Aquatic Vegetation of Green Lake
Isanti County, Minnesota
(DOW 30-0136-00)
June 14-15, 2005

Green Lake (DOW 30-0136-00) Isanti Co. June 15, 2005

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Summary

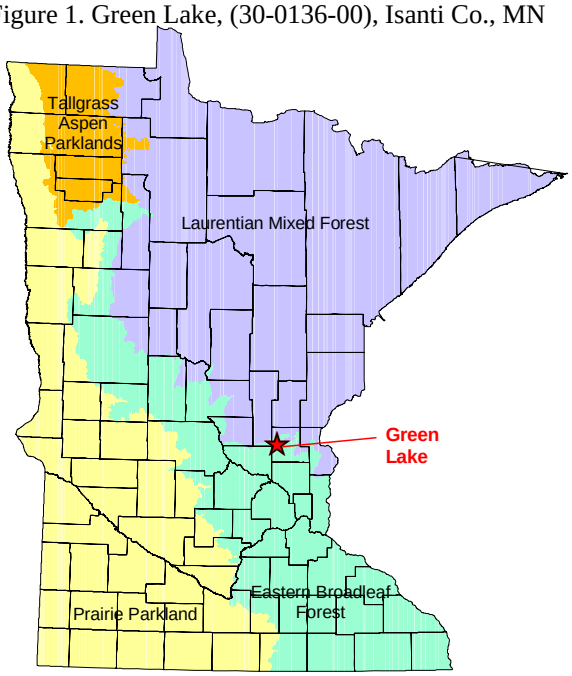
An aquatic vegetation survey of Green Lake (30-0136-00), Isanti County, Minnesota, was conducted on June 14-15, 2005. Submerged plants were found distributed throughout the lake basin to a maximum depth of fifteen feet, although most vegetation was restricted to water depths less than ten feet. Within the zone from shore to 15 feet, 83 percent of the sites contained vegetation. The aquatic plant community was primarily composed of species tolerant of low water clarity. Eleven native species were found and the most common were bushy pondweed, (*Najas* sp.) (found in 53 percent of the sample sites) and Canada waterweed (23 percent). All other native plant species were found in less than 10 percent of the sample sites. The non-native species, Eurasian watermilfoil (*Myriophyllum spicatum*) was the second most frequent species found, occurring in 34 percent of the sample sites. Another non-native species, curly-leaf pondweed *(Potamogeton crispus)* was found in only four percent of the sites.

A note to readers:

Text that appears in blue and underlined indicates a hyperlink to a web page. If you are viewing this report on a computer that is connected to the Internet, double-click on the hyperlink text to view additional information.

Introduction

Figure 1. Green Lake, (30-0136-00), Isanti Co., MN

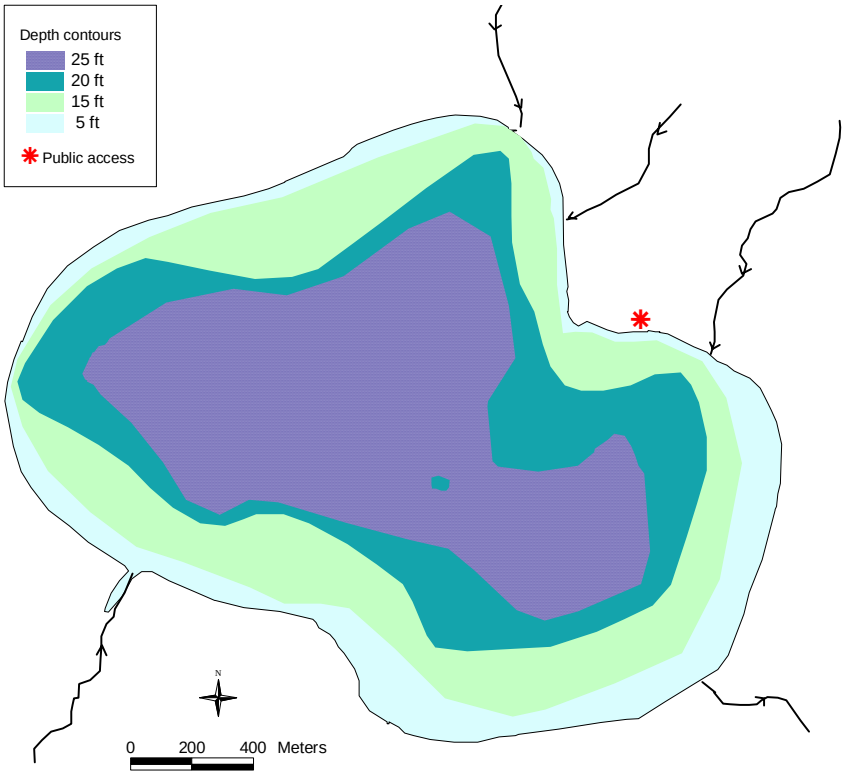


Survey Lake Description

Green Lake (DOW 30-0136-00) is located about ten miles west of the City of Cambridge in Isanti County, Minnesota (Fig. 1).

