growth and yellow shading = moderate growth.

Conclusions: The aquatic plant community in 2015 had 3 species of submerged plants and included coontail, curlyleaf pondweed, and elodea. This is a low plant diversity condition.

In September aquatic plants covered about 13% of the lake and grew out to about 5-feet of water depth.

Eurasian watermilfoil was not found in this survey.

Curlyleaf Pondweed Delineation and Assessment And a Point Intercept Survey for Moody Lake, Chisago County, Minnesota, 2015

Moody Lake, Chisago County (ID: 13-0023)
Size: 45 acres (MnDNR)
Littoral area: 22 acres (MnDNR)
Maximum depth: 48 ft (MnDNR)

Introduction

A curlyleaf pondweed delineation was conducted on April 18, 2015 on 45 acre Moody Lake, Chisago County. The objective of the delineation was to check the distribution and abundance of curlyleaf pondweed. A curlyleaf pondweed assessment was conducted on June 2, 2015 again to check the distribution and abundance of curlyleaf pondweed. A full point-intercept survey was conducted on September 1, 2015 to characterize the aquatic plant conditions and to check for non-natives including curlyleaf pondweed and Eurasian watermilfoil.

Methods

Delineation and Assessment Surveys: The curlyleaf pondweed (CLP) delineation and assessment of Moody Lake were conducted by Blue Water Science in April 18, 2015 and June 2, 2015. For the delineation 78 sites were evaluated around Moody Lake and for the assessment 67 sites were evaluated. Sample sites were randomly selected around Moody Lake. For the CLP delineation, at each sample point, a sampling rake was lowered into the water and a plant sample was taken. If more than 4 CLP stems per rake sample were measured, future growth at this site was considered to be heavy. If 3 stems or less were sampled, future growth was considered to be light and would not be treated.

For the June CLP assessment, 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 5 with 1 being sparse and 5 being a nuisance. Based on these sample sites, plant distribution maps were constructed.

Figure 1. Moody Lake has natural landscape around much of the lake.

Aquatic Plant Survey Point Intercept Survey: An aquatic plant survey of Moody Lake using a point intercept sampling method was conducted by Blue Water Science on September 1, 2015. A map and sampling grid were prepared by Blue Water Science and a consisted of a total of 83 points that were distributed throughout the lake (Figure 1). Points were spaced 50 meters apart. Each point represented about 0.6 acres. GPS coordinates used a UTM WGS84 datum. 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 5 (Figure 2). A density of a "1" indicated sparse growth with one or two stems present on the rake sampler. A 4.5 or 5 rating indicated matting surface plant growth.

Chart of Aquatic Plant Density Ratings

Figure 2. Aquatic plant density ratings from 1 to 5. A density rating of 4.5 or 5 is used for plants topping out at the surface.

