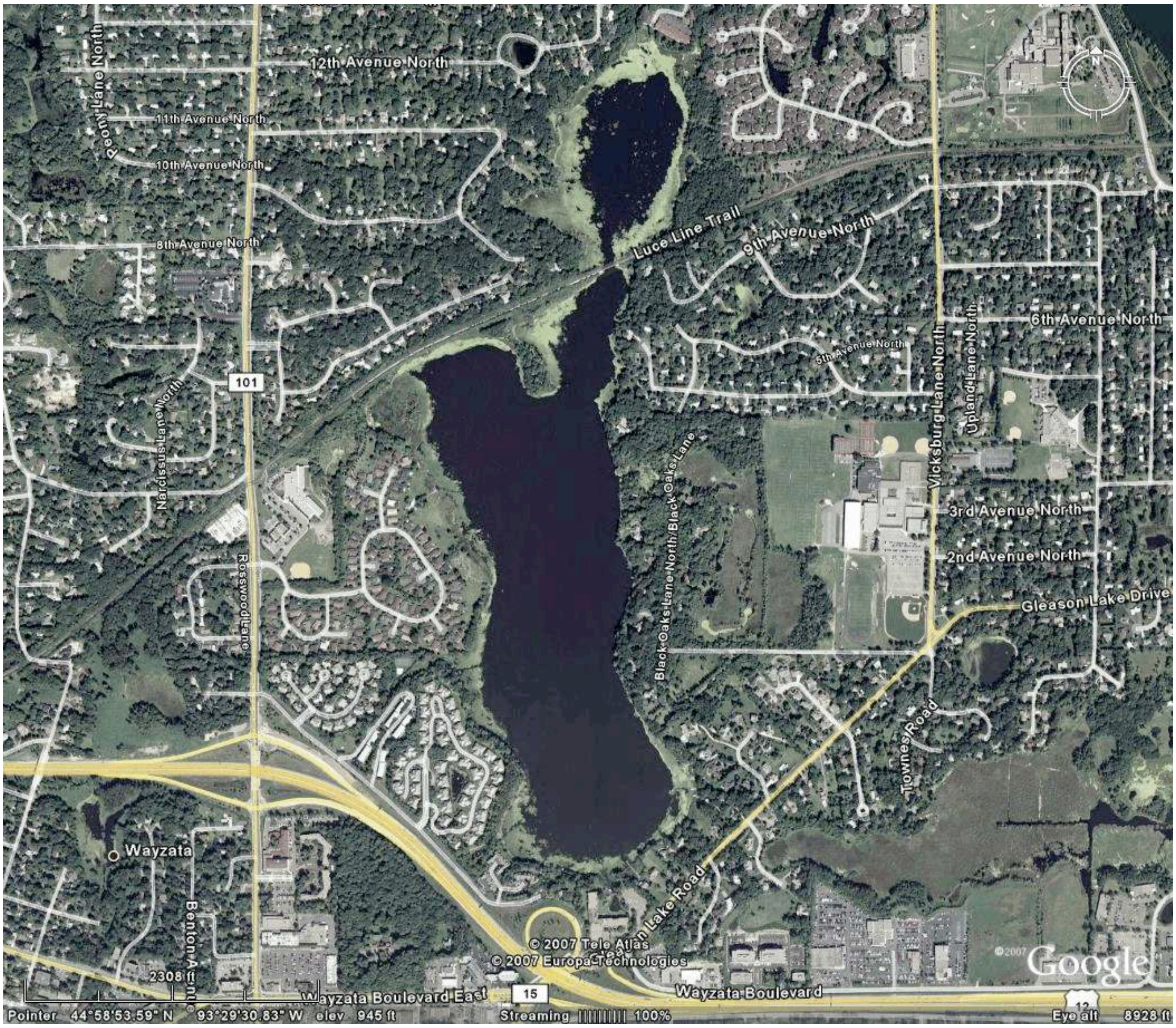


Gleason Lake, Scott County, MN (Google Earth Map)

Curlyleaf Pondweed and Eurasian Watermilfoil Growth Potential Based on Gleason Lake Sediment Characteristics

[Sediments Collected October 30, 2008]

Prepared by: Steve McComas, Blue Water Science

February 2009

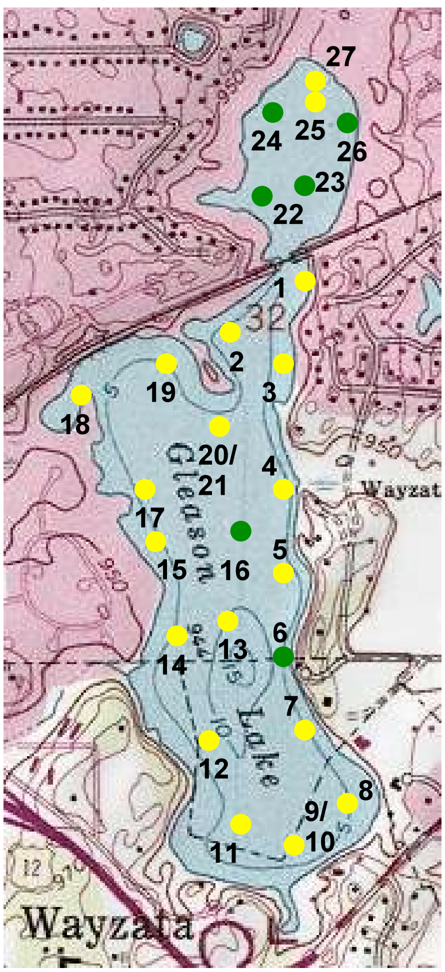
Curlyleaf Pondweed and Eurasian Watermilfoil Growth Potential Based on Gleason Lake Sediment Characteristics

Summary

For managing non-native plants it is helpful to know where the plants have the potential to grow to nuisance conditions. A technique developed by Blue Water Science shows where nuisance growth of curlyleaf pondweed and Eurasian watermilfoil can occur in a lake based on lake sediment characteristics. This technique was applied to Gleason Lake. Gleason Lake sediments were collected from 27 sites around the lake on October 30, 2008. The lake sediments were analyzed at the Soils Lab at the University of Minnesota.