The lake is basically oval in outline with a surface area of 802 acres and a maximum depth of 28 feet. Approximately 50 percent of the lake is less than 20 feet deep, providing potential habitat for aquatic vegetation (Fig. 2). Green Lake receives inflow from several creeks and tributaries on the northeast and southwest end of the lake (Fig. 2). Green Brook is the outlet on the southeast end of the lake and is a tributary to the Rum River; during extreme spring water levels Green Brook flow can reverse into Green Lake (MNDNR Lake Files). The shoreline of Green Lake is developed with residential homes and a public boat access occurs on the north end (Fig. 2).

Figure 2. Depth contour map of Green Lake (Isanti Co) (DOW 30-0136-00).



The lake is described as eutrophic (high fertility) with heavy summer algal growth (MnDNR Lake Files). Mean summer water clarity as measured by Secchi depth between 1995 and 2005 was about five feet (MPCA 2005). Water clarity may fluctuate annually because it is strongly influenced by annual precipitation, which in turn influences nutrient loadings from the watershed into the lake (Ramthun 1992). In years with higher precipitation, higher phosphorous loadings from runoff are expected which may lead to higher

levels of algae and lower water clarity.

Previous aquatic vegetation surveys of Green Lake have been conducted in 1925 (Hotchkiss 1932), 1949, 1957, 1971, 1982, and 2002 (MNDNR Fisheries Lake Files). These surveys were conducted using various methods and the results are not always directly comparable but they provide a general description of the historic plant community. The maximum depth at which plants were found varied with water clarity. In 1971, during a period of clear water (Secchi Depth = 10 feet), plants were found to a depth of 15 feet. Previously, in 1957, plants were found to depths of only six to eight feet. In 2002 most vegetation was found in depths of five feet and less.

Bulrush (*Scirpus* spp.), white waterlily (*Nymphaea odorata*) and yellow waterlily (*Nuphar variegata*) have been recorded in Green Lake but their distribution has been limited. Ten native submerged species have been previously recorded and mostly include species that are tolerant of low water clarity (Nichols 1999): sago pondweed (*Stuckenia pectinata*), clasping-leaf pondweed (*Potamogeton richardsonii*), Canada waterweed (*Elodea canadensis*) and coontail (*Ceratophyllum demersum*).

Two non-native submerged species, curly-leaf pondweed (*Potamogeton crispus*) and Eurasian watermilfoil (*Myriophyllum spicatum*) occur in Green Lake. Curly-leaf pondweed was first recorded in 1971 and by 2002 it was found in 2/3rds of the sampling transects (MnDNR Lake Files). Eurasian watermilfoil was first documented in 2000 and in 2002 it was found in at least 50% of the sampling transects (MnDNR Lake Files); a 2004 survey found Eurasian milfoil along several shorelines and it formed surface mats along the of southwest end the lake (Crowell 2004) (Fig. 3).

Aquatic plant growth on Green Lake is controlled by mechanical harvesting and herbicide control through permits from the MnDNR. For more information about the laws pertaining to aquatic plant control, see: MnDNR Aquatic Plant Management Program.

Figure 3. Eurasian watermilfoil in Green Lake (30-0136-00) July 20, 2004.

Vegetation Survey Objectives
The purpose of the 2005 survey of Green Lake was to obtain quantitative, baseline data to describe the current aquatic plant community including:

1) Estimate the maximum depth of rooted vegetation
2) Estimate the percent of the lake occupied by rooted vegetation
3) Record the aquatic plant species that occur in the lake
4) Estimate frequencies of occurrence of individual species
5) Develop maps of the distribution of the common species

Methods

Vegetation Survey Methods
A Point-Intercept vegetation survey of Green Lake was conducted on June 14-15, 2005 following the methodology described by Madsen (1999). A Geographic Information System (GIS) was used to generate sample points across the lake surface in a 70 meter by 70 meter grid. In the field, surveyors decided not to sample in depths greater than 20 feet because vegetation was sparse beyond the 20 foot depth. As a result, 339 sites were actually sampled and 329 of those sites occurred within the zone from shore to the 20 feet depth (Fig. 4).

Figure 4. Vegetation sample sites on Green Lake (30-0136-00) Isanti Co. 2005.

