Aquatic Vegetation of Green Lake

(ID #34-0079-00)

Kandiyohi County, Minnesota

2009

Green Lake, August 2009.

Minnesota
DEPARTMENT OF NATURAL RESOURCES

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This report should be cited as:
D. Perleberg and S. Loso. 2010. Aquatic Vegetation of Green Lake (DOW 34007900), Kandiyohi County, Minnesota, 2009. Minnesota Dept. of Natural Resources, Ecological Resources Division, 1601 Minnesota Drive, Brainerd, MN 56401. 14 pages.

Summary

Green Lake is the largest lake in Kandiyohi County, with a surface area of about 5,400 acres. Relatively high water clarity and broad shallow zones provide extensive potential habitat for aquatic vegetation but windswept shorelines limit the amounts of rooted vegetation.

Vegetation was sampled at 287 sites within the 0-30 feet depth zone and 64% of the sites contained plants. Plants were found to a depth of 28 feet and were most frequent in the 11 to 20 feet depth zone, where 91% of the sites were vegetated; in shallower water, plant frequency was 55% and in deeper water it was 45%.

Macroalgae dominated the plant community, occurring in 62% of the sample sites. Muskgrass (*Chara* sp.) was the dominant plant in the 0 to 20 feet depth zone and stonewort (*Nitella* sp.) was the most frequent plant in depths greater than 20 feet.

Rooted plants were found in only 5% of all sites and were most frequent in depths less than 6 feet, where they occurred in 14% of the sites. Native submerged plants included coontail (*Ceratophyllum demersum*), native pondweeds (*Potamogeton* spp.), northern watermilfoil (*Myriophyllum sibiricum*), and the rare plant, widgeon grass (*Ruppia maritima*).

The non-native submerged plant, Eurasian watermilfoil (*Myriophyllum spicatum*), was found in 1% of the sample sites and occurred in depths of 5 to 9 feet.

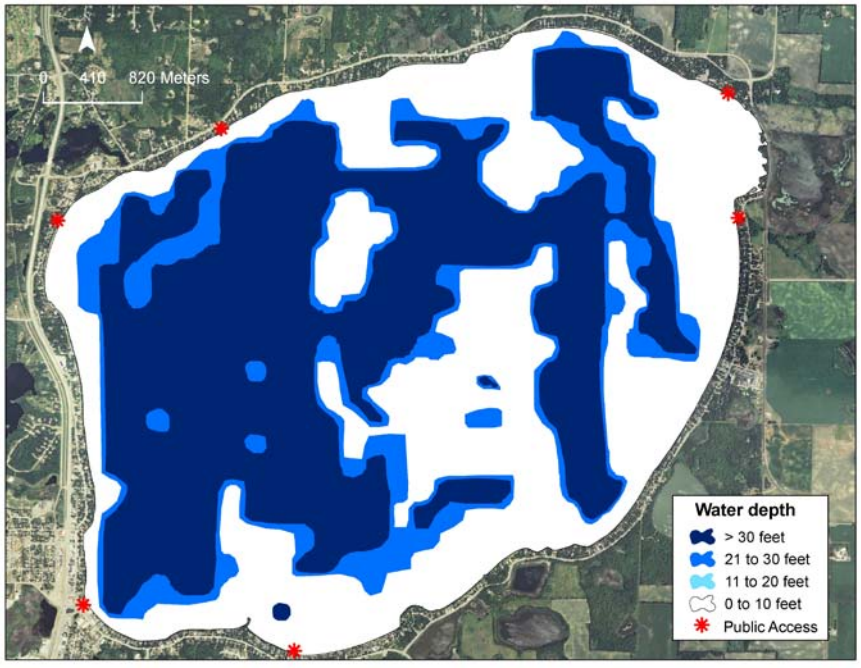
Introduction

Figure 1. Location of Green Lake in the Middle Fork Crow River Watershed, Kandiyohi County, Minnesota.

