

**Minnesota Dept. of Natural Resources
Division of Fish and Wildlife
Section of Fisheries**

**Aquatic vegetation point intercept survey of Green Lake (30-0136),
Isanti County, Minnesota**

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Introduction

Green Lake is an 832 acre lake located in western Isanti County in east central Minnesota (Figure 1). The lake basin is roughly oval in shape and shallow, with 43 percent of the surface area having a depth of 15 feet or less. The maximum depth is 28 feet. Green Lake is directly connected to Green Lake Brook, which drains to the Rum River and eventually the Mississippi River. The lake lies in the Anoka Sand Plain, an area characterized by well drained sandy soils. The total drainage area of Green Lake is 15,875 acres, resulting in a catchment: lake surface area ratio of 19:1. Predominant land cover types within the watershed include cultivated crops, deciduous forest, pasture or hay fields, and wetlands.

Green Lake has a history of algae blooms and low water clarity. A 1949 DNR Fisheries lake survey shows a Secchi depth of 1.8 feet in late August. Citizen volunteers and the Green Lake Improvement District have conducted Secchi transparency and water quality monitoring since the late 1980's. Data from 2004-2011 including total phosphorus, chlorophyll a, and Secchi depth, have been used to calculate Carlson's Trophic State Index (TSI) values for Green Lake. An overall mean TSI value of 57.6 for these years places Green Lake in the "eutrophic" category. No significant trends were found in the three water quality parameters from 2004-2011.

The aquatic vegetation community of Green Lake consists mainly of submerged vegetation, with very few emergent or floating leaf species present. The shallow, sandy shoreline areas would be capable of supporting beds of hardstem bulrush and other emergent vegetation, but there is little information available to indicate whether emergent vegetation beds were historically present. The 1949 Fisheries lake survey reported sago pondweed as the only species of aquatic vegetation of any type, and it was only found in isolated patches. Common carp entered the lake from the Rum River in 1941 and increased greatly in number in the 1940's. Carp may have been responsible for disturbing vegetation and reducing water clarity, limiting vegetation growth. Lake surveys from 1957-1992 reported varying amounts of submerged vegetation, usually dominated by species such as coontail which are tolerant of low water clarity.

Two non-native species of aquatic vegetation are present in Green Lake. Curlyleaf pondweed has been reported from vegetation surveys since 1971. Eurasian watermilfoil was first documented in Green Lake in 2000. A vegetation survey conducted by DNR Ecological Services (now Ecological and Water Resources) personnel in 2005 found Eurasian watermilfoil at 34 percent of sample points.

This vegetation survey was completed to update information from the 2005 survey, and to provide guidance for lake management planning efforts.

Methods

A point intercept vegetation survey was conducted on June 15, 2012, according to methodology described by Madsen (1999) and the Minnesota Department of Natural Resources (2008). Sample points, generated by GIS in a 70 by 70 meter grid, were the same points used in the 2005 point-intercept survey.

A Garmin GPSMap 298 GPS unit with color depth finder was used to navigate a boat to each sample point. Vegetation was observed on one side of the boat in an area approximately one meter square. A double headed garden rake was used to sample vegetation that could not be visually identified from the boat. The rake was tossed once at each sample point. Depth was measured with a stadia rod. The depth finder signal was used to determine the presence or absence of vegetation in deeper water. Several deep points that appeared to have no vegetation were verified by rake sampling. Once a maximum depth of vegetation growth was established, no points in areas deeper than 15 feet were sampled with the rake.

Data was entered in the field on a laptop computer using the DNR Fisheries Lake Survey application.

Results and discussion

Thirteen species of plants were sampled at survey points (Table 2). Plants were found growing to a maximum depth of 10.5 feet, although most species were found at depths of 8 feet or less. The most common plant species was curlyleaf pondweed, which was found at 36 percent of points. This is an increase from the 2005 survey, when curlyleaf pondweed was only sampled at 4 percent of points (Table 3). Muskgrass, Eurasian watermilfoil, small pondweed, and coontail were also found at over 15 percent of the sampling points. Muskgrass, small pondweed, and coontail showed increases in frequency compared with 2005, while bushy pondweed and Canada waterweed decreased. Plant communities can show considerable variability from year to year depending on plant life cycles, weather patterns, water levels, and water clarity, so these changes may or may not be part of an overall trend.

