Aquatic Vegetation of Big Lake
Sherburne County, Minnesota
(DOW 71-0082-00)
June 8 and 10, 2004

(version 2, revised March 2008)

Report by: Donna Perleberg
MNDNR Ecological Resources Division
1601 Minnesota Dr.
Brainerd, MN 56401
Phone: 218-833-8727
Email: donna.perleberg@dnr.state.mn.us

Lake sampling: Nicole Brown, Josh Knopik and Joe Backowski, MnDNR Division of Ecological Resources

Data Entry/ Analysis / Maps: Nicole Brown, Donna Perleberg, Patrick McGowan, MnDNR Division of Ecological Resources

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**This report has been revised from an earlier version (2005). Map errors in the 2005 version have been corrected in this report.*

Summary

An aquatic vegetation survey of Big Lake (71-0082-00), Sherburne County, Minnesota, was conducted on June 8 and 10, 2004. Plants were distributed throughout the lake basin to a maximum depth of twenty-one feet. Vegetation was present in 87% of the sites surveyed within the vegetation zone (shore to twenty-one feet deep). Eleven native submerged aquatic plant taxa were identified and common groups included muskgrass *(Chara sp.)* (42% occurrence), coontail (*Ceratophyllum demersum*)(29%), bushy pondweed *(Najas sp.)*(29%), broad-leaf pondweeds (*Potamogeton gramineus, P. illinoensis, P. praelongus*) (28%), northern watermilfoil (*Myriophyllum sibiricum*)(26%) and narrow-leaf pondweeds (*