Green Lake is located near the town of Spicer in Kandiyohi County, south central Minnesota. The lake lies in the Middle Fork Crow River watershed (Figure 1). The Middle Fork of the Crow River begins in the southwest corner of Stearns County and flows southeast about 57 miles, connecting a series of lakes, including Green Lake. Green Lake receives inflow from Nest Lake and outlets to Calhoun Lake.

Green Lake is the largest lake in the county and in the watershed with a surface area of about 5,400 acres. The lake is primarily round in outline and measures about 3.5 miles in width with about 12 miles of shoreline. The lake is also the deepest in the county and watershed with a maximum depth of 110 feet. The mean lake depth is 27 feet and about a fourth of the lake basin is shallow (10 feet or less in depth) (Figure 2). The eastern half of the lake has the broadest shallow zones with some shallow bars extending more than a mile into the lake.

Figure 2. Green Lake depth contours (based on 2009 survey data).



Green Lake is described as mesotrophic (moderate nutrients), with good water clarity. In 2008, the average summer Secchi disc reading was 11 feet (MPCA, 2008). With extensive shallow areas and relatively clear water, Green Lake has the potential to support abundant aquatic plant growth. However, the lake is heavily wind-swept which limits rooted plant growth.

Previous vegetation surveys of Green Lake have found submerged plant growth as deep as 40 feet. At least 18 different native submerged plants have been identified in the lake (DNR Fisheries Lake Files) with muskgrass (*Chara* sp.) historically dominating the plant community. Emergent bulrush *(Schoenoplectus* sp.) beds occur at two locations: the south side of the lake and at the outlet on the east end of the lake. The non-native plant, curly-leaf pondweed (*Potamogeton crispus*) has been previously recorded in the lake (DNR Fisheries Lake Files). The non-native plant, Eurasian watermilfoil (*Myriophyllum spicatum*) was found in the lake in 2000.

This survey provides a quantitative description of the 2009 plant population in Green Lake. Specifically, it describes:

1. The general distribution of vegetation within the lake including depth zone where majority of vegetation occurs
2. The abundance (frequency) and distribution of commonly occurring plant taxa.

This survey was designed to estimate the lakewide distribution of the commonly occurring plant taxa and was not intended to map all locations of less frequently occurring plants. Site specific searches may be more appropriate for that objective.

This survey was conducted in late July when most native plants are at peak growth. It was not designed to describe the distribution of the non-native plant, curly-leaf pondweed, which reaches peak growth earlier in the year. A spring (mid May to mid June) survey would be required to adequately assess curly-leaf pondweed abundance and distribution.

Methods

Green Lake was surveyed on July 28 and 29, 2009. A point-intercept (grid) survey method was used and followed the methods described by Madsen (1999). Survey waypoints were created using a Geographic Information System (GIS) computer program and downloaded into a handheld Global Positioning System (GPS) receiver. Survey points were placed across the entire lake and spaced 200 meters (256 feet) apart.

The survey was conducted by boat and surveyors sampled 287 sites within the shore to 30 feet depth zone (Figure 3, Table 1). A GPS unit was used to navigate the boat to each sample point. At each point, water depth was recorded in one-foot increments using a measured stick in water depths less than seven feet and an electronic depth finder in depths greater than seven feet.

Surveyors recorded all plant taxa found within a one square meter sample site at a pre-designated side of the boat. A double-headed, weighted garden rake, attached to a rope was used to survey vegetation not visible from the surface (Figure 4). Plant identification and nomenclature followed MnTaxa (2009).

Figure 3. 2009 vegetation survey sites in Green Lake.