Eurasian watermilfoil was found at 28 percent of points, which is slightly lower than the 2005 frequency of 34 percent. Points where Eurasian watermilfoil was found were most often in the 4-7 foot depth range. The most dense beds of Eurasian watermilfoil were located in the northwest part of the lake and along the south shore (Figure 3). During the 1992 Fisheries lake survey, northern watermilfoil, a native milfoil closely related to Eurasian, was found growing abundantly throughout the lake in 2-5 feet of water. Dense mats of northern watermilfoil occurred on the north, west, and south portions of the lake, where Eurasian watermilfoil was most abundant in 2012. It appears that Eurasian watermilfoil has displaced northern watermilfoil in Green Lake, although other native species such as muskgrass and coontail are still common.

While Eurasian watermilfoil is considered an invasive species, from an aquatic ecosystem perspective it is providing habitat for fish and invertebrates. In a lake such as Green, with a limited number of plant species, the habitat value of milfoil must be considered in any aquatic vegetation management plan. Management goals for Eurasian watermilfoil should focus on reducing milfoil in areas where it creates nuisance conditions or special problems, such as at boat accesses. If Eurasian watermilfoil is not growing at nuisance levels and impeding recreational use, an acceptable management strategy may simply be monitoring.

Curlyleaf pondweed was sampled throughout the entire littoral area, with heaviest concentrations in the northwest and south portions of the lake (Figure 4). Although sampling took place during the usual peak of curlyleaf pondweed abundance, surface mats were observed only in small areas. While frequency of

occurrence increased from 2005 levels, it is unclear whether this is a trend or year to year variability. The lack of snow cover on ice in the winter of 2011-2012 likely contributed to increased curlyleaf pondweed growth on Green and other lakes. Unlike other pondweeds, curlyleaf grows underneath the ice in winter, reaching peak growth by late spring. By mid-summer curlyleaf pondweed stems die and release buds called turions, which form new plants in the fall. Curlyleaf pondweed can grow to nuisance levels, particularly in shallow, eutrophic basins with soft substrates, low densities of native plants and low water clarity (Valley et al 2004, Nichols 1999).

The relative health of a lake ecosystem can be assessed using measurements of plant or animal communities. A plant-based index of biotic integrity (IBI) was recently developed for Minnesota lakes (Beck et al. 2010). This index derives a numerical score from various aspects of point intercept survey data including maximum depth of plant growth, relative frequency of sensitive and tolerant species, and other factors (Table 5). Scores are on a scale of 0-100, with higher numbers indicating better condition of the plant community. The IBI score for Green Lake, 34.51, was lower than average for lakes in the Hinckley management area. More widespread use of the plant-based IBI will be required before detailed comparisons can be made.

References

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- Nichols, S.A. 1999. Distribution and habitat descriptions of Wisconsin lake plants. Wisconsin Geological and Natural History Survey, Bulletin 96. Madison.
- Valley, R.D., T.K. Cross, and P. Radomski. 2004. The role of submersed aquatic vegetation as habitat for fish in Minnesota lakes, including the implications of non-native plant invasions and their management. Minnesota Dept. of Natural Resources, Special Publication 160. St. Paul, Minnesota.