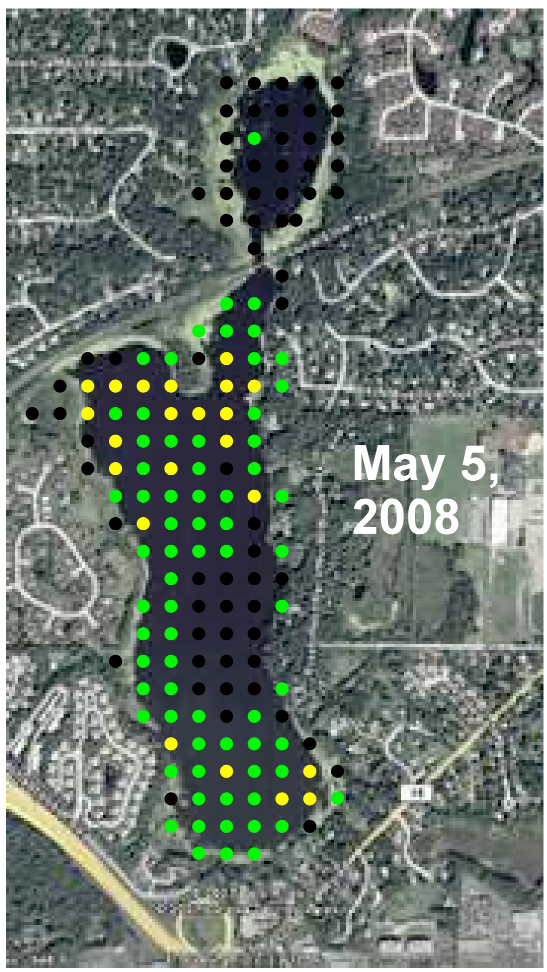
Curlyleaf Pondweed Growth Potential: Lake sediment sampling results from 2008 have been used to predict lake bottom areas that have the potential to support three types of curlyleaf pondweed plant growth: light, moderate, or heavy based on the key sediment parameters of pH, the Fe:Mn ratio, sediment bulk density, and organic matter (McComas, unpublished).

Predicted Curlyleaf Pondweed Growth



Sediment sample locations are shown with a circle. The circle color indicates the type of curlyleaf pondweed growth predicted to occur at that site. Key: green = light; yellow = moderate.

Actual Curlyleaf Pondweed Growth - 2008



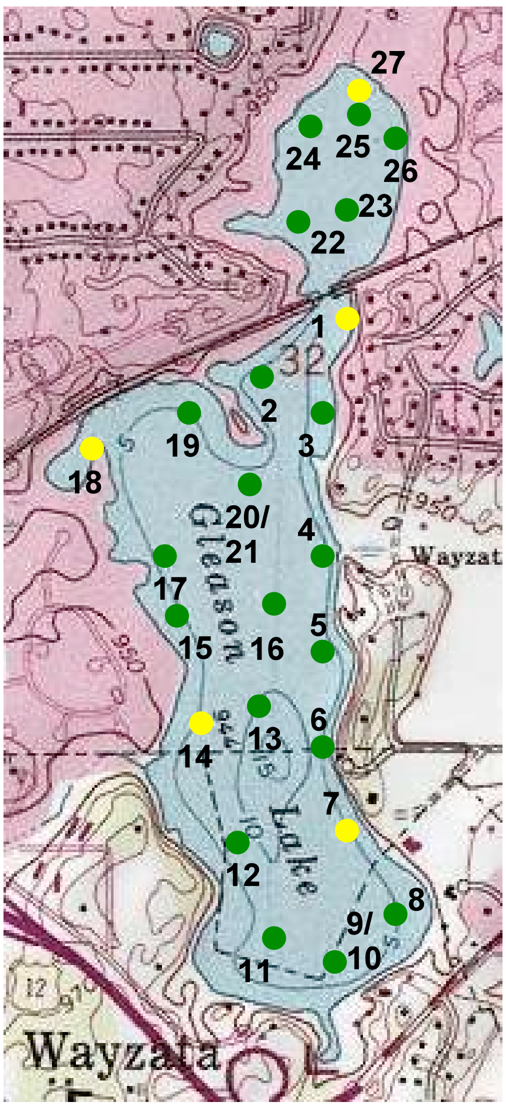
Curlyleaf pondweed coverage for May 5, 2008 (pre-herbicide) conditions. Key: green = light growth; yellow = moderate growth.

Curlyleaf pondweed growth is predicted to produce mostly moderate growth (where plants may occasionally top out in a broken canopy) in Gleason Lake.

Eurasian Watermilfoil Growth Potential: Lake sediment sampling results from 2008 have been used to predict lake bottom areas that have the potential to support three types of EWM growth. Eurasian watermilfoil has been in Gleason Lake since 1998. Based on the key sediment parameters of NH_4 and organic matter (McComas, unpublished), a map was prepared that predicts what type of milfoil growth could be expected in the future in Gleason Lake.

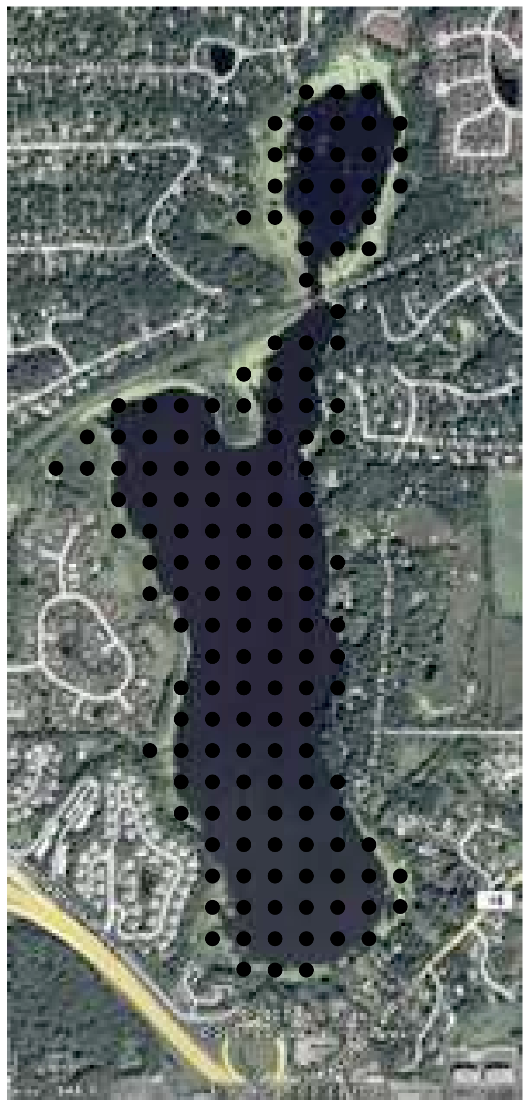
The sediment nitrogen conditions in Gleason Lake range from low to high with sediments over 10 ppm of nitrogen as candidates for heavy milfoil growth. However, all the sediment sites, except for Site 6, have a high percentage of organic matter. It has been found that curlyleaf does not grow well in sediments with over 20% organic matter. Under current sediment conditions, no areas in Gleason Lake are predicted to exhibit heavy milfoil growth in Gleason Lake. Eurasian watermilfoil could grow more widely in Gleason Lake in the future, but it is predicted that it not will produce extensive perennial nuisance matting conditions (which are defined as heavy growth conditions). No Eurasian watermilfoil has been observed in Gleason Lake in the last two years of surveys (2007 and 2008).