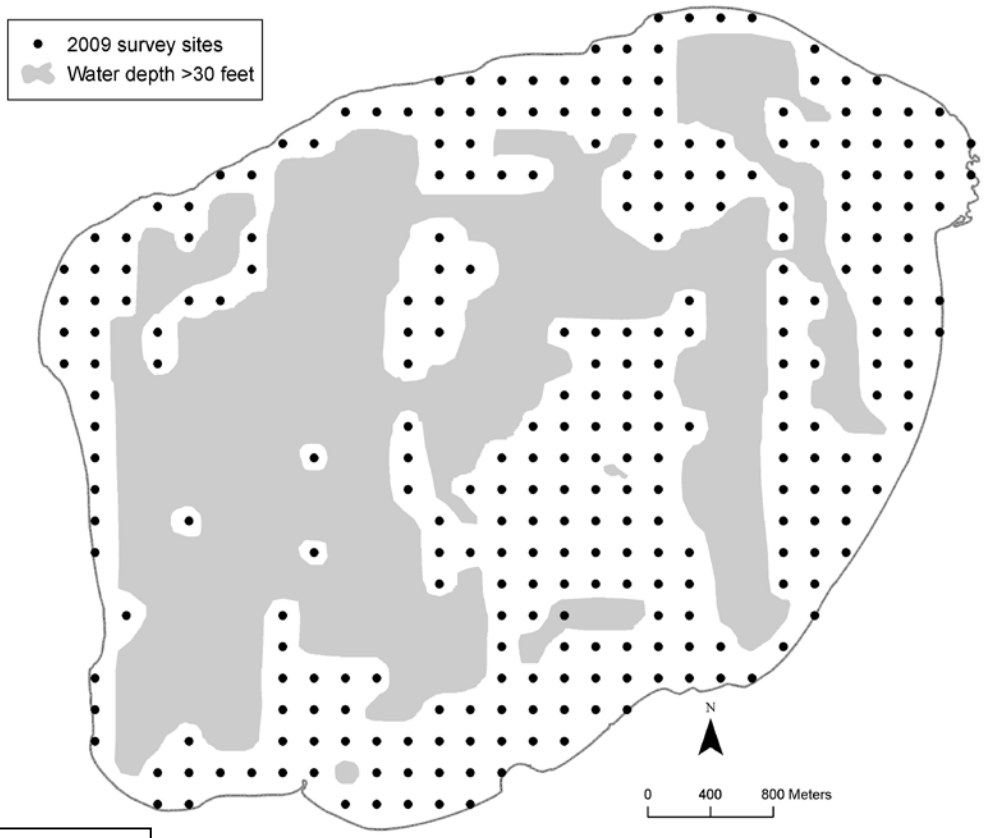


Figure 4. Sampling rake.

Table 1. Sampling effort by water depth.

Water depth interval (feet)	Number of sample sites
0 to 5	51
6 to 10	108
11 to 15	53
16 to 20	24
21 to 25	24
26 to 30	27
total	287

Frequency of occurrence was calculated as the percent of sites in which taxa occurred (See example). Frequency of occurrence was calculated for the entire 0 to 30 feet depth zone as well as each of the six depth zones sampled (Table 1).

Example:
There were 287 samples sites in the 0-30 feet zone.
Muskgrass (*Chara* sp.) occurred in 155 sites.
Muskgrass frequency in 0-30 feet zone = (155/287)*100 = 54%

Surveyors described bottom substrate at each sample site where water depth was seven feet and less. Standard substrate classes were used (Table 2) and if several substrate types occurred at a site, surveyors recorded the most common type.

Table 2. Substrate classes

muck	decomposed organic material
marl	calcareous material
silt	fine material with little grittiness
sand	diameter less than 1/8 inch
gravel	diameter 1/8 to 3 inches
rubble	diameter 3 to 10 inches
boulder	diameter over 10 inches

Results

Shoal substrates
The shoal substrates of Green Lake were hard substrates of sand, gravel and rubble.

Number and types of plants recorded
A total of 28 aquatic plant taxa have been recorded in Green Lake in recent years (Table 3). The in-lake plant community includes 23 submerged, one floating-leaved and four emergent plant taxa (Table 3). The submerged plants include macroalgae and rooted, leafy plants. A rare (Special Concern) submerged species, widgeon grass (*Ruppia maritima*) was documented for the first time in 2009. Two non-native submerged plants, curly-leaf pondweed (*Potamogeton crispus*) and Eurasian watermilfoil (*Myriophyllum spicatum*), occur in the lake.