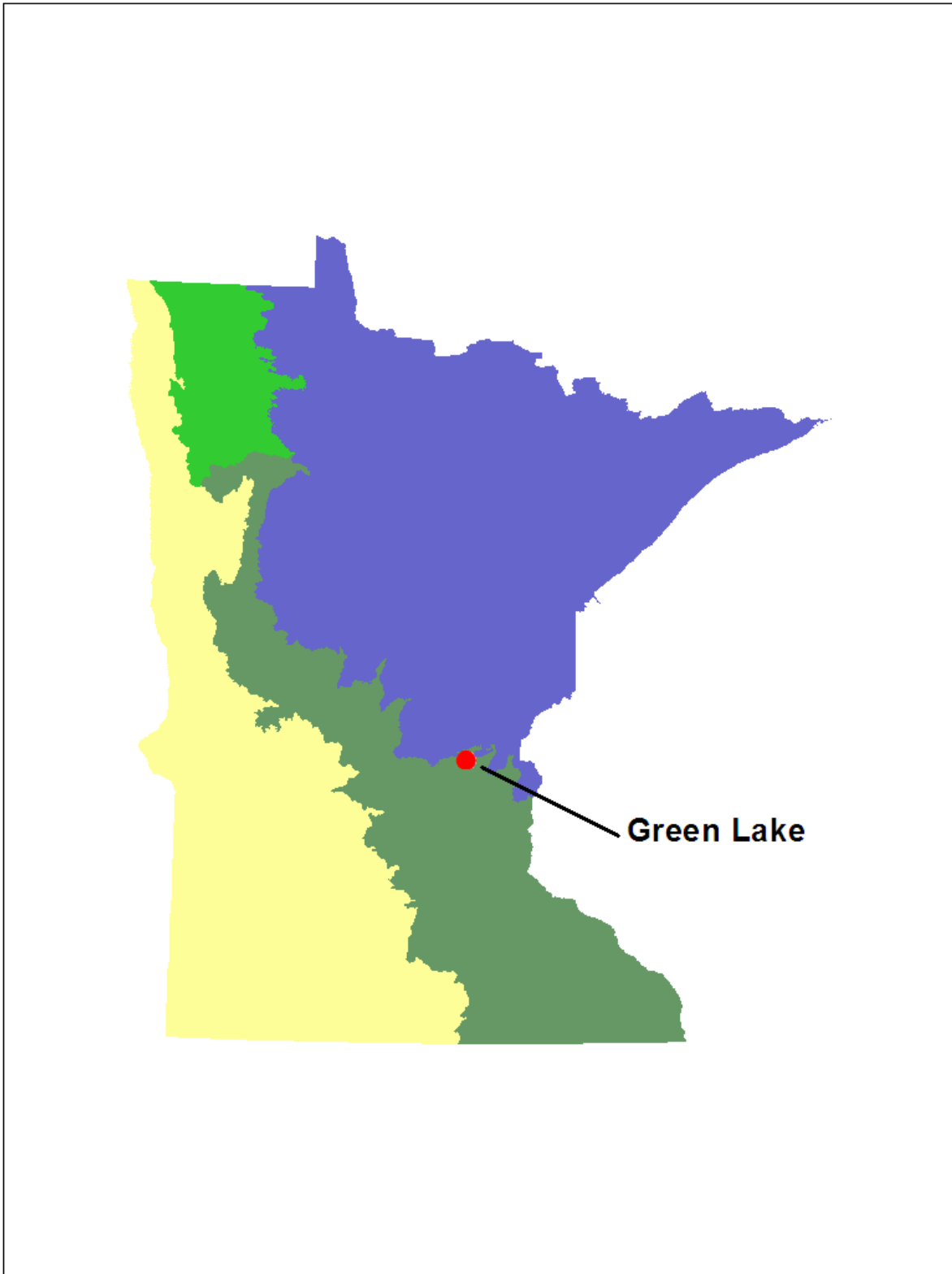


Figure 1. Location of Green Lake (30-0136), Isanti County, Minnesota.