Predicted Eurasian Watermilfoil Growth



Sediment sample locations are shown with a circle. The circle color indicates the type of Eurasian watermilfoil growth predicted to occur at that site. Key: green = light; yellow = moderate; red = heavy.

Actual Eurasian Watermilfoil Status - 2008



Eurasian watermilfoil coverage for 2008 conditions. No Eurasian watermilfoil was observed in 2008.

Conclusions:

The Gleason Lake sediment survey results indicate a potential for moderate growth of curlyleaf in the main basin and light growth in the north basin. Sediment survey results indicate a potential for mostly light growth of Eurasian watermilfoil throughout Gleason Lake.

Introduction

For managing non-native plants it is helpful to know where the plants have the potential to grow to nuisance conditions. A technique developed by Blue Water Science shows where nuisance growth of curlyleaf pondweed and Eurasian watermilfoil can occur in a lake based on lake sediment characteristics. This technique was applied to Gleason Lake.

Gleason Lake sediments were collected from 27 sites around the lake on October 30, 2008. The lake sediments were analyzed at the Soils lab at the University of Minnesota and results are presented in this report.

Methods

Lake Soil Collection: A total of 27 lake sediment samples were collected from the depth of 2.5 to 12.5 feet on October 30, 2008 by Steve McComas, Blue Water Science. Samples were collected using a modified soil auger, 5.2 inches in diameter (Figure 1) and soils were sampled to a depth of 6 inches. The lake soil from the sampler was transferred to 1-gallon zip-lock bags and delivered to the University of Minnesota soil testing laboratory.

Lake Soil Analysis: At the lab, sediment samples were air dried at room temperature, crushed and sieved through a 2 mm mesh sieve. Sediment samples were analyzed using standard agricultural soil testing methods. Fifteen parameters were tested for each soil sample. A summary of extractants and procedures is shown in Table 1. Routine soil test results are given on a weight per volume basis.

Table 1. Soil testing extractants used by University of Minnesota Crop Research Laboratory. These are standard extractants used for routine soil tests by most Midwestern soil testing laboratories (reference: Western States Laboratory Proficiency Testing Program: Soil and Plant Analytical Methods, 1996-Version 3).

Parameter	Extractant
P-Bray	0.025M HCL in 0.03M NH_4F
P-Olsen	0.5M $NaHCO_3$
NH_4-N	2N KCL
K, Ca, Mg	1N NH_4OA_c (ammonium acetate)
Fe, Mn, Zn, Cu	DTPA (diethylenetriamine pentaacetic acid)
B	Hot water
SO_4-S	$Ca(H_2PO_4)_2$
pH	water
Organic matter	Loss on ignition at 360°C

Figure 1. Soil auger used to collect lake sediments.

Reporting Lake Soil Analysis Results: Lake soils and terrestrial soils are similar from the standpoint that both provide a medium for rooting and supply nutrients to the plant.

However, lake soils are also different from terrestrial soils. Lake soils (or sediments) are water logged, generally anaerobic and their bulk density ranges from being very light to very dense compared to terrestrial soils.

There has been discussion for a long time on how to express analytical results from soil sampling. Lake sediment research results are often expressed as grams of a substance per kilogram of lake sediment, commonly referred to as a weight basis (mg/kg). However, in the terrestrial sector, to relate plant production and potential fertilizer applications to better crop yields, soil results typically are expressed as grams of a substance per cubic foot of soil, commonly referred to as a weight per volume basis. Because plants grow in a volume of soil and not a weight of soil, farmers and producers typically work with results on a weight per volume basis.

That is the approach used here for lake sediment results: they are reported on a weight per volume basis or $\mu g/cm^3$.

A bulk density adjustment was applied to lake sediment results as well. For agricultural purposes, in order to standardize soil test results throughout the Midwest, a standard scoop volume of soil has been used. The standard scoop is approximately a 10-gram soil sample. Assuming an average bulk density for an agricultural soil, a standard volume of a scoop has been a quick way to prepare soils for analysis, which is convenient when a farmer is waiting for results to prepare for a fertilizer program. It is assumed a typical silt loam and clay texture soil has a bulk density of 1.18 grams per cm^3. Therefore a scoop size of 8.51 cm^3 has been used to generate a 10-gram sample. It is assumed a sandy soil has a bulk density of 1.25 grams per cm^3 and therefore a 8.00 cm^3 scoop has been used to generate a 10-gram sample. Using this type of standard weight-volume measurement, the lab can use standard volumes of extractants and results are reported in ppm which is close to $\mu g/cm^3$. For all sediment results reported here a scoop volume of 8.51 cm^3 was used.

However lake sediment bulk density has wide variations but only a single scoop volume of 8.51 cm^3 was used for all lake sediment samples. This would not necessarily produce a consistent 10-gram sample. Therefore, for our reporting, we have used corrected weight volume measurements and results have been adjusted based on the actual lake sediment bulk density. We used a standard scoop volume of 8.51 cm^3, but sediment samples were weighed. Because test results are based on the premise of a 10 gram sample, if our sediment sample was less than 10 grams, then the reported concentrations were adjusted down to account for the less dense bulk density. If a scoop volume weighed greater than 10.0 grams than the reported concentrations were adjusted up. For example, if a 10-gram scoop of lake sediment weighed 4.0 grams, then the correction factor is 4.00 g/ 10.00 g = 0.40. If the analytical result was 10 ppm based on 10 grams, then it should be 0.40 x 10 ppm = 4 ppm based on 4 grams. The results could be written as 4 ppm or 4 $\mu g/cm^3$. Likewise, if a 10-gram scoop of lake sediment weighed 12 grams, then the correction factor is 12.00 g / 10.00 g = 1.20. If the analytical result was 10 ppm based on a 10 gram scoop, then it should be 1.20 x 10 ppm = 12 ppm based on 12 grams. The result could be written as 12 ppm or 12 $\mu g/cm^3$. These are all dry weight determinations.

Delineating Areas of Potential Nuisance Curlyleaf and Milfoil Growth: Delineating an area of potential nuisance plant growth is based on conventional soil survey methods. When a sediment sample analysis has a nitrogen reading over 10 ppm and has an organic matter content of less than 20%, it has a high potential for nuisance milfoil growth. For sediment results with a high growth potential collected in a cove, typically, the water depths in the cove from 5 to 7 feet would be designated as having a potential for nuisance growth. If high potential samples are found along a stretch of shoreline, a designated high potential area would be delineated until there was a shoreline break or change in sediment texture. In other cases, if the next site down the shoreline records a low potential reading, then the designated nuisance area would extend midway between a high and low potential sample sites.