Distribution of aquatic plants
Within the sampled area (0 to 30 feet), 63% of the sites contained vegetation (Figure 6). This vegetated area covers about 50% of the lake but plant growth was not continuous within this zone. Vegetation was most frequent in the 11 to 20 feet depth zone, where 91% of the sites were vegetated; in shallower water, plant frequency was 55% and in deeper water it was 45% (Figure 7).

Table 3. Aquatic plants present in Green Lake July 2008 and August 2009 (with frequency values provided from 2009 survey).

(Frequency is the percent of 2009 sample sites in which a plant taxon occurred. There were 287 sample sites in the 0-30 ft water depth.)

Life Form		Common Name	Scientific Name	Frequency N=287
SUBMERGED	Large Algae and Mosses	Muskgrass	*Chara* sp.	54
		Stonewort	*Nitella* sp.	9
		Water moss	*(not identified to genus)*	*
	Pondweeds	Illinois pondweed	*Potamogeton illinoensis*	1
		Clasping-leaf pondweed	*Potamogeton richardsonii*	<1
		River pondweed	*Potamogeton nodosus*	*
		Robbin's pondweed	*Potamogeton robbinsii*	*
		Flat-stem pondweed	*Potamogeton zosteriformis*	*
		Narrow-leaf pondweed	*Potamogeton* sp.	<1
		Fries' pondweed	*Potamogeton friesii*	P
		Sago pondweed	*Stuckenia pectinata*	*
		Curly-leaf pondweed	*Potamogeton crispus*	*
	Grass-leaf plants	Widgeon grass	*Ruppia maritima*	1
		Water celery	*Vallisneria americana*	*
		Water star-grass	*Zosterella dubia*	<1
	Small-leaf plants	Bushy pondweed	*Najas flexilis*	<1
		Canada waterweed	*Elodea canadensis*	*
	Divided-leaf plants	Eurasian watermilfoil	*Myriophyllum spicatum*	1
		Northern water milfoil	*Myriophyllum sibiricum*	<1
		Coontail	*Ceratophyllum demersum*	1
		Greater bladderwort	*Utricularia vulgaris*	<1
		Mare's tail	*Hippuris vulgaris*	*
		Water buttercup	*Ranunculus* sp.	*
FLOATING-LEAF		Floating-leaf pondweed	*Potamogeton natans*	P
EMERGENT		Hard-stem bulrush	*Schoenoplectus acutus*	1
		Arrowhead	*Sagittaria* sp.	<1
		Narrow-leaf cattail	*Typha angustifolia*	P
		Needlerush	*Eleocharis* sp.	*

P = present during survey, but not in survey sites
*= not detected during 2009 survey but documented in 2008