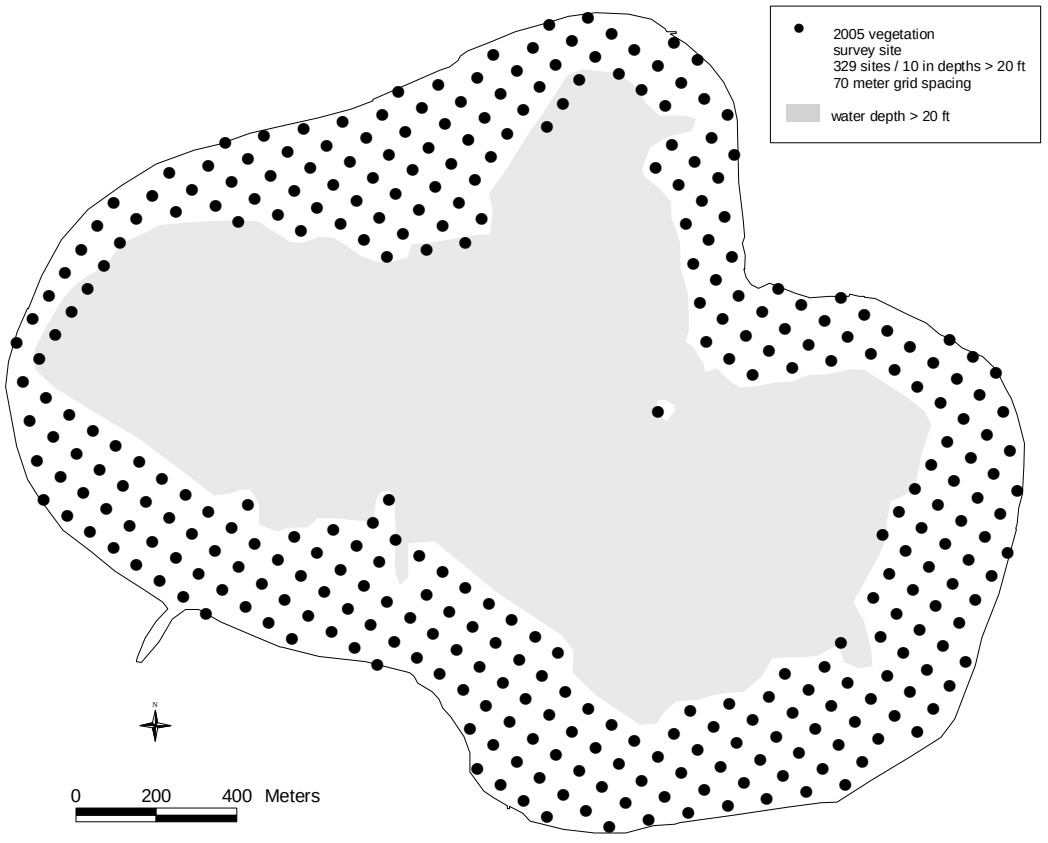


Figure 5: Rake used to sample vegetation.

After the survey points were generated in the GIS, they were uploaded into a Global Positioning System (GPS) unit, which was used to navigate the boat to each sample point. One side of the boat was designated as the sampling area. At each site, water depth was recorded in one foot increments using a measured stick in water depths less than eight feet and an electronic depth finder in water depths greater than eight feet. The surveyors recorded all plant species found within a one meter squared sample site at the pre-designated side of the boat. A double-headed, weighted garden rake (Fig. 5), attached to a rope was used to survey vegetation not visible from the surface. If non-native species such as curly-leaf pondweed (*Potamogeton crispus*) or Eurasian watermilfoil (*Myriophyllum spicatum*) were present at a site, surveyors recorded whether or not the plants formed surface mats at that site.

Nomenclature followed Crow and Hellquist (2000). Voucher specimens were collected for most plant species.

Data were entered into a Microsoft Access database and frequency of occurrence was calculated for each species as the number of sites in which a species occurred divided by the total number of sample sites. Frequency was calculated for the entire sampled area (0-20 feet) and sampling points were also grouped by water depth and separated into five depth zones for analysis: 0 to 5 feet, and 6 to 10 feet, 11 to 15 feet, and 16 to 20 feet.

Example: There were 329 sample sites within the shore to 20 feet zone.
Eurasian watermilfoil occurred in 113 of those sample sites.
Frequency of Eurasian watermilfoil = (113 / 329)*100 = 34%

Results

Distribution of vegetation by water depth

In Green Lake, aquatic plants were found in 75 percent of the sampled sites (Fig. 7) to a maximum depth of 15 feet. Within the shore to 15 feet zone, 83 percent of the sites were vegetated. Vegetation abundance varied with water depth and plants were most common in depths less than 11 feet where nearly 89 percent of

Figure 6. Sampling vegetation in Green Lake (30-0136) Isanti Co. June 14, 2006.