Figure 2. Minnehaha Creek Watershed District staff assisted with Gleason Lake sediment collection on October 30, 2008.

Results

Potential for Heavy Growth of Non-native Invasive Plants Based on Lake Sediment Characteristics

A total of 27 sediment sites were sampled around Gleason Lake. Sediment sites and locations are shown in Table 2 and Figure 2.

Table 2. Gleason Lake sediment sample locations and field observations on October 30, 2008.

Sample ID	Sample Depth (ft)	GPS Coordinates (WGS 84 datum)		Notes
		East	North	
South Basin				
1	5	61 284	81 590	Soft, peaty sediments with coontail present.
2	7	61 120	81 462	
3	5	61 249	81 347	Peat - brackish, by some waterlilies.
4	7	61 244	81 085	
5	8	61 277	80 900	
6	8	61 256	80 664	
7	6	61 320	80 513	
8	6	61 389	80 334	
9/10	7	61 242	80 229	Replicate samples.
11	7	61 107	80 271	
12	8	61 046	80 481	
13	12.5	61 122	80 758	Middle of lake (no plants present).
14	7.5	60 986	80 717	
15	5	60 983	80 942	
16	9.5	61 137	80 972	Middle of lake (no plants present).
17	5	60 916	81 083	
18	2.5	60 784	81 330	White waterlily bed.
19	5.5	60 970	81 387	
20/21	6.5	61 083	80 277	An area of heavy curlyleaf pondweed growth (replicate samples).
North Basin				
22	4	61 204	80 755	
23	5	61 289	80 772	
24	3.5	61 233	80 937	
25	5	61 318	80 954	
26	4	61 413	80 891	
27	2	61 338	82 049	

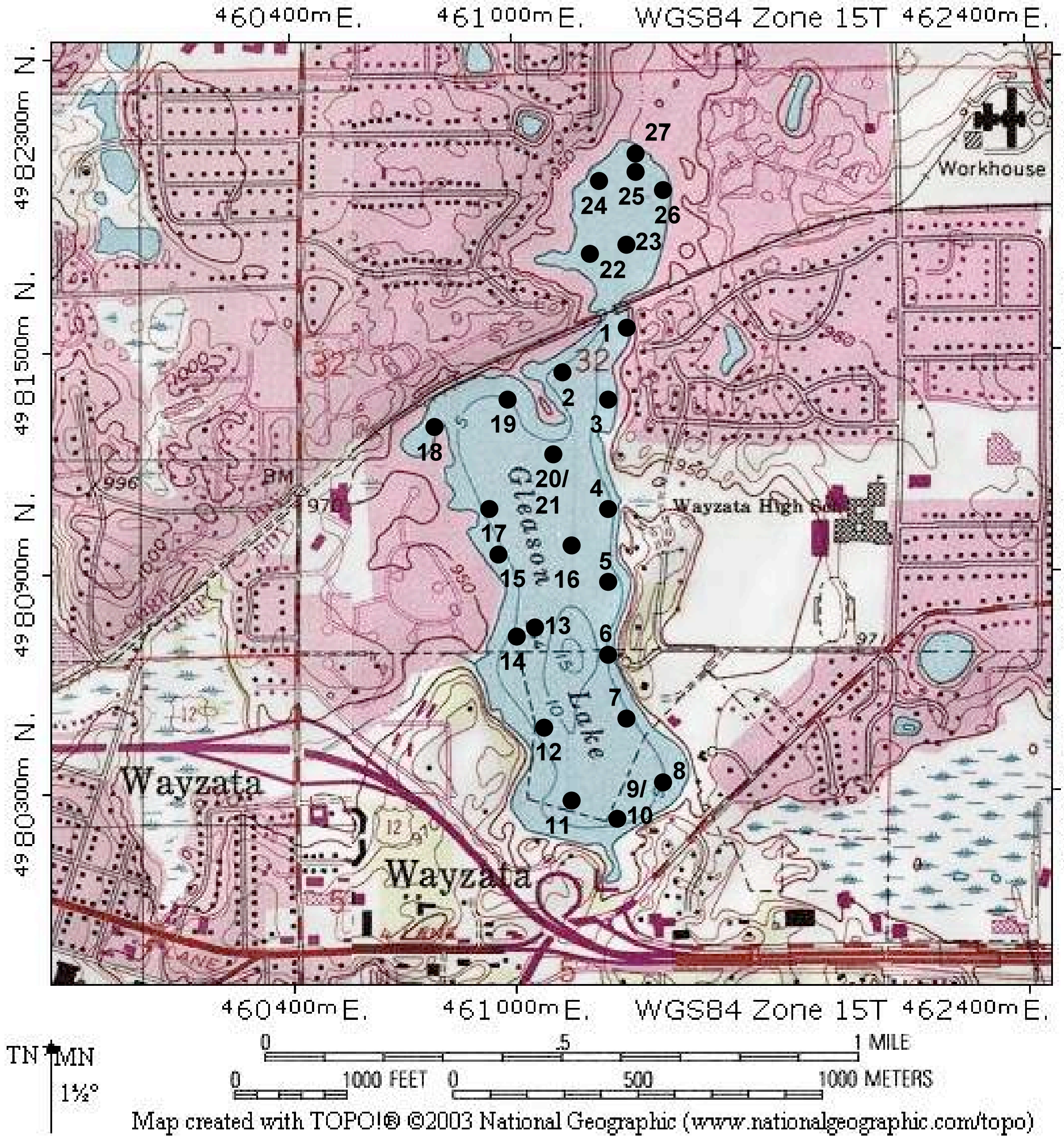


Figure 3. Lake sediment sample locations are shown with black circles.

Gleason Lake sediment results are shown in Table 3. A total of 15 parameters were analyzed for each sediment sample. A low bulk density (less than 0.60 g/cm^3) indicates lake sediments are soft and mucky. Most of Gleason Lake samples had high organic matter content. For other parameters, like phosphorus and nitrogen, concentrations were variable and ranged from low to high.

Table 3. Gleason Lake soil data. Sample were collected on October 30, 2008. Soil chemistry results are reported as μg/cm^3-dry which is equivalent to ppm except for organic matter (%) and pH (standard units).