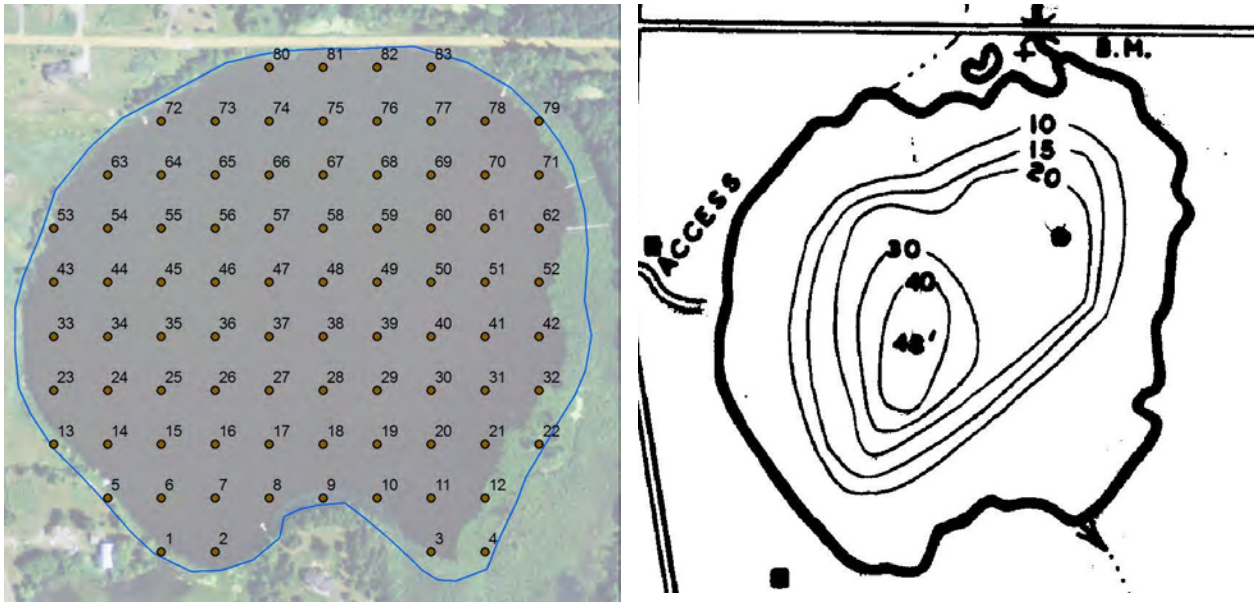


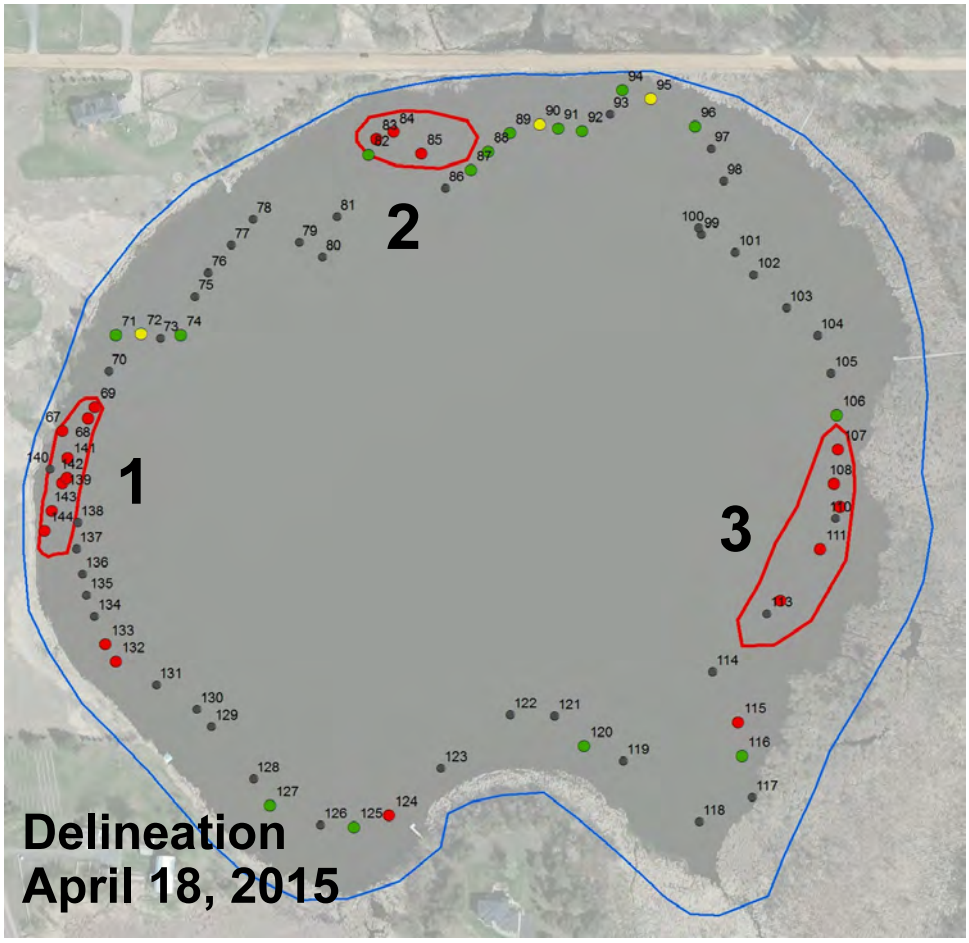
Figure 3. [left] Point locations for the aquatic plant surveys. Lake map with UTM coordinates using the NAD1983 datum.
[right] MnDNR contour map.

Results for the April 18, 2015 Curlyleaf Pondweed Delineation

Results of the delineation conducted on April 18, 2015 found there was significant curlyleaf pondweed growth at most of the sample sites (Table 1). A total of 6 areas representing 6 acres were delineated that had the characteristic stem densities that were predicted to produce heavy growth at peak CLP abundance in June (Figure 4). Elodea was the only other plant species observed (Table 1).

Table 1. Moody Lake aquatic plant occurrences and densities for the April 18, 2015 survey based on 78 sites. Density ratings are 1-5 with 1 being low and 5 being most dense.

	All Stations (n=78)	
	Occur	% Occur
Curlyleaf pondweed (*Potamogeton crispus*)	38	49



Site	Acres of CLP
1	0.4
2	0.5
3	1.1

Figure 4. Curlyleaf pondweed potential treatment areas Moody Lake that were delineated on April 18, 2015. Key: Red outlined areas are potential treatment sites. Green dots = light growth, yellow dots = moderate growth, red dots = heavy growth, and black dots = no growth.

Individual Site Plant Data for the Delineation

Low plant diversity was found in Moody Lake with a total of 1 aquatic plant species (Table 2). Curlyleaf pondweed was the most common plant observed in this delineation survey.

Table 2. Aquatic plant occurrence and stem density for CLP sample points in Moody Lake, April 18, 2015. CLP stem densities of 3 or less were considered to produce light growth at peak abundance which would be in May.

Site	Depth (ft)	CLP stems
67	4	4
68	5	4
69	5	4
70	5	
71	5	1
72	6	3
73	6	
74	6	1
75	6	
76	6	
77	6	
78	6	
79	8	
80	9	
81	8	
82	6	1
83	6	6
84	6	5
85	7	6
86	7	
87	6	1
88	7	1
89	6	2
90	6	3
91	7	2
92	7	1
93	7	
94	5	2
95	5	3
96	5	1
97	6	
98	6	
99	12	
100	12	
101	9	
102	8	
103	7	
104	6	
105	6	
106	6	2
107	6	4
108	6	5
109	6	12
110	5	

Site	Depth (ft)	CLP stems
111	6	8
112	6	12
113	6	
114	7	
115	6	4
116	6	1
117	4	
118	3	
119	5	
120	5	1
121	7	
122	7	
123	7	
124	7	4
125	5	1
126	5	
127	5	1
128	7	
129	7	
130	7	
131	6	
132	6	6
133	6	7
134	6	
135	6	
136	6	
137	6	
138	6	
139	5	7
140	3	
141	4	15
142	5	10
143	5	6
144	4	8
Average		6
Occurrence (78 sites)		38

Results for the June 2, 2015 Curlyleaf Pondweed Assessment

Results of the June 2, 2015 assessment found there were 3 submerged plant species and curlyleaf pondweed was the dominant plant in the lake (Table 3). Results from the assessment found that curlyleaf pondweed was growing out to a depth of 7 feet with heavy growth close to or within the areas that were delineated on April 18, 2015 (Figure 5).