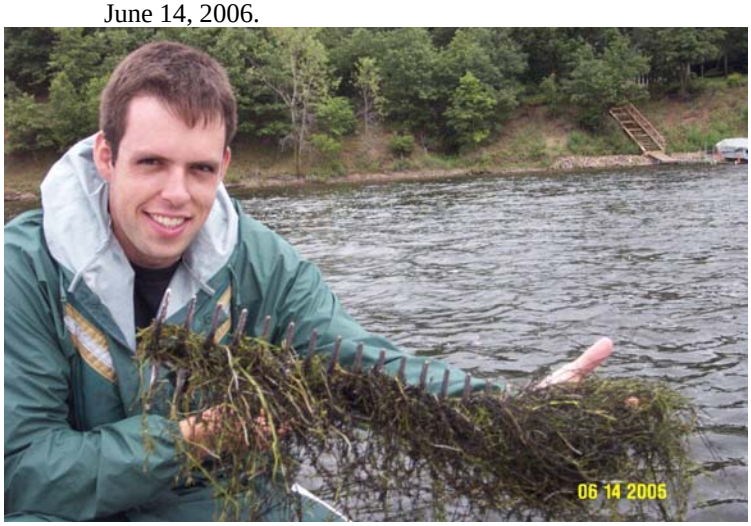
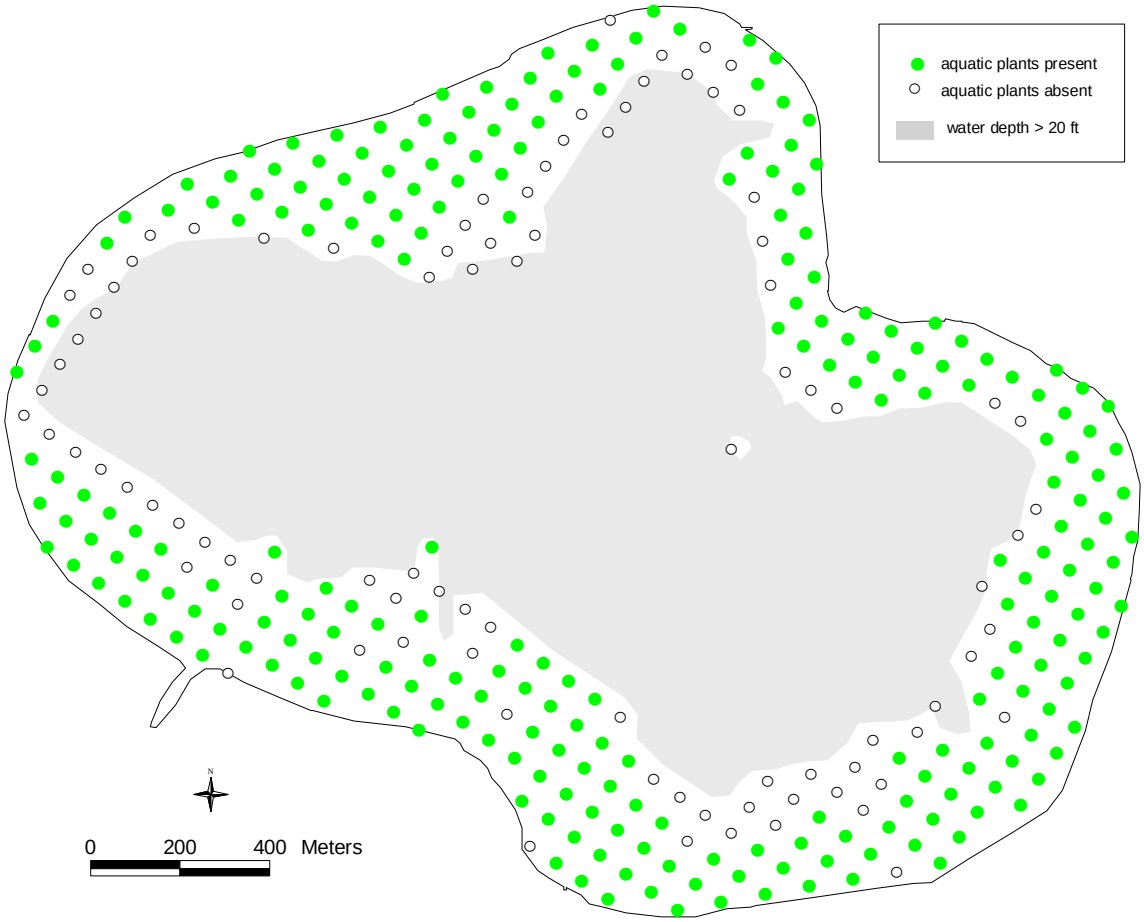
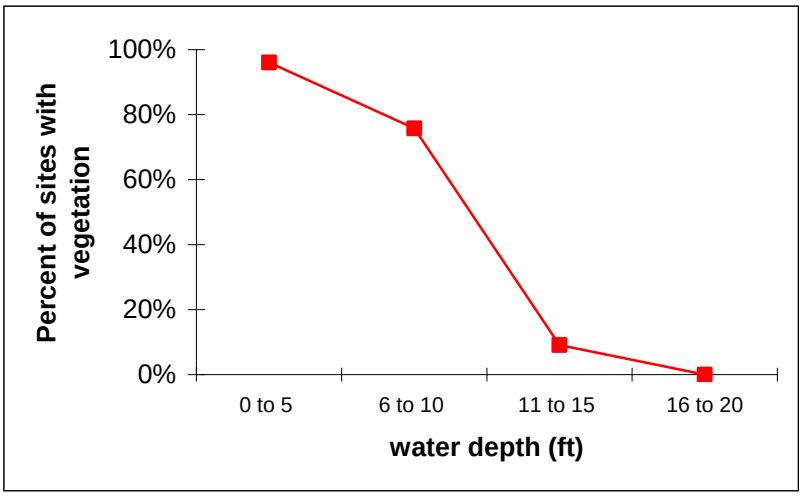