Sample Number	Depth (ft)	Bulk Density (g/cm3)	O.M. (%) by L.O.I.	pH	Bray-P (ppm) (corr)	Olsen-P (ppm) (corr)	K (ppm) (corr)	Ca (ppm) (corr)	Mg (ppm) (corr)	Boron (ppm) (corr)	NH4-N (ppm) (corr)	Fe (ppm) (corr)	Cu (ppm) (corr)	Mn (ppm) (corr)	Zn (ppm) (corr)	SO4-S (ppm) (corr)
South Basin																
1	5	0.4853	39.8	6.8 / 6.8	6	4	41	1509	137	0.53	33.6	135	1.4	18	1.5	45
2	7	0.1888	59.2	6.7	1	0	4	252	31	0.16	38.9	29	0.2	2	0.1	2
3	5	0.2362	54.0	6.5	2	1	6	294	39	0.26	4.1	35	0.4	2	0.3	3
4	7	0.4516	56.8	6.6	5	1	24	820	95	0.65	14.5	107	0.5	7	0.8	21
5	8	0.5715	47.6	6.8	4	1	39	1471	189	0.57	8.2	111	1.4	15	1.2	34
6	8	1.5006	0.7	6.9	24	3	29	561	78	0.28	2.4	40	0.5	8	0.9	52
7	6	0.5844	20.1	6.9	3	1	37	1104	163	0.52	9.3	51	0.7	5	0.7	10
8	6	0.5781	54.7	6.5	4	2	40	985	142	0.90	50.0	154	0.9	11	0.7	11
9	7	0.3733	45.5	7.3	3	1	20	978	94	0.35	5.6	43	0.6	7	1.7	24
9R	7	0.3678	45.8	7.0	5	1	18	935	96	0.38	6.6	47	0.6	6	1.4	14
11	7	0.5472	50.0	7.3	4	2	30	1458	126	0.66	34.9	110	0.8	12	1.3	19
12	8	0.6992	42.6	7.0	4	2	61	2012	216	0.62	7.9	112	1.5	18	1.6	30
13	12.5	0.6514	51.5	7.0	40	4	48	1854	231	0.94	28.2	159	1.8	15	3.4	48
14	7.5	0.4693	28.8	7.4	3	1	42	1265	151	0.36	10.9	67	0.9	4	0.5	18
15	5	0.4454	46.5	7.3	3	1	28	1561	137	0.40	4.9	71	0.7	7	0.9	17
16	9.5	0.6761	57.8	6.8	12	1	48	1633	266	1.19	7.0	138	1.6	19	1.5	19
17	5	0.3443	48.7	7.1	3	1	16	669	68	0.34	11.9	44	0.4	4	0.6	5
18	2.5	0.4728	33.6	6.5	9	4	38	1293	195	0.57	48.8	142	1.2	14	1.4	24
19	5.5	0.3498	54.7	6.9	2	1	18	929	92	0.24	5.6	51	0.4	5	0.4	7
20	6.5	0.4007	51.8	7.2	2	1	18	1166	91	0.37	5.0	94	0.6	7	0.9	24
20R	6.5	0.4818	57.6	7.0	3	1	25	1075	98	0.52	4.2	105	0.7	8	1.0	23
North Basin																
22	4	0.1911	63.7	6.9	2	0	6	303	24	0.20	14.4	38	0.2	3	0.3	8
23	5	0.2640	62.1	7.0 / 7.0	5	2	7	561	43	0.30	31.9	119	0.2	7	0.3	7
24	3.5	0.2742	69.6	6.5	2	0	9	491	56	0.34	18.4	92	0.2	6	0.4	5
25	5	0.3561	49.3	6.4	4	2	20	849	93	0.53	54.4	159	0.8	11	1.4	20
26	4	0.2636	61.6	6.4	4	1	7	582	71	0.39	31.1	81	0.3	8	0.5	9
27	2	0.5061	37.1	6.7	5	5	52	1538	149	0.71	64.7	279	1.7	32	1.6	

Figure 4. Gleason Lake sediments were highly organic.

Curlyleaf Pondweed Growth Potential in Gleason Lake

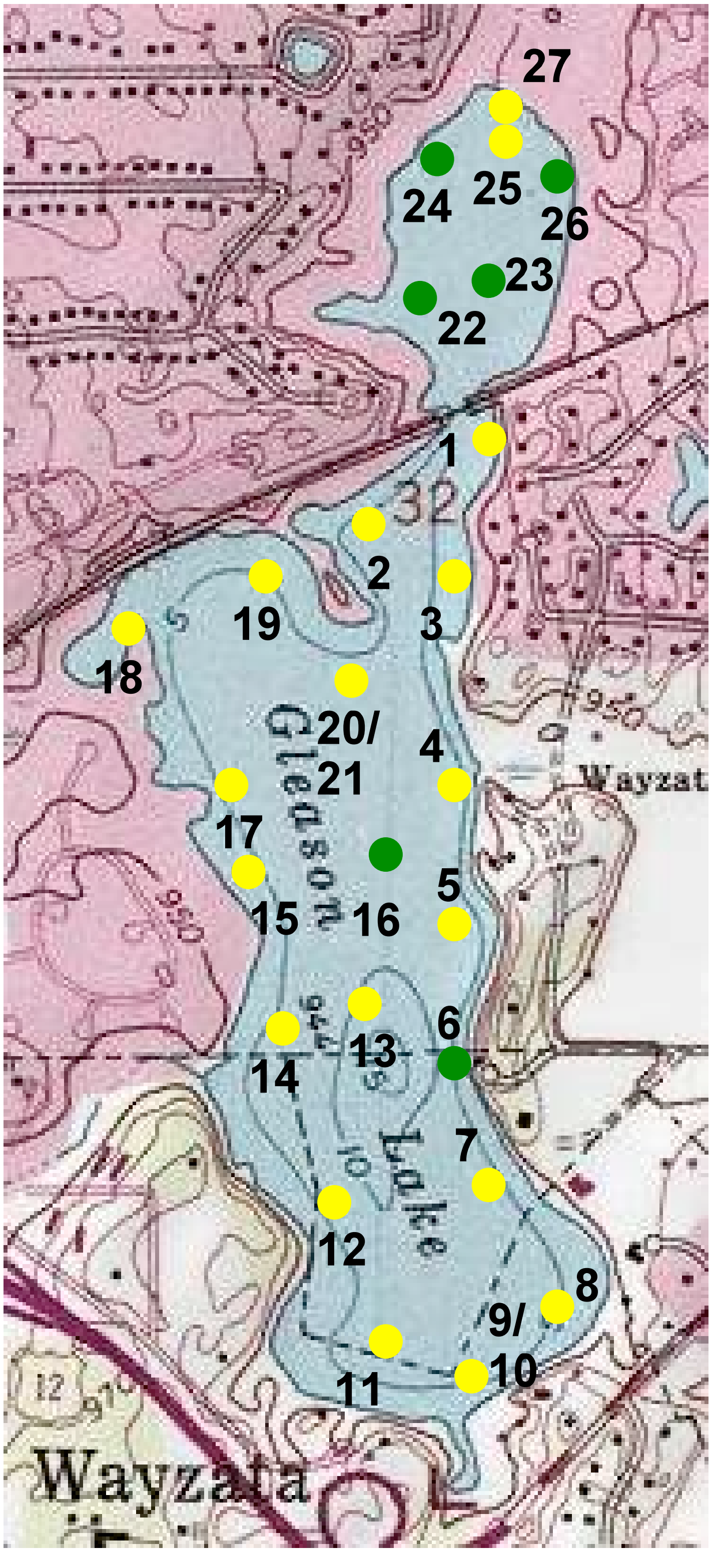
Lake sediment sampling results from 2008 have been used to predict lake bottom areas that have the potential to support three types of curlyleaf pondweed plant growth: light, moderate, or heavy. Based on the key sediment parameters of pH, the Fe:Mn ratio, sediment bulk density, and organic matter (McComas, unpublished), the predicted growth characteristics of curlyleaf pondweed are shown in Table 4 and Figure 5.