Figure 6. Distribution of aquatic plants in Green Lake, 2009

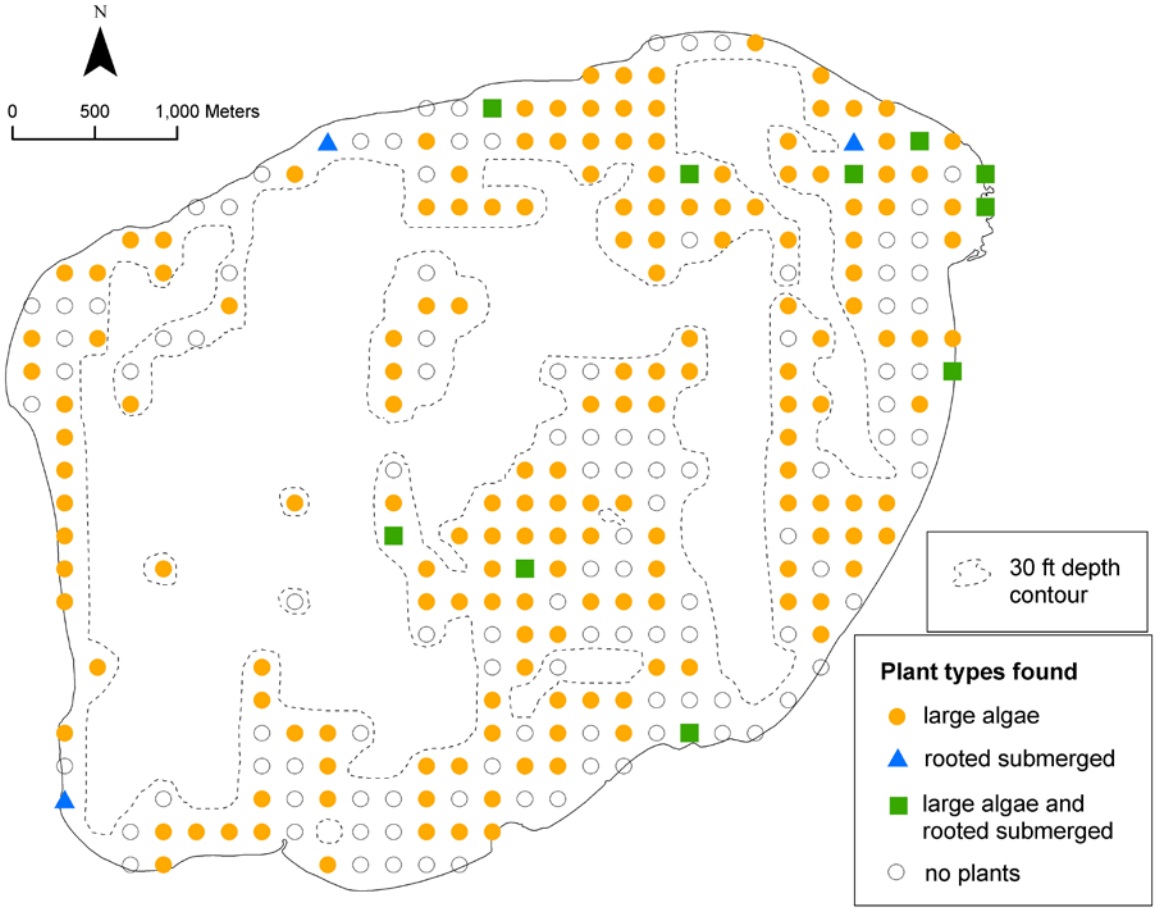
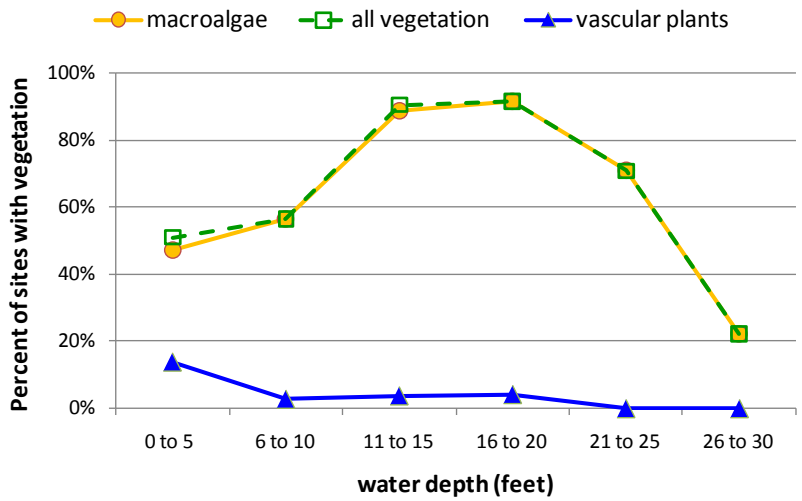


Figure 7. Frequency of vegetation by water depth interval.



Macroalgae were the most common plant type and were present in 62% of the sites (Figure 6). Of sites that contained vegetation, 97% contained only macroalgae. Macroalgae were found to a depth of 28 feet (Figure 7) and likely occurred at scattered locations beyond the 30 feet depth (the maximum depth sampled). Only 5% of all sites contained rooted plants. Rooted plants were found to a maximum depth of 17 feet and were most frequent in depths less than 6 feet, where they occurred in 14% of the sites (Figure 6).