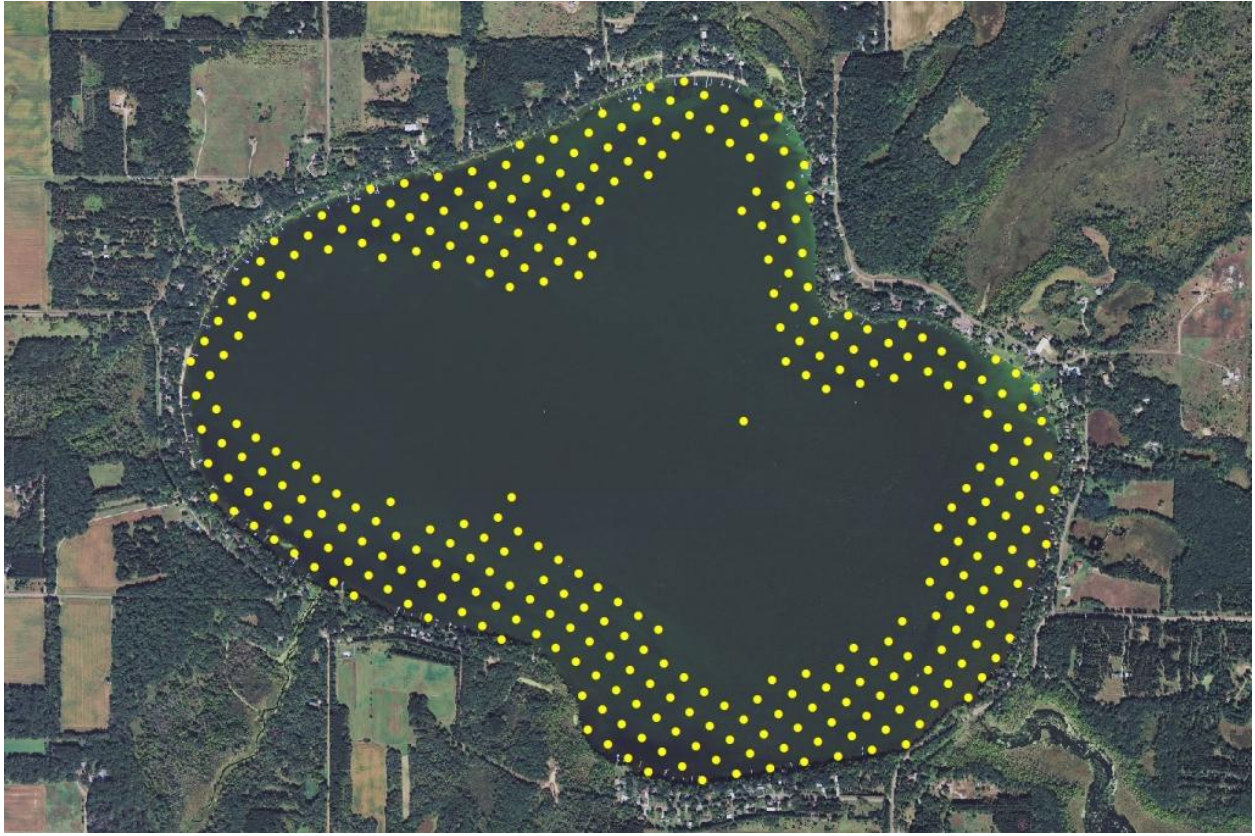


Figure 2. Grid of points sampled in the 2012 survey.