Figure 7. Location of surveyed sites in Green Lake (30-0136-00) that contained vegetation in 2005.



the sites were vegetated (Fig. 8). Maximum plant abundance occurred in depths less than six feet where 96 percent of the sample sites contained vegetation (Fig. 8).

Figure 8. Plant abundance by water depth. Green Lake (30-0136-00) June 14-15, 2005.



Types of aquatic plants found

Eleven taxa of native aquatic plants were identified during the survey, including nine submerged, one free-floating, and one floating-leaved species (Table 1). Two non-native submerged species, curly-leaf pondweed (*Potamogeton crispus*) and Eurasian watermilfoil *(Myriophyllum spicatum)*, were also observed during the survey.

Table 1. Aquatic Plants of Green Lake, Isanti Co. (DOW 30-0136-00). June 14-15, 2005

Frequency calculated for vegetated zone (shore to 20 feet depth)
Frequency = percent of sites in which species occurred
329 sample sites

Life Forms	Common Name	Scientific Name	Frequency
SUBMERGED	Bushy pondweed	*Najas flexilis*	0.53
	Eurasian watermilfoil	*Myriophyllum spicatum*	0.34
	Canada waterweed	*Elodea canadensis*	0.23
	Coontail	*Ceratophyllum demersum*	0.09
	Narrow-leaf pondweed	*Potamogeton sp.*	0.05
	Curly-leaf pondweed	*Potamogeton crispus*	0.04
	Muskgrass	*Chara sp.*	0.04
	Water stargrass	*Zosterella dubia*	0.02
	Clasping-leaf pondweed	*Potamogeton richardsonii*	0.01
	Sago pondweed	*Stuckenia pectinata*	0.01
	Northern water milfoil	*Myriophyllum sibiricum*	<0.01
FREE-FLOATING	Greater duckweed	*Spirodela polyrhiza*	<0.01
FLOATING	Yellow waterlily	*Nuphar variegata*	present

The majority of the vegetated sites contained only one or two species (Fig. 9) and most species were restricted to water depths less than 10 feet.

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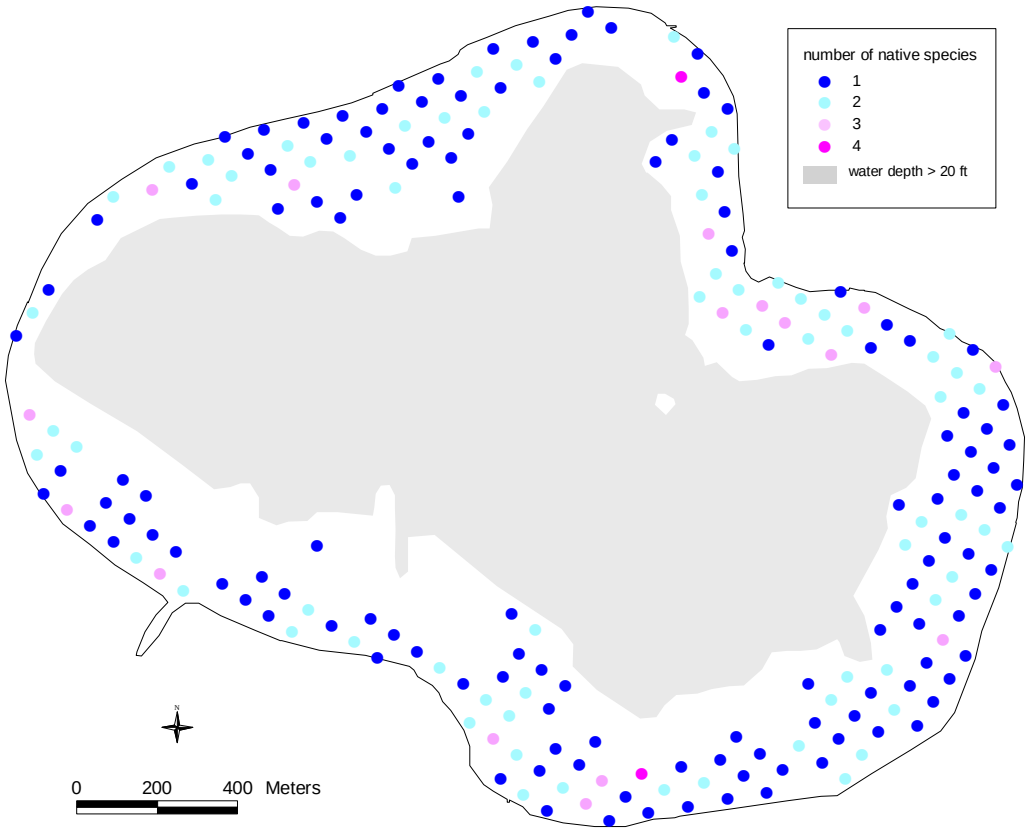
Figure 9. Number of native taxa in Green Lake (30-0136-00), Isanti Co., June 14-15, 2005