The number of plant taxa found at each one square meter sample site ranged from zero to five. Most sites (58%) contained only one plant taxon and only 5% contained more than one taxa.

Macroalgae

Macroalgae are multi-celled plants that lack true roots, stems or leaves. Unlike microscopic algae that float freely in the water column, macroalgae resemble larger plants and often form low-growing mats on the lake bottom. Muskgrass (Figure 8) and Stonewort (Figures 9, 10) were the macroalgae identified in Green Lake.

Muskgrass (*Chara* sp.) dominated the plant community of Green Lake. It occurred in 54% of the sites and was the most common plant in the 0 to 20 feet depth (Figure 11). This macroscopic algae is common in many hard water Minnesota lakes. It has a brittle texture and a characteristic "musky" odor. Because muskgrass does not form true stems, it is a low-growing plant, often found entirely beneath the water surface where it may form low "carpets" on the lake bottom. Muskgrass is adapted to variety of substrates and is often the first taxa to colonize open areas of lake bottom where it can act as a sediment stabilizer. Beds of muskgrass can provide important fish spawning and nesting habitat.

Stonewort (*Nitella* sp.) is also a large algae but lacks the brittle texture and musky odor of muskgrass. It is often found in deeper water than muskgrass. In Green Lake it occurred in 9% of the sample sites (Table 3) and was found in depths of 18 to 28 feet. Stonewort was the most commonly occurring plant in depths of 21 to 30 feet depth zone where it was present in 37% of the sample sites (Figure 11.)

Figure 8. Muskgrass

Figure 9. Stonewort in Green Lake.

Figure 10. Close-up of Stonewort.

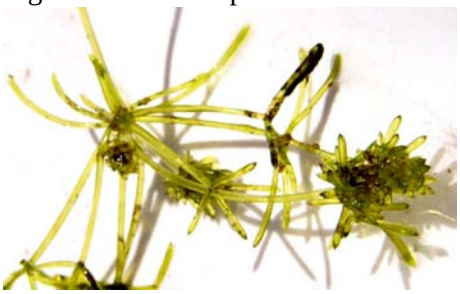
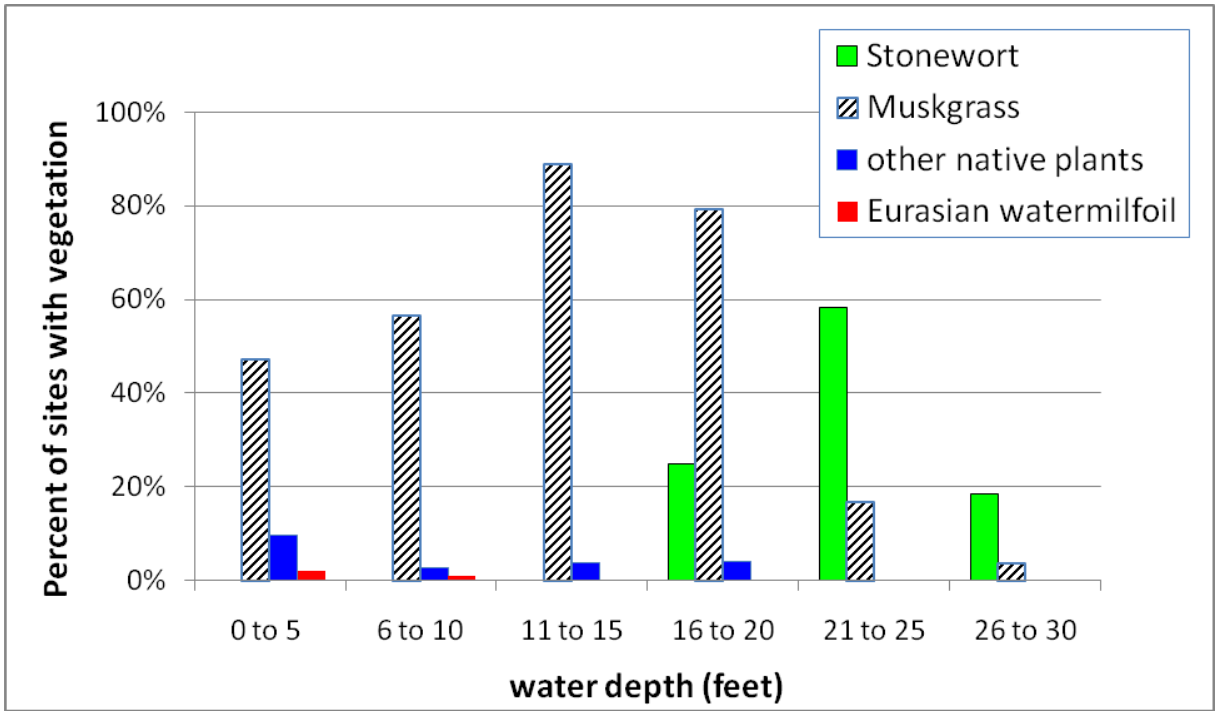