Curlyleaf pondweed growth is predicted to produce mostly moderate growth (where plants may occasionally top out in a broken canopy) in Gleason Lake.

Table 4. Gleason Lake sediment data and ratings for potential nuisance curlyleaf pondweed growth.

Site	Depth (ft)	pH (su)	Fe:Mn Ratio	Bulk Density (g/cm^3 dry)	Organic Matter (%)	Potential for Nuisance Curlyleaf Pondweed Growth
Light Growth		**<7.0**	**>6.0**	**1.04**	**5 - 10 >60**	**Low (green)**
Moderate Growth		**7.0 - 7.6**	**1.6 - 6.0**	**0.94**	**10 - 20 50 - 60**	**Medium (yellow)**
Heavy Growth		**>7.7**	**<1.6**	**<0.51**	**20 - 50**	**High (red)**
Main Basin						
1	5	6.8 / 6.8	7.6	0.49	39.8	Medium
2	7	6.7	15.2	0.19	59.2	Medium
3	5	6.5	18.7	0.24	54.0	Medium
4	7	6.6	15.2	0.45	56.8	Medium
5	8	6.8	7.6	0.57	47.6	Medium
6	8	6.9	5.0	1.50	0.7	Low
7	6	6.9	10.7	0.58	20.1	Medium
8	6	6.5	13.8	0.58	54.7	Medium
9	7	7.3	6.0	0.37	45.5	Medium
9R	7	7.0	7.6	0.37	45.8	Medium
11	7	7.3	9.3	0.55	50.0	Medium
12	8	7.0	6.2	0.70	42.6	Medium
13	12.5	7.0	10.9	0.65	51.5	Medium
14	7.5	7.4	16.9	0.47	28.8	Medium
15	5	7.3	10.3	0.45	46.5	Medium
16	9.5	6.8	7.2	0.68	57.8	Low
17	5	7.1	10.5	0.34	48.7	Medium
18	2.5	6.5	10.3	0.47	33.6	Medium
19	5.5	6.9	10.0	0.35	54.7	Medium
20	6.5	7.2	13.9	0.40	51.8	Medium
20R	6.5	7.0	12.5	0.48	57.6	Medium
North Basin						
22	4	6.9	14.6	0.19	63.7	Low
23	5	7.0 / 7.0	16.0	0.26	62.1	Low
24	3.5	6.5	16.4	0.27	69.6	Low
25	5	6.4	14.6	0.36	49.3	Medium
26	4	6.4	10.6	0.26	61.6	Low
27	2	6.7	8.7	0.51	37.1	Medium

Gleason Lake Curlyleaf Growth Potential Based on Lake Sediments



Light growth (left) refers to light nuisance growth that is mostly below the surface and is not a recreational or ecological problem. 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.

Figure 5. Sediment sample locations are shown with a circle. The circle color indicates the type of curlyleaf pondweed growth predicted to occur at that site. Key: green = light; yellow = moderate; red = heavy.

Predicted curlyleaf growth (Figure 6a) is similar to what was observed in Gleason Lake in 2008 (Figure 6b). If early season herbicide applications stopped and if sediment chemistry didn't change, curlyleaf would be expected to grow back to mostly moderate conditions in the main lake and mostly light conditions in the north basin.

Predicted Curlyleaf Pondweed Growth

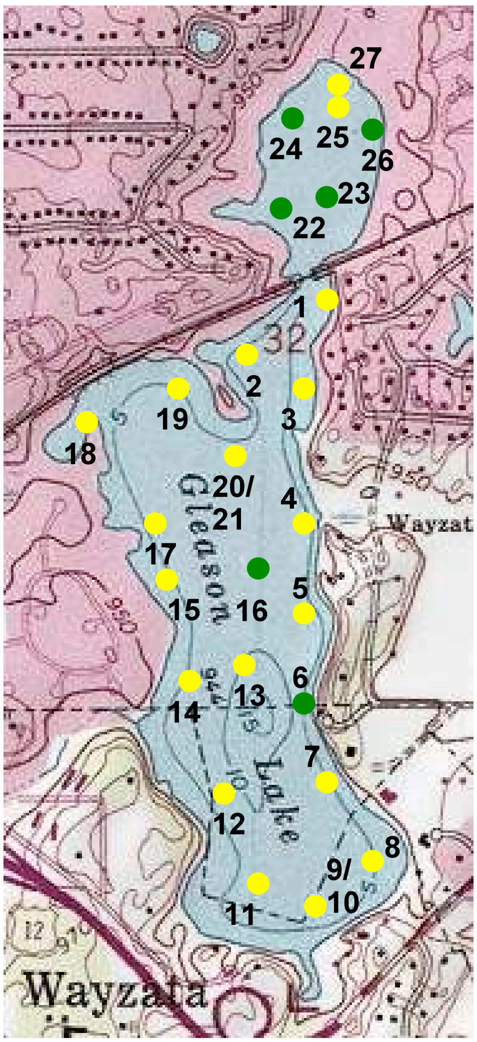


Figure 6a. Sediment sample locations are shown with a circle. The circle color indicates the type of curlyleaf pondweed growth predicted to occur at that site. Key: green = light; yellow = moderate; red = heavy.