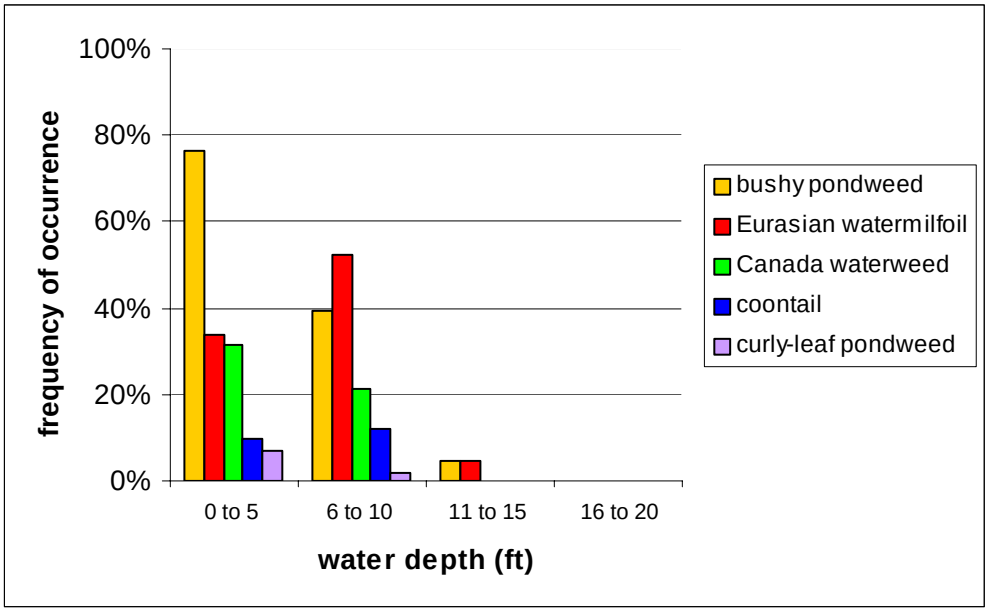
Common native plants

The most common native plant was bushy pondweed (*Najas* sp.) which occurred in 53 percent of the sample sites within the shore to 20 foot zone (Table 1). Bushy pondweed is a native, low-growing annual plant (Fig. 10) and germinates each year from seed. It was found to a maximum depth of 11 feet but was most frequent in depths less than six feet where it was the most frequently occurring taxa (Fig. 11).

Figure 10. Bushy pondweed (*Najas sp*)

Canada waterweed (*Elodea Canadensis*) was present in 23 percent of the sites (Table 1) and was found to a depth of eight feet. All other native submerged species were found in less than 10 percent of the sample sites and included Coontail (*Ceratophyllum demersum*), narrowleaf pondweed (*Potamogeton* sp.), Muskgrass (*Chara* sp.), water stargrass (*Zosterella dubia*), clasping leaf pondweed (*Potamogeton richardsonii*), sago pondweed (*Stuckenia pectinata*) and Northern watermilfoil (*Myriophyllum sibiricum*).

Figure 11. Frequency of common aquatic plants in Green Lake by depth.