Figure 11. Common plants at each water depth interval, Green Lake 2009.



Rooted submerged plants

Rooted submerged plants are often anchored to the lake bottom by underground rhizomes that also act to help stabilize lake sediments. This group of plants produces true leaves and are often described by their leaf shapes: broad-leaf, grass-leaf or fine, divided-leaf plants. A wide variety of leaf shapes provides a diversity of underwater habitat for fish and other aquatic organisms. In shallow, protected waters some submerged plants may also form floating-leaves that can provide additional shade and shelter for aquatic life. Unlike algae, these plants produce true flowers, though they may be smaller and less showy than terrestrial plant flowers.

Figure 12. Coontail

Coontail (*Ceratophyllum demersum*; Figure 12) is the most common submerged plant in Minnesota. It is named for its bushy form that resembles a raccoon tail (Figure 12). Coontail grows entirely submerged and its roots are only loosely anchored to the lake bottom. It is adapted to a broad range of lake conditions and is tolerant of higher turbidity and can grow in muck substrates (Nichols 1999). Coontail is perennial and can over winter as a green plant under the ice and then begins new growth early in the spring, spreading primarily by stem fragmentation. The finely divided leaves of this plant provide a home for insects valuable as fish food. Coontail occurred in 1% of the Green Lake sample sites (Table 3). It was present in water depths of 9 to 17 feet and was the only leafy plant found beyond the 15 feet depth.

Pondweeds (*Potamogeton* spp. and *Stuckenia* spp.) are rooted perennial plants and their rhizomes may form mats on the lake bottom that help consolidate soil (Arber 1920). These underwater plants have opposite, entire leaves and form "cigar-shaped" flowers that emerge above the water surface. Many pondweed species over-winter as hardy rhizomes while other species produce tubers, specialized winter buds, or remain "evergreen" under the ice. Seeds and tubers of pondweeds are an important source of waterfowl food. The foliage of pondweeds provides food for a variety of marsh birds, shore birds and wildlife and provides shelter, shade and spawning sites for a range of fish species (Borman et al. 2001). Pondweeds inhabit a wide range of aquatic sites and species vary in their water chemistry and substrate preferences and tolerance to turbidity. There are more than 20 species of pondweeds in Minnesota and they vary in leaf shapes and sizes. Several native pondweeds occur in Green Lake (Table 3).

Illinois pondweed (*Potamogeton illinoensis*) is a broad-leaf pondweed that grows primarily submerged but may form floating leaves in shallower water (Figure 13). This plant is sometimes called "cabbage" by anglers because of its wide leaves. The foliage of this plant provides cover for fish and its fruits are valuable waterfowl food. Illinois pondweed was found in 1% of all Green Lake sample sites (Table 3). It was found to a depth of 9 feet but was most frequent in depths less than 5 feet.