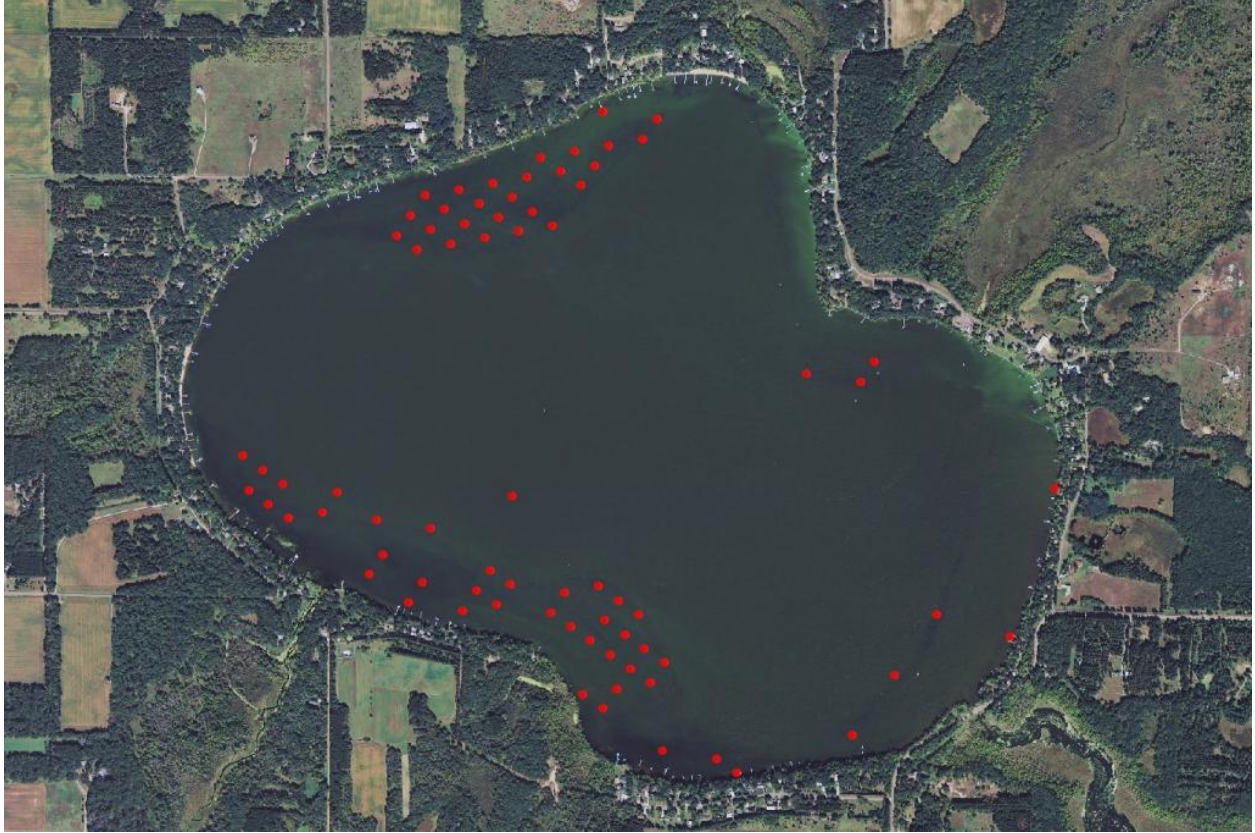


Figure 3. Points where Eurasian watermilfoil was sampled in 2012.