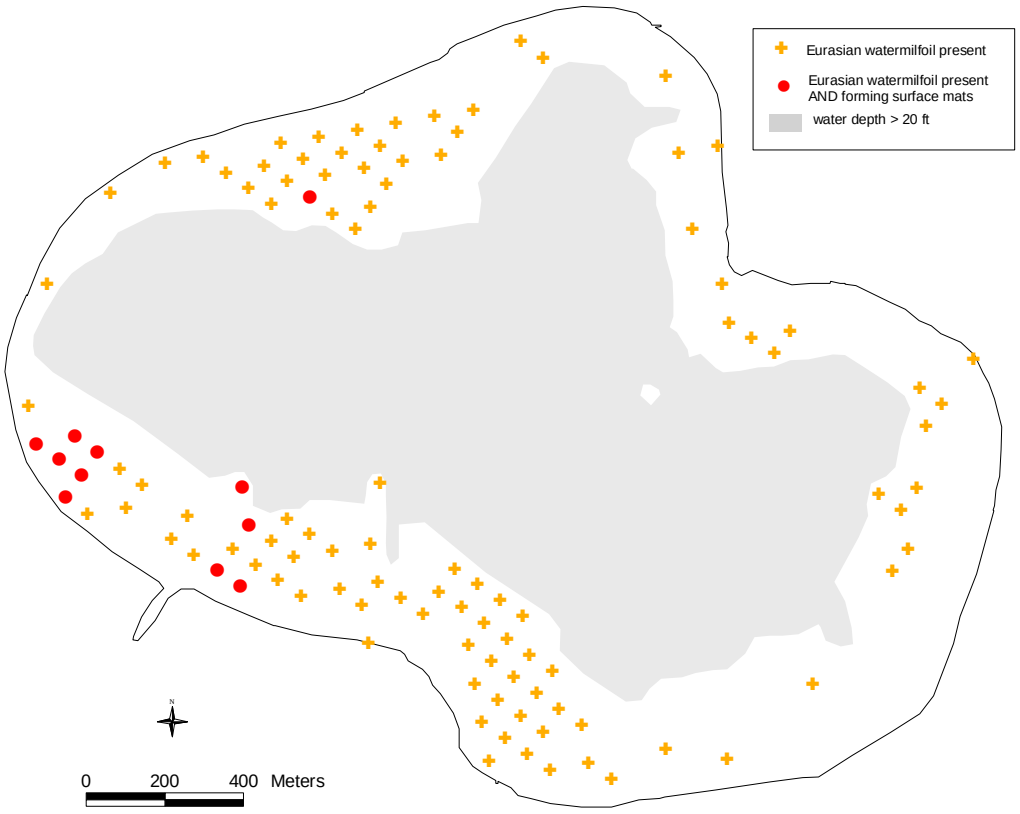
Non-native plants

The non-native species, Eurasian watermilfoil (*Myriophyllum spicatum*) (Fig. 12) was found in 34 percent of the sample sites within the shore to 20 feet zone (Table 1). It occurred to a depth of 15 feet but was most common in depths of eight feet and less (Fig. 11). Eurasian watermilfoil was found at numerous locations around the lake and formed surface mats at the southwest end of the lake (Fig. 13). This non-native species is adapted to survive in lower light levels than many native aquatic plants but still requires adequate light for growth. Lower clarity in Green Lake likely prevents this species from becoming abundant at depths greater than eight feet. In comparison, the native species, northern watermilfoil (*Myriophyllum sibiricum*) is not tolerant of low light levels and was found in less than one percent of the sample sites (Table 1).

Fig. 12. Eurasian watermilfoil (*Myriophyllum spicatum*).

Curly-leaf pondweed (*Potamogeton crispus*) (Fig. 14.) is a non-native, submerged plant that has been present in Minnesota since at least 1910 (Moyle and Hotchkiss 1945) and is now found in at least 700 Minnesota lakes (Invasive Species Program 2005). Like many native submerged plants, it is perennial but it has a unique life cycle which may provide a competitive advantage over native species. Curly-leaf pondweed is actually dormant during late summer and begins new growth in early fall. Winter foliage is produced and continues to grow under ice (Wehrmeister and Stuckey, 1978). Curly-leaf reaches its maximum growth in May and June,

Fig. 13. Distribution of Eurasian watermilfoil in Green Lake, June 14-15, 2005.