Figure 13. Illinois pondweed
photo: ©1996 Allison Fox, Univ of Florida Center for Aquatic Plants

Clasping-leaf pondweed (*Potamogeton richardsonii*) is another broad-leaf pondweed found in Green Lake. It is similar in form and habitat value to Illinois pondweed but it only forms submerged leaves (Figure 14). This plant was found at scattered locations in depths less than 5 feet.

Figure 14. Clasping-leaf pondweed with waterlilies.

Curly-leaf pondweed (*Potamogeton crispus*; Figure 15) resembles clasping-leaf pondweed but it is a non-native to Minnesota. This submerged plant that has been present in the state since at least 1910 (Moyle and Hotchkiss 1945) and is now found in more than 700 Minnesota lakes (Invasive Species Program 2008). Like many native submerged plants, it is perennial but has a unique life cycle that 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, 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).

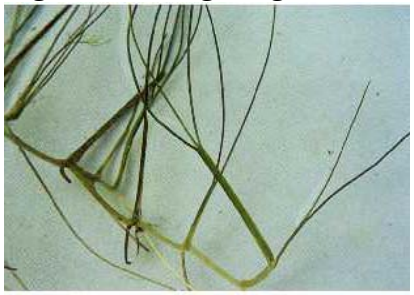
Figure 15. Curly-leaf pondweed.

The foliage of curly-leaf pondweed does provide some fish and wildlife habitat, but it may also create problems in some lakes, or in areas of some lakes. During its peak growth in spring, curly-leaf may reach the water surface at certain depths and create dense mats. These dense growths may compete with native vegetation and can also cause problems for recreational lake users.

Curly-leaf pondweed was not located during the August 2009 survey of Green Lake but it has been previously recorded in the lake. This plant is most likely to be found during its peak growth period in May and June.

Widgeon grass (*Ruppia maritima*) is one of the "grass-leaved" plants that occur in Green Lake. This submerged plant has elongated, fine leaves (Figure 16) that may grow nearly 2 feet in length. This plant's name refers to its importance as a waterfowl food source. Widgeon grass is designated as a rare species in Minnesota because of its limited distribution in the state. This plant is restricted to western Minnesota lakes with high alkalinity, high conductivity and high pH. This plant often grows as an annual, re-sprouting from seed each year. Therefore, the actual distribution of widgeon grass within a lake may vary widely from year to year, depending on seed set and distribution in the previous year. In 2009, widgeon grass was found in 1% of all survey sites in Green Lake (Table 3). It occurred in water depths of 5 to 12 feet.

Figure 16. Widgeon grass



Edward G. Voss. USDA NRCS. 1992. *Western wetland flora: Field office guide to plant species.* West Region, Sacramento. Courtesy of USDA NRCS Wetland Science Institute.

Northern watermilfoil (*Myriophyllum sibiricum*) is a native, submerged, rooted plant with finely divided, feather-shaped leaves (Figure 17). Particularly in depths less than 10 feet, this plant may reach the water surface and its flower stalk will extend above the water surface. It spreads primarily by stem fragments and over-winters by hardy rootstalks and winter buds. Northern watermilfoil is not tolerant of turbidity and grows best in clear water lakes (Nichols 1999). In Green Lake, northern watermilfoil was found in 9 feet of water and was present in less than 1% of the sample sites (Table 3).

Figure 17. Northern watermilfoil

Eurasian watermilfoil (*Myriophyllum spicatum*; Figure 18) closely resembles northern watermilfoil but it is not native to Minnesota. Eurasian watermilfoil is adapted to survive in lower light levels than many native aquatic plants but still requires adequate light for growth. In Green Lake it was found in 1% of the sample sites and occurred in the 5-9 feet depth zone. It co-occurred with muskgrass, northern watermilfoil and widgeon grass.

Figure 18. Eurasian watermilfoil

Several plants that were found in previous summer surveys of Green Lake were not located during the 2009 survey. These plants likely still occur in the lake but occur at low frequencies.

For more information:
on the values of aquatic plants: Value of aquatic plants
on curly-leaf pondweed and Eurasian watermilfoil: DNR Invasive Species Annual Report

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