Actual Curlyleaf Pondweed Growth - 2008

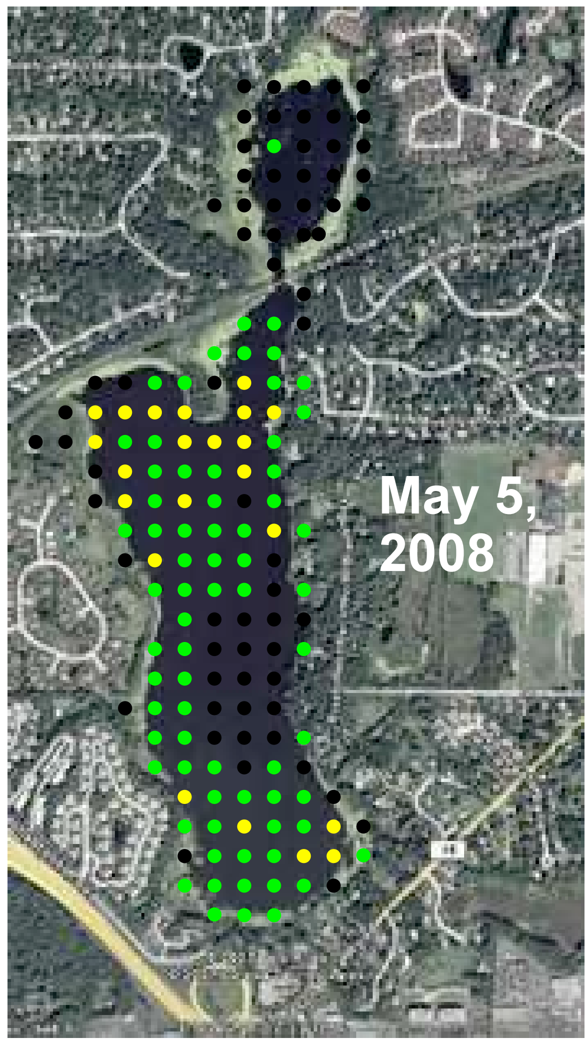


Figure 6b. Curlyleaf pondweed coverage for May 5, 2008 (pre-herbicide) conditions. Key: green = light growth and yellow = moderate growth.

Eurasian Watermilfoil Growth Potential in Gleason Lake

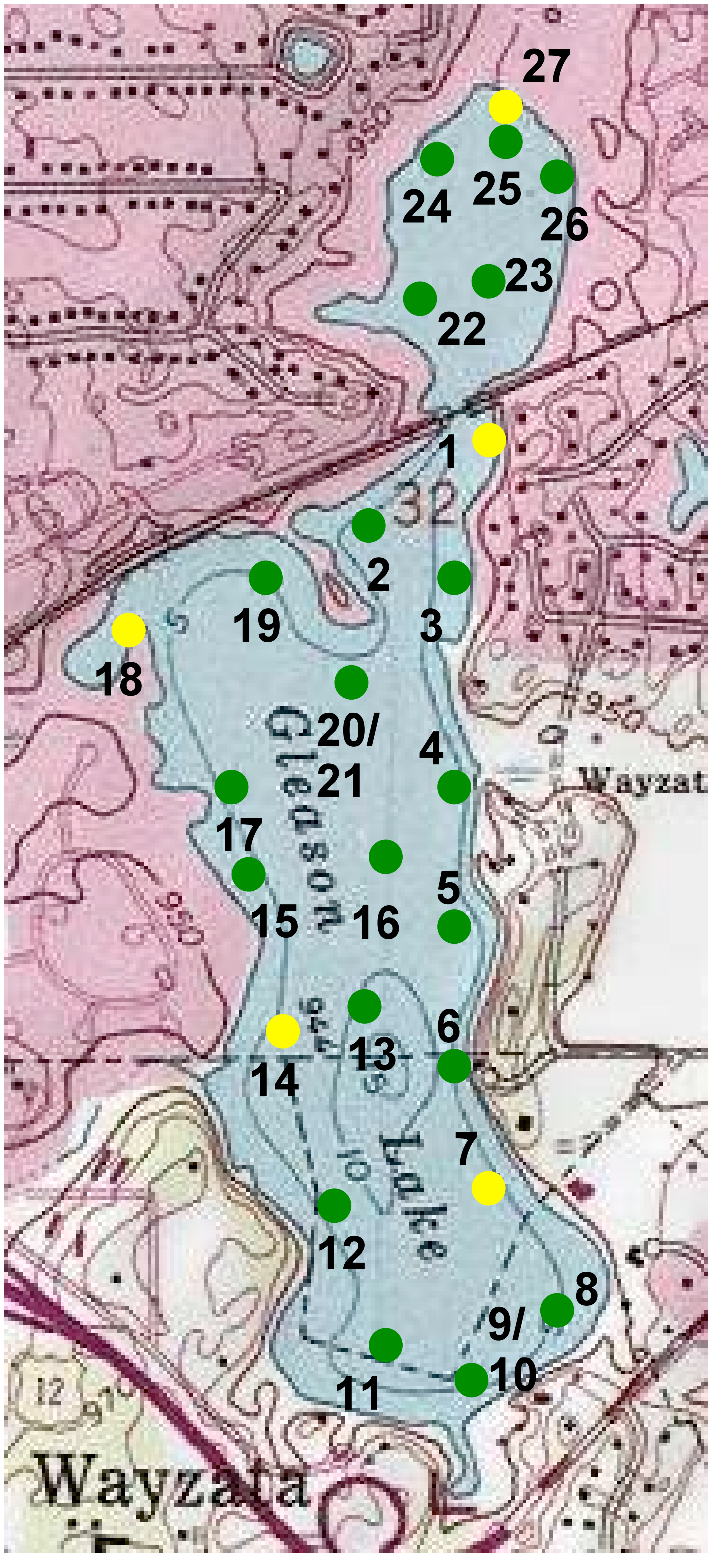
Lake sediment sampling results from 2008 have been used to predict lake bottom areas that have the potential to support three types of EWM growth. Eurasian watermilfoil has been in Gleason Lake since 1998. Based on the key sediment parameters of NH_4 and organic matter (McComas, unpublished), a table and map were prepared that predict what type of milfoil growth could be expected in the future (Table 5 and Figure 7).

The sediment nitrogen conditions in Gleason Lake range from low to high with sediments over 10 ppm of nitrogen as candidates for heavy milfoil growth. However, all the sediment sites, except for Site 6, have a high percentage of organic matter. It has been found that curlyleaf does not grow well in sediments with over 20% organic matter. Under current sediment conditions, no areas in Gleason Lake are predicted to exhibit heavy milfoil growth in Gleason Lake. Eurasian watermilfoil may grow widely through Gleason Lake in the future, but it is predicted that it not will produce extensive perennial nuisance matting conditions (which are defined as heavy growth conditions).

Table 5. Gleason Lake sediment data and ratings for potential nuisance EWM growth.

Site	Depth (ft)	NH_4 Conc (ppm)	Organic Matter (%)	Potential for Nuisance EWM Growth
Light Growth or Moderate Growth		<10	>20	Low (green) to Medium (yellow)
Heavy Growth		>10	0.6 - 20	High (red)
Main Basin				
1	5	33.6	39.8	Medium
2	7	38.9	59.2	Low
3	5	4.1	54.0	Low
4	7	14.5	56.8	Low
5	8	8.2	47.6	Low
6	8	2.4	0.7	Low
7	6	9.3	20.1	Medium
8	6	50.0	54.7	Low
9	7	5.6	45.5	Low
10	7	6.6	45.8	Low
11	7	34.9	50.0	Low
12	8	7.9	42.6	Low
13	12.5	28.2	51.5	Low
14	7.5	10.9	28.8	Medium
15	5	4.9	46.5	Low
16	9.5	7.0	57.8	Low
17	5	11.9	48.7	Low
18	2.5	48.8	33.6	Medium
19	5.5	5.6	54.7	Low
20	6.5	5.0	51.8	Low
21	6.5	4.2	57.6	Low
North Basin				
22	4	14.4	63.7	Low
23	5	31.9	62.1	Low
24	3.5	18.4	69.6	Low
25	5	54.4	49.3	Low
26	4	31.1	61.6	Low
27	2	64.7	37.1	Medium

Gleason Lake Eurasian Watermilfoil Growth Potential Based on Lake Sediments



Light growth (left) refers to light 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%.