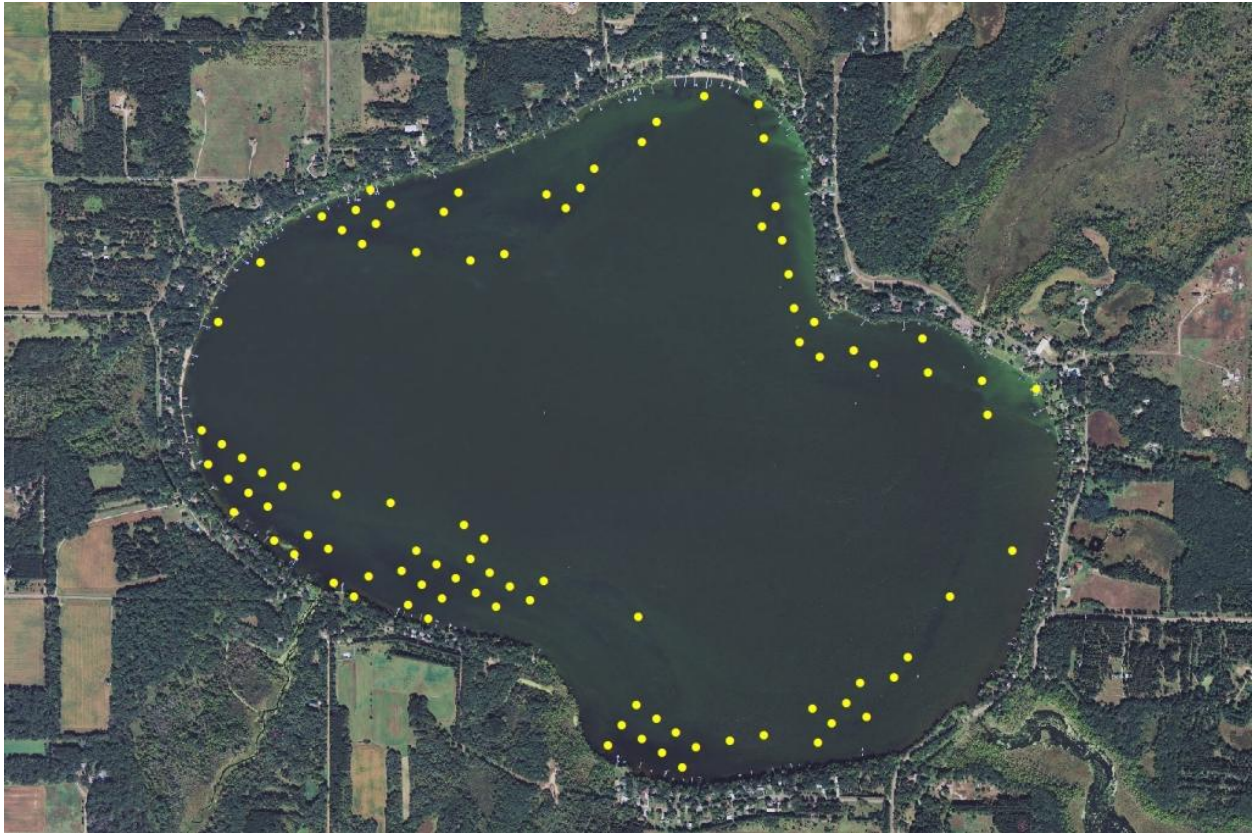


Figure 4. Points where curlyleaf pondweed was sampled in 2012

Table 1. List of aquatic plant species that have been recorded in Green Lake

Common name	Scientific name	Survey years
Emergent species (9 total)		
Broad leaved arrowhead	<i>Sagittaria latifolia</i>	B, C, D
Cane	<i>Phragmites communis</i>	C, D
Cattail	<i>Typha latifolia</i>	B, C, D, F
Great water dock	<i>Rumex orbiculatus</i>	F
Hardstem bulrush	<i>Scirpus acutus</i>	B,
Sedge	<i>Carex or Cyperaceae</i>	E, F
Swamp horsetail	<i>Equisetum fluviatile</i>	F
Swamp milkweed	<i>Asclepias incarnate</i>	F
Water smartweed	<i>Polygonum amphibium</i>	B, E
Submerged and floating leaf species (21 total)		
Berchtold's pondweed	<i>Potamogeton Berchtoldi</i>	C, D
Bushy pondweed	<i>Najas flexilis</i>	E, F, G
Canada waterweed	<i>Elodea canadensis</i>	B, E, F, G, H
Claspingleaf pondweed	<i>Potamogeton Richardsonii</i>	C, D, E, F, G, H
Coontail	<i>Ceratophyllum demersum</i>	B, C, D, E, F, G, H
Curlyleaf pondweed	<i>Potamogeton crispus</i>	C, D, E, F, G, H
Eurasian watermilfoil	<i>Myriophyllum spicatum</i>	F, G, H
Filamentous algae		H
Flatstem pondweed	<i>Potamogeton zosteriformis</i>	E
Greater duckweed	<i>Spirodela polyrhiza</i>	F, G
Lesser duckweed	<i>Lemna minor</i>	B, C, D, E, F, H
Muskgrass	<i>Chara sp.</i>	E, F, G, H
Narrowleaf pondweed	<i>Potamogeton sp.</i>	G, H
Northern watermilfoil	<i>Myriophyllum sibiricum (exalbescens)</i>	D, E, F, G
Sago pondweed	<i>Stuckenia pectinata</i>	A, B, E, F, G, H
Small pondweed	<i>Potamogeton pusillus</i>	H
Water meal	<i>Wolffia sp.</i>	F
White waterlily	<i>Nymphaea tuberosa</i>	B, D, E
Whitestem pondweed	<i>Potamogeton praelongus</i>	H
Wild celery	<i>Vallisneria americana</i>	E, F, H
Yellow water starwort	<i>Zosterella dubia</i>	F, G, H
Yellow waterlily	<i>Nuphar variegatum</i>	B, G