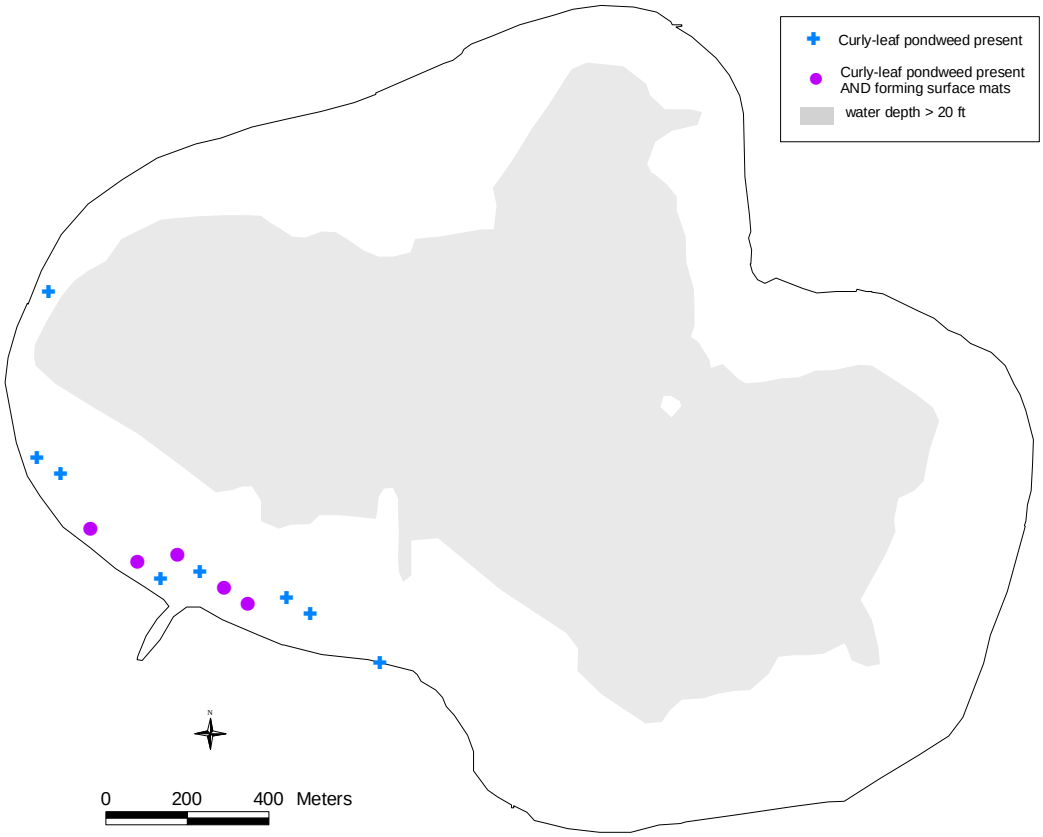


when water temperatures are still too low for most native plant growth. In late spring and early summer, curly-leaf plants form structures called "turions" which are hardened stem tips that break off and fall to the substrate. Turions remain dormant through the summer and germinate into new plants in early fall (Catling and Dobson, 1985).

During the 2005 survey of Green Lake, curly-leaf pondweed was identified in only four percent of the survey sites (Table 1). It occurred to a depth of seven feet but was more common in depths less than six feet (Fig. 11). Curly-leaf was most often found along the southwestern shore of Green Lake (Fig. 15).

Figure 14. Turions forming at tips of curly-leaf pondweed (*Potamogeton crispus*) plants.

Fig. 15. Distribution of curly-leaf pondweed (Potamogeton crispus) in Green Lake, June 14-15, 2005.



Aquatic habitat and change in Green Lake plant community over time

A broad zone of shallow water provides ideal conditions for aquatic plants in Green Lake. Although non-native species are present, the plant community still provides critical habitat for the fish and wildlife of the lake.

The 2005 vegetation survey gives a "snapshot" of Green Lake conditions. Data collected during the 2005 survey can be compared to future quantitative surveys of Green Lake to better estimate how the plant community may be changing. Monitoring changes in aquatic plant communities can help reflect changes in the overall water quality of the lake and watershed.

In general, factors that may lead to change in native and non-native aquatic plant communities include:

- **Change in water clarity**
  Light availability is a significant factor limiting plant distribution and abundance. The amount of light available to submersed aquatic plants is typically dependent on both water clarity and depth. Excess nutrients, such as elevated phosphorus levels, often result in nuisance algal levels that contribute to decreased water clarity. If Green Lake water clarity increases, native submerged vegetation may be more common at depths greater than 15 feet.
- **Snow and ice cover**

Curly-leaf pondweed, in particular, may fluctuate in abundance in response to snow and ice cover. Many native submerged plants also have the ability to grow under the ice, particulary if there is little snow cover and sunlight reaches the lake bottom. In years following low snow cover, and/or in years with shorter ice over periods, curly-leaf and some native submerged plants may increase in abundance.

- **Water temperatures / length of growing season**
  In years with cool spring temperatures, submerged plants may be less abundant than in years with early springs and prolonged warm summer days.
- **Natural fluctuation in plant species.**
  Many submerged plants are perennial and regrow in similar locations each year. However, a few species such as bushy pondweed (*Najas* sp.*)* are annuals and are dependant on the previous years seed set for regeneration.
- **Aquatic plant management activities**
  Herbicide and mechanical control of aquatic plants can directly impact the aquatic plant community. Monitoring these control activities can help insure that non-target species are not negatively impacted.
- **Shoreland management activities**
  Most of Green Lake shoreline has been converted to year round residential homes. In order to maintain the relatively good water quality that promotes a healthy aquatic plant community, efforts should be made to minimize disturbance to the aquatic environment through the use of shoreline best management practices. These include minimizing activities that contribute to eutrophication (high-nutrient lake with poor water quality due to nuisance algal blooms) such as fertilizing lawns and malfunctioning septic systems, both of which add nutrients to a lake. Additionally, the Green Lake aquatic ecosystem would benefit from implementing lakescaping and shoreline restoration. A strip of shoreline vegetation provides a buffer zone between the lake and developed residential areas. Benefits include minimizing soil erosion from wave action while the plants uptake excess nutrients that may otherwise flow into the lake.

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