Table 3. Moody Lake aquatic plant occurrences and densities for the June 2, 2015 survey based on 67 sites. Density ratings are 1-5 with 1 being low and 5 being most dense.

	All Stations (n=67)		
	Occur	% Occur	Density
Elodea (*Elodea canadensis*)	9	13	2.2
Curlyleaf pondweed (*Potamogeton crispus*)	54	81	3.0
Stringy pondweed (*P. sp*)	1	1	1.0

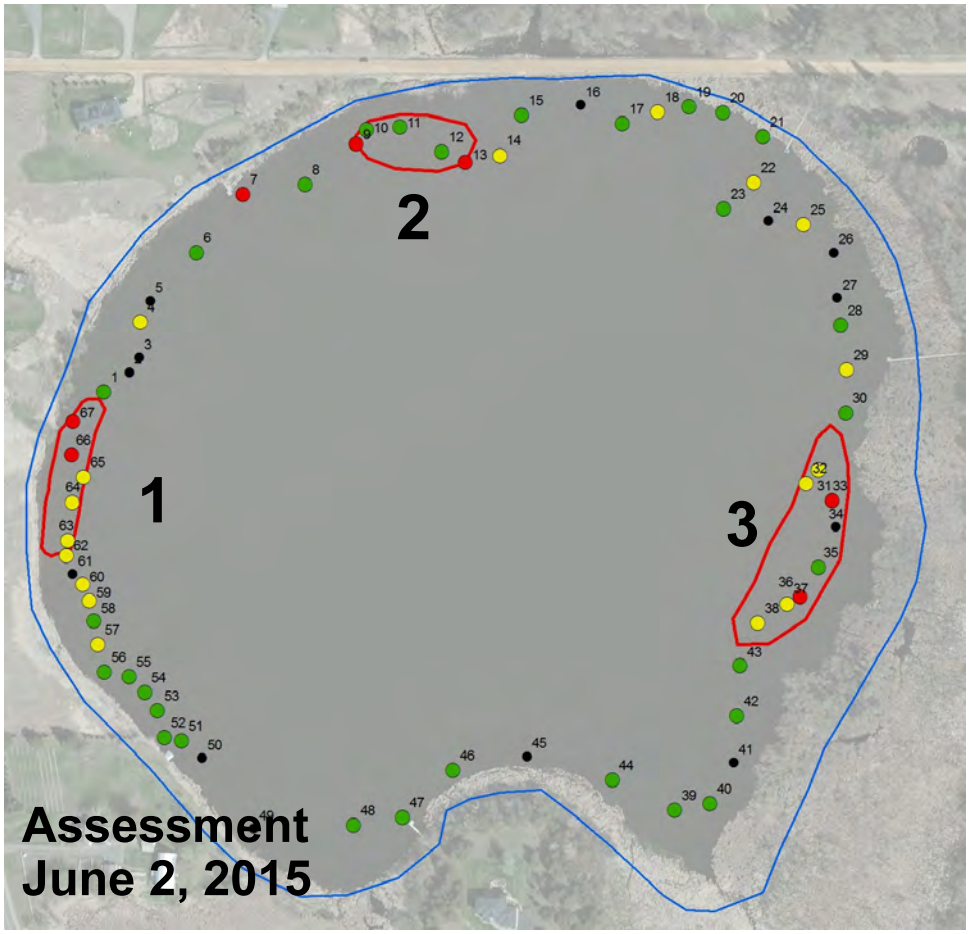


Figure 5. Curlyleaf pondweed coverage for Moody Lake on June 2, 2015.
Key: Red outlined areas are potential treatment sites. Green dots = light growth, yellow dots = moderate growth, red dots = heavy growth, and black dots = no growth.

Individual Site Plant Data for the Assessment

Low plant diversity was found in Moody Lake with a total of 3 aquatic plant species (Table 4). Curlyleaf pondweed was the most common plant observed in this survey.

Table 4. Aquatic plant occurrence and density for individual sample points in Moody Lake, June 2, 2015. Density is rated on a scale from 1 to 5 with 5 being the densest.

Site	Depth (ft)	CLP	CLP - stems	Elodea	Stringy	No plants
106	6	2	6			
107	6			4		
108	5			3		
109	6	3	13			
110	7					1
111	7	1	3			
112	5	4	20			
113	6	1	4			
114	4	4	20			
115	6	1	3			
116	6	2	9			
117	5	2	6			
118	5	4	20			
119	6	3	15			
120	7	2	9			
121	8					1
122	7	1	5			
123	5	3	14			
124	6	2	5			
125	7	1	4			
126	6	2	6			
127	4	3	12			
128	4	2	8			
129	5				1	
130	6	3	15			
131	8					1
132	7					1
133	6	1	3			
134	5	3	18			
135	5	2	10			
136	6	3				
137	6	3				
138	6	4				
139	6					1
140	7	1	3			
141	6	4				
142	6	3				
143	6	3				
144	6	2	6			
145	7	1	4			
146	6					1
147	6	1	4			
148	6	2	6			
149	6	1	4			
150	5			2		
151	5	2	8			
152	5	1	4			
153	5	2	6	2		
154	5			1		
155	5					1
156	5	1	6			
157	6	2	12			
158	6	2	7			
159	6	1	3			
160	5	1	6			
161	5	1	4	2		
162	5	3	18	1		
163	4	2	1			
164	3	3				
165	3	3				
166						1
167	5	3		2		
168	5	3		3		
169	5	3				
170	5	3				
171	4	4				
172	5	4				
Average		3		2	1	
Occurrence (67 sites)		54		9	1	8
% occur		81		13	1	

Curlyleaf pondweed was distributed around the perimeter of Moody Lake and covers much of the nearshore area. In June of 2015, curlyleaf was found to grow at a moderate to heavy densities (Figure 6). In a few areas, curlyleaf was found at light densities.

Figure 6. (top) Curlyleaf pondweed in Moody Lake was reaching the surface in a few locations close to shore on June 2, 2015.
(bottom) Curlyleaf pondweed was still growing in June 2015.

Comparison of 2014 and 2015 Curlyleaf Pondweed Conditions

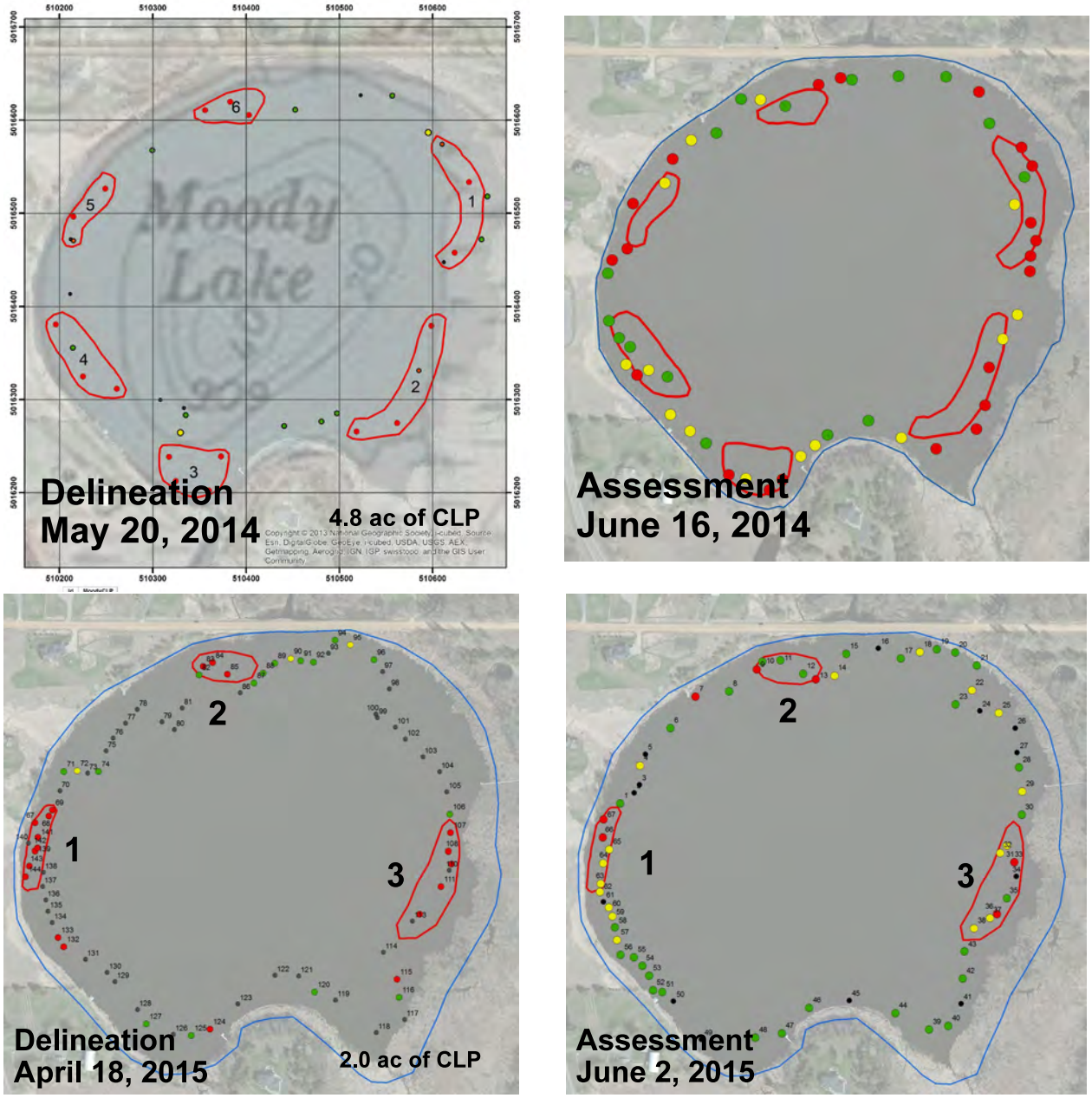


Figure 7. [top-left] Curlyleaf pondweed potential treatment areas Moody Lake that were delineated on May 20, 2014. In the delineation, red outlined areas are potential treatment sites totaling 4.8 acres.
[top-right] Curlyleaf pondweed coverage for Moody Lake on June 12, 2014. The May delineation predicted areas of heavy growth in June.
[bottom-left] Curlyleaf pondweed potential treatment areas Moody Lake that were delineated on April 18, 2015. In the delineation, red outlined areas are potential treatment sites of 2.0 acres.
[bottom-right] Curlyleaf pondweed coverage for Moody Lake on June 2, 2015. The April delineation predicted areas of heavy growth in June.
Key: green dots = light growth, yellow dots = moderate growth, red dots = heavy growth, and black dots = no growth.

Results of the Point Intercept Survey -- September 1, 2015

The most abundant plant on the September 1, 2015 point-intercept plant survey for Moody Lake was elodea, found at 10 out of 83 sites (12%) but at light growth (Figure 8 and Table 5). The other submerged plants observed were coontail and curlyleaf pondweed, each found at 1 site at light growth (Figure 8).

A summary of plant density and occurrence for coontail and curlyleaf pondweed is shown in Tables 5 and 6.

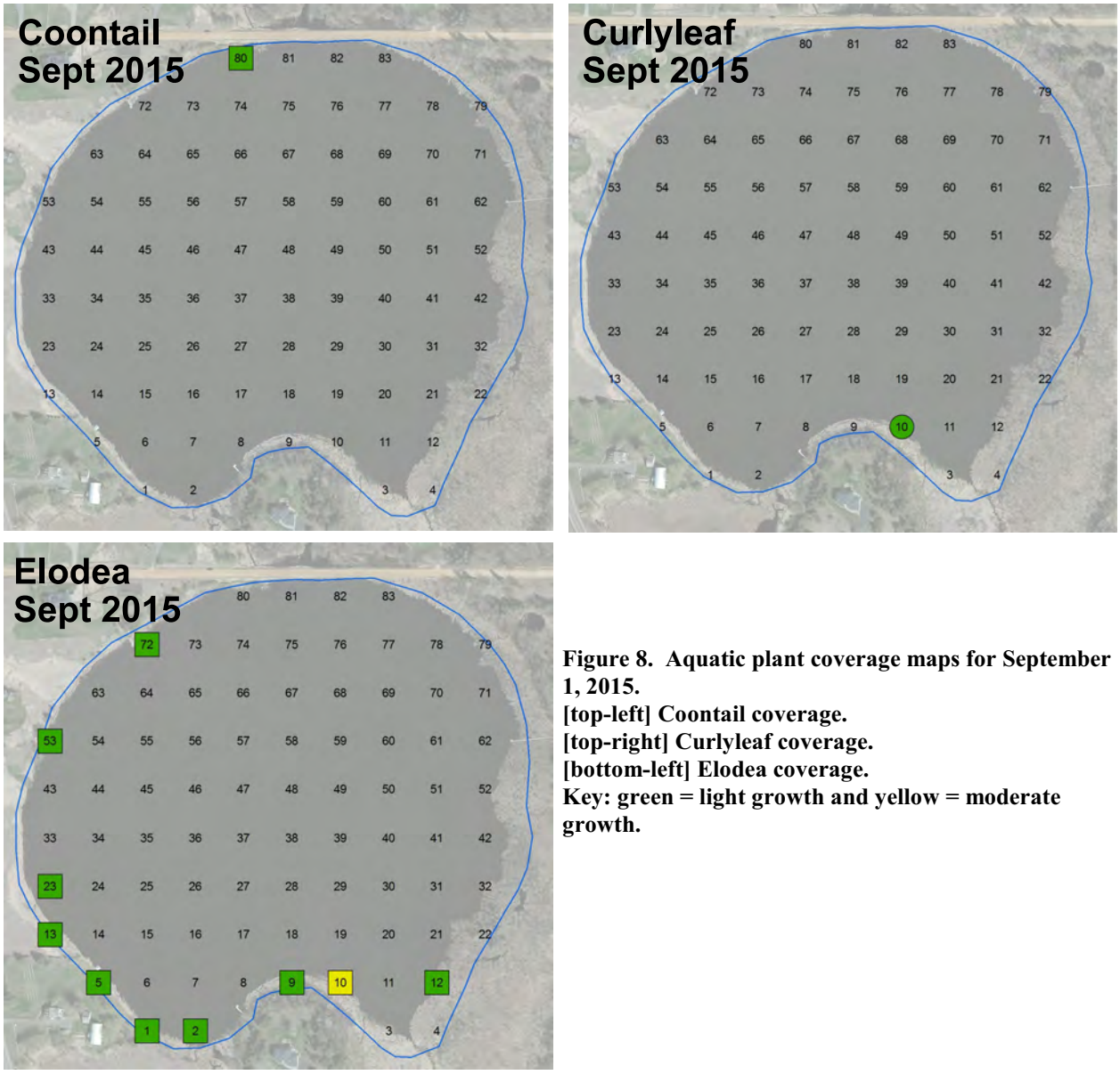


Figure 8. Aquatic plant coverage maps for September 1, 2015.
[top-left] Coontail coverage.
[top-right] Curlyleaf coverage.
[bottom-left] Elodea coverage.
Key: green = light growth and yellow = moderate growth.

Table 5. Moody Lake aquatic plant occurrences and densities for the September 1, 2015 survey based on 83 sites. Density ratings are 1-5 with 1 being low and 5 being most dense.

	September 1, 2015 % Occur (83 sites)
Cattails (*Typha sp*)	2
Duckweed (*Lemna sp*)	5
Coontail (*Ceratophyllum demersum*)	1
Elodea (*Elodea canadensis*)	12
Curlyleaf pondweed (*Potamogeton crispus*)	1

Table 6. Individual site data for September 1, 2015. Numbers indicate plant density.

Site	Depth (ft)	Cat-tails	Duck-weed	Coon-tail	CLP	Elodea	No plants
1	2	1	1			2	
2	4					2	
3	13						1
4	land						1
5	3					1	
6							1
7							1
8	5						1
9	2	2	1			1	
10	4		2		1	3	
11							1
12	4					1	
13	3		1			2	
14							1
15							1
16							1
17							1
18							1
19							1
20							1
21	5						1
22	6						1
23	5					1	
24							1
25							1
26							1
27							1
28							1
29							1
30							1
31	6						1
32	land						1
33	6						1
34							1
35							1
36							1
37							1
38							1
39							1
40							1
41							1
42	6						1
43	6						1
44							1

Site	Depth (ft)	Cat-tails	Duck-weed	Coon-tail	CLP	Elodea	No plants
45							1
46							1
47							1
48							1
49							1
50							1
51							1
52	5						1
53	4					1	
54							1
55							1
56							1
57							1
58							1
59							1
60							1
61							1
62	6						1
63	6						1
64							1
65							1
66							1
67							1
68							1
69							1
70							1
71	5						1
72	3					2	
73							1
74							1
75							1
76							1
77							1
78	6						1
79	3						1
80	5			1			
81	6						1
82	6						1
83	5						1
Average		1.5	1.25	1	1	1.6	
Occurrence (83 sites)		2	4	1	1	10	72
% occur		2	5	1	1	12	

Conclusions: The aquatic plant community in 2015 had 3 species of submerged plants including coontail, curlyleaf pondweed, and elodea. This is a low plant diversity condition. Curlyleaf pondweed was the only non-native plant present.

Curlyleaf pondweed covered about 1% (0.5 acres) in September. Aquatic plants covered about 13% of the lake and grew out to about 5-feet of water depth.

Eurasian watermilfoil was not found in this survey.

Figure 9. Elodea was most common submerged aquatic plant found on September 1, 2015.

Appendix

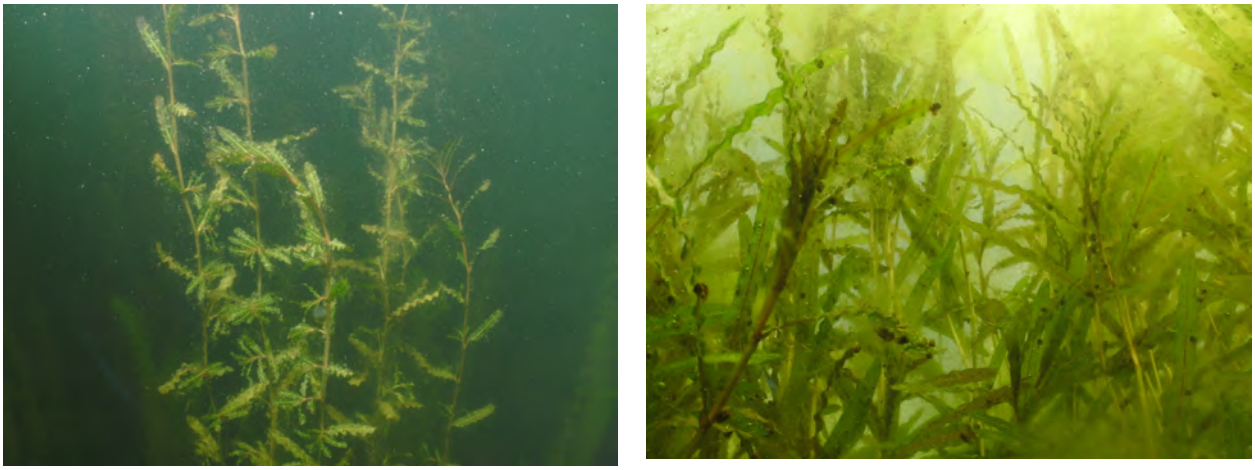
Curlyleaf Pondweed (non-native aquatic plant) Potential Future Growth in Moody Lake

Moody Lake Status: Present in Moody Lake.

Potential for Curlyleaf Pondweed Growth in Moody Lake: Mostly moderate growth potential with scattered areas of light and heavy growth potential.

Lake sediment sampling results from 2014 have been used to predict lake bottom areas that have the potential to support heavy curlyleaf pondweed plant growth. Various types of curlyleaf growth patterns are shown in Figures 5 and 6. Based on the key sediment parameters of pH, sediment bulk density, organic matter, and the Fe:Mn ratio (McComas, unpublished), the predicted growth characteristics of curlyleaf pondweed in Moody Lake are shown in below.

Curlyleaf pondweed growth is predicted to produce heavy growth (where plants top out in a solid canopy) at Site 5 in Moody Lake. Otherwise, for the rest of the lake, curlyleaf pondweed is expected to exhibit mostly moderate growth with occasional heavy growth.



Underwater views of curlyleaf pondweed. Light growth (left) and moderate growth (right).

Examples of Curlyleaf Pondweed Growth Characteristics

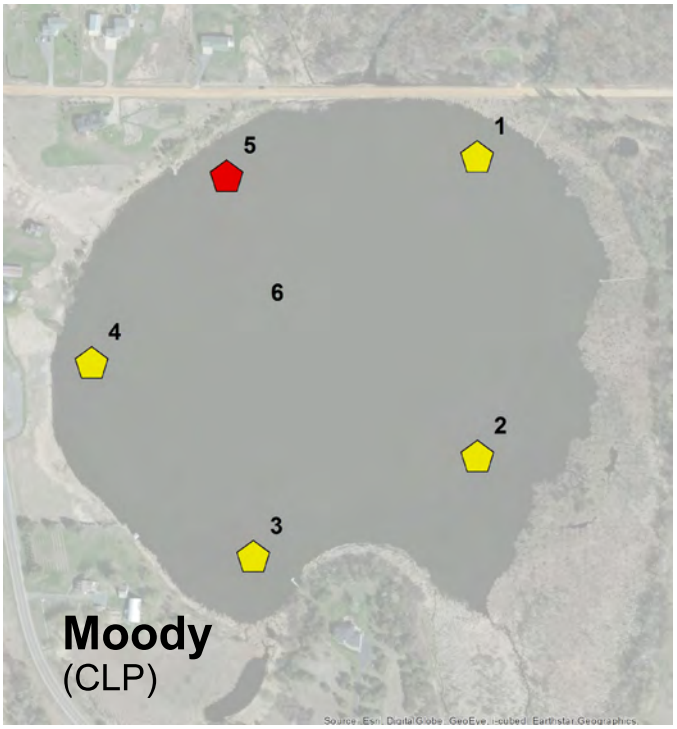
Light growth (left) refers to non-nuisance growth that is mostly below the surface and is not a recreational or ecological problem. Moderate growth (middle) refers to growth that is just below the water surface. Heavy growth (right) refers to nuisance matting curlyleaf pondweed. This is the kind of nuisance growth predicted by high sediment pH and a sediment bulk density less than 0.51.

Curlyleaf Pondweed Growth Potential Based on Lake Sediments: Curlyleaf pondweed is present in Moody Lake. Research has found curlyleaf is limited or enhanced based on lake sediment characteristics. Based on lake sediment characteristics, curlyleaf has the potential to produce light, moderate, or heavy growth on an annual basis.

In Moody Lake it is predicted that curlyleaf will grow at mostly moderate densities. One area in the northwest end of the lake may produce high growth on a year to year basis.

Moody Lake sediment data and ratings for potential growth of curlyleaf pondweed growth.

Site	Depth (ft)	pH (su)	Bulk Density (g/cm3 dry)	Organic Matter (%)	Fe:Mn Ratio	Potential for Curlyleaf Pondweed Growth
Light Growth		**<7.4**	**>1.04**	**0.1-5**	**>4.5**	**Light (green)**
Moderate Growth		**7.4 - 7.7**	**0.52 - 1.03**	**6-20**	**1.6 - 4.5**	**Moderate (yellow)**
Heavy Growth		**>7.7**	**<0.51**	**>20**	**<1.6**	**Heavy (red)**
Moody 1	7	6.6	0.33	51.9	6.7	Moderate
Moo 2	7	6.5	0.28	76.9	4.7	Moderate
Moo 3	6	6.5	0.32	62.6	7.5	Moderate
Moo 4	6	6.4	0.35	55.5	7.4	Moderate
Moo 5	6	6.5	0.51	19.7	7.3	Heavy
Moo 6	34	6.5	0.50	50.7	4.2	



The color indicates the potential growth of curlyleaf pondweed. Key: yellow = moderate growth and red = heavy growth.

Potential Eurasian Watermilfoil (non-native aquatic plant) Growth in the Future

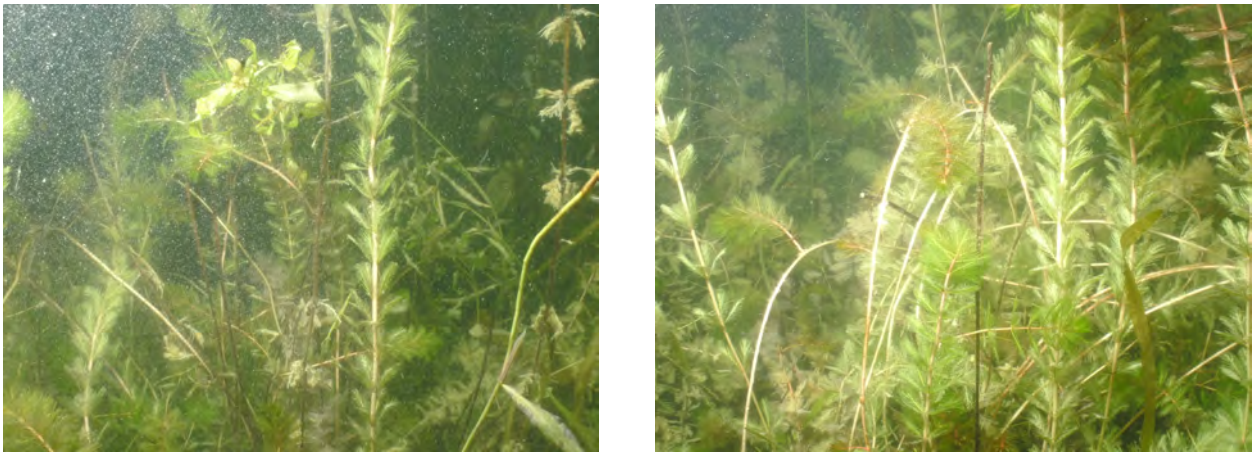
Moody Lake Status: Not found in Moody Lake.

Nearest Occurrence: Bone Lake, Washington County

Potential for Eurasian Watermilfoil Growth in Moody Lake: Mostly light to moderate potential.

Lake sediment sampling results from 2014 have been used to predict lake areas that have the potential to support heavy Eurasian watermilfoil growth. Examples of milfoil growth characteristics are shown below. Based on the key sediment parameters of NH_4 and organic matter (McComas, unpublished), a table and map were prepared that predict the type of growth that could be expected in the future if milfoil becomes established in Moody Lake.

In Moody Lake a majority of sites had low to moderate nitrogen but higher than optimal organic matter and these areas are predicted to have the potential to produce mostly light growth of milfoil on an annual basis unless water clarity is limiting.



Underwater views of Eurasian watermilfoil.

Examples of Eurasian Watermilfoil Growth Characteristics

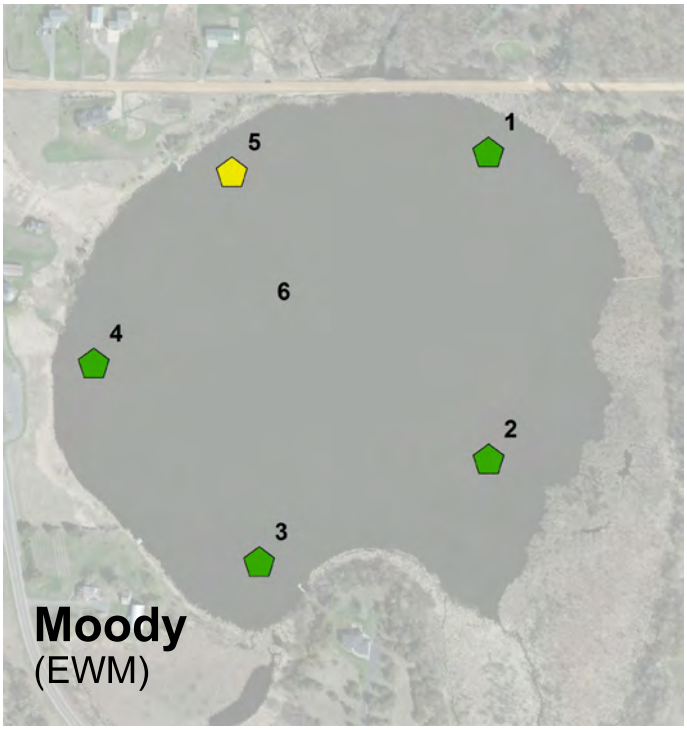
Light growth (left) refers to non-nuisance growth that is mostly below the surface and is not a recreational or ecological problem. Heavy growth (right) refers to nuisance matting Eurasian watermilfoil. This is the kind of nuisance growth predicted by high sediment nitrogen values and a sediment organic matter content less than 20%.

Eurasian Watermilfoil (EWM) Growth Potential Based on Lake Sediments: Lake sediment sampling results from 2014 have been used to predict lake bottom areas that have the potential to support either light, moderate, or heavy EWM growth. Eurasian watermilfoil has not been observed in Moody Lake as of June 2014. The potential for milfoil growth, based on lake sediment sampling, would be light to moderate growth. Heavy milfoil growth has been correlated with high sediment nitrogen condition and Moody Lake has mostly light to moderate nitrogen conditions, and high organic matter content could be limiting as well.

For Moody Lake, it is estimated the plants have the potential to grow down to about 5 to 6 feet of water depth based on existing water clarity conditions and that could limit EWM distribution.

Moody Lake sediment data and ratings for potential growth of Eurasian watermilfoil.

Site	Depth (ft)	NH_4 Conc (ppm)	Organic Matter (%)	Potential for Eurasian Watermilfoil Growth
Light Growth		**<4**	**<0.5 and >20**	**Light (green)**
Moderate Growth		**4 - 10**	**0.6 - 2 and 18 - 20**	**Moderate (yellow)**
Heavy Growth		**>10**	**3 - 17**	**Heavy (red)**
Moody 1	7	3.7	51.9	Light
Moo 2	7	1.9	76.9	Light
Moo 3	6	5.5	62.6	Light
Moo 4	6	4.9	55.5	Light
Moo 5	6	7.4	19.7	Moderate
Moo 6	34	179.0	50.7	



The color indicates the potential growth of Eurasian watermilfoil.
Key: green = light growth and yellow = moderate growth.