A) 1949 Fisheries lake survey; B) 1957 Fisheries lake survey; C) 1971 Fisheries lake survey; D) 1982 Fisheries lake survey; E) 1992 Fisheries lake survey; F) 2002 Fisheries lake survey; G) 2005 Ecological Services vegetation point intercept survey; H) 2012 Fisheries vegetation point intercept survey

Table 2. Aquatic plants sampled in Green Lake in 2012.

type	Common name	Scientific name	Frequency (%)
submerged	Curlyleaf pondweed	<i>Potamogeton crispus</i>	35.7
	Muskgrass	<i>Chara sp.</i>	29.8
	Eurasian watermilfoil	<i>Myriophyllum spicatum</i>	27.6
	Small pondweed	<i>Potamogeton pusillus</i>	18.8
	Coontail	<i>Ceratophyllum demersum</i>	17.7
	Sago pondweed	<i>Stuckenia pectinata</i>	3.7
	Canada waterweed	<i>Elodea canadensis</i>	2.2
	Narrowleaf pondweed	<i>Potamogeton sp.</i>	1.8
	Water stargrass	<i>Zosterella dubia</i>	0.7
	Whitestem pondweed	<i>Potamogeton praelongus</i>	0.7
	Claspingleaf pondweed	<i>Potamogeton Richardsonii</i>	0.7
	Water celery	<i>Vallisneria americana</i>	0.7
	Lesser duckweed	<i>Lemna minor</i>	0.4

number of points used in frequency calculation: 272

mean number of species per point = 1.4 (range 0-4)

number of points with no vegetation: 49 (16.9%)

maximum depth of vegetation growth: 10.5 feet

Table 3. Percent frequencies of aquatic plant species in Green Lake from point intercept surveys done in 2005 and 2012.

type	Common name	Scientific name	% Frequency	
			2005	2012
submerged	Bushy pondweed	<i>Najas flexilis</i>	53	present
	Curlyleaf pondweed	<i>Potamogeton crispus</i>	4	35.7
	Muskgrass	<i>Chara sp.</i>	4	29.8
	Eurasian watermilfoil	<i>Myriophyllum spicatum</i>	34	27.6
	Small pondweed*	<i>Potamogeton pusillus</i>	0	18.8
	Coontail	<i>Ceratophyllum demersum</i>	9	17.7
	Sago pondweed	<i>Stuckenia pectinata</i>	1	3.7
	Canada waterweed	<i>Elodea canadensis</i>	23	2.2
	Narrowleaf pondweed*	<i>Potamogeton sp.</i>	5	1.8
	Water stargrass	<i>Zosterella dubia</i>	2	0.7
	Whitestem pondweed	<i>Potamogeton praelongus</i>	0	0.7
	Claspingleaf pondweed	<i>Potamogeton Richardsonii</i>	1	0.7
	Water celery	<i>Vallisneria americana</i>	0	0.7
	Northern watermilfoil	<i>Myriophyllum sibiricum</i>	<1	0
free floating	Lesser duckweed	<i>Lemna minor</i>	0	0.4
	Greater duckweed	<i>Spirodela polyrhiza</i>	<1	0
floating	Yellow waterlily	<i>Nuphar variegata</i>	present	0

*Small pondweed and narrowleaf pondweed may have been combined under “narrowleaf pondweed” in 2005

Table 4. Plant-based index of biotic integrity (IBI) metrics and scores for Green Lake, 2012

Metric	Raw score	Scaled score
Maximum depth of plant growth (ft), 95% occurrence	7.9	3.74
Percentage of littoral vegetated	0.91	9.07
Number of species with frequency occurrence >10%	5	4.10
Relative frequency of submersed species	1.00	0.09
Relative frequency of sensitive species	0.00	0.00
Relative frequency of tolerant species	0.58	3.89
Number of native taxa	11	3.27
	IBI score (0-100)	34.51