Figure 7. Sediment sample locations are shown with a circle. The circle color indicates the type of Eurasian watermilfoil growth predicted to occur at that site. Key: green = light; yellow = moderate; red = heavy.

Predicted Eurasian watermilfoil growth (Figure 8a) based on lake sediment characteristics indicates that light growth is expected with the potential for moderate growth in a few areas. Actual Eurasian watermilfoil growth in Gleason Lake has been scarce. It has not been observed in the last 2 years during surveys. Milfoil was first observed in Gleason Lake in 1998, but it has not produced much of a presence in the lake.

Predicted Eurasian Watermilfoil Growth

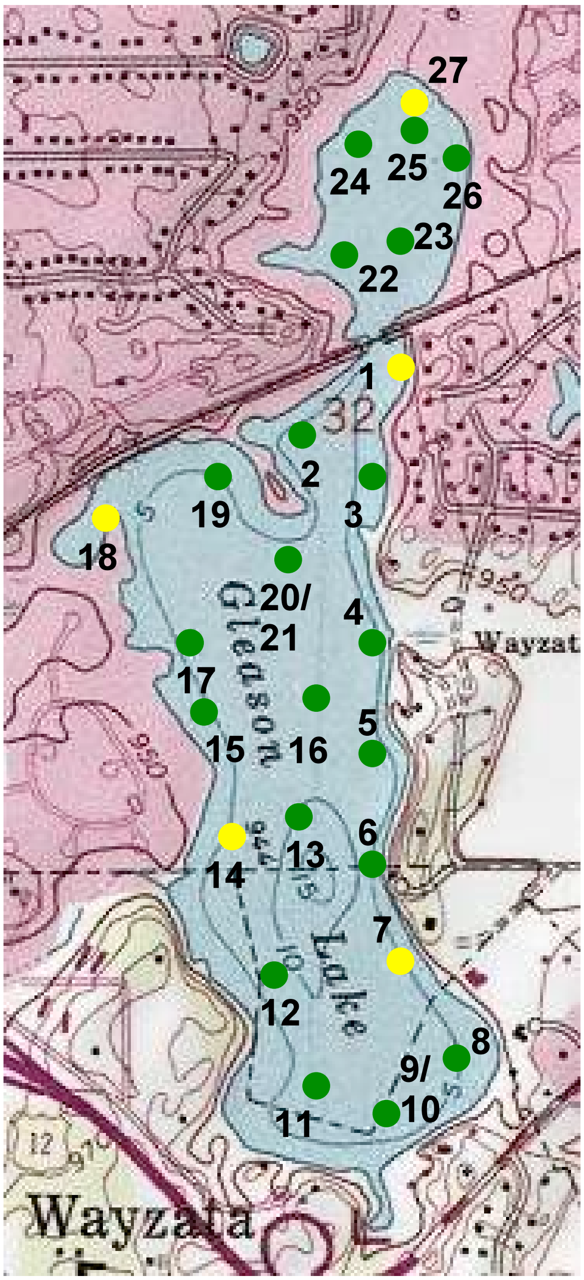


Figure 8a. Sediment sample locations are shown with a circle. The circle color indicates the type of Eurasian watermilfoil growth predicted to occur at that site. Key: green = light; yellow = moderate.

Actual Eurasian Watermilfoil Status - 2008

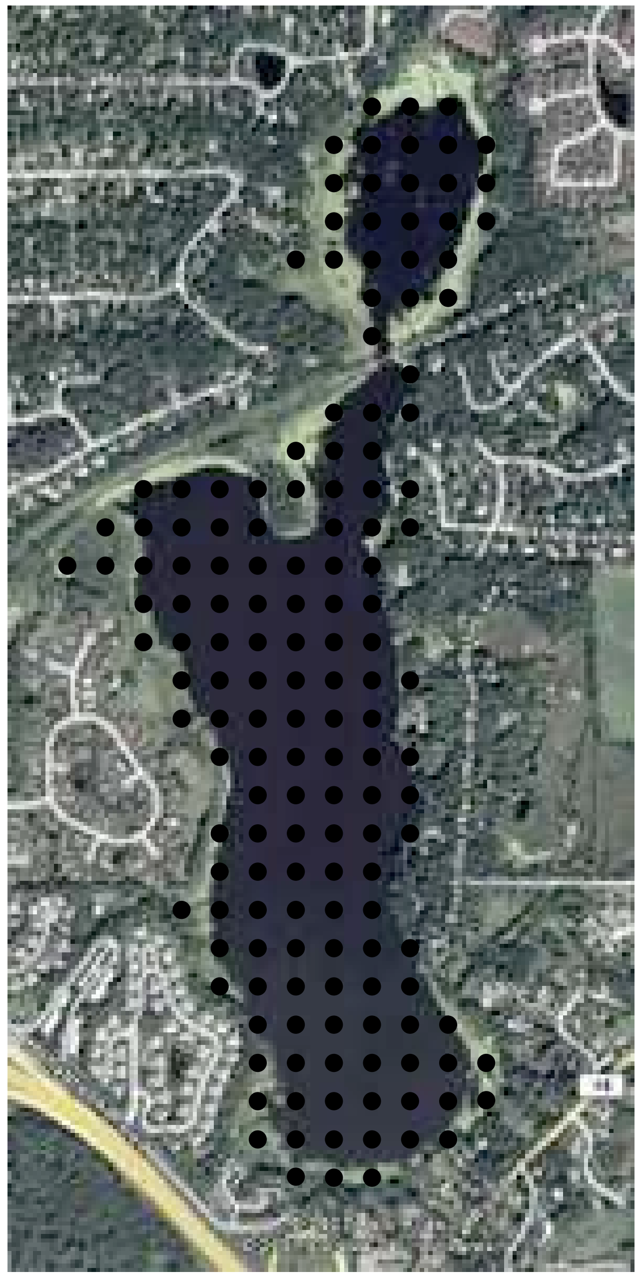


Figure 8b. Eurasian watermilfoil coverage for 2008 conditions. No Eurasian watermilfoil was observed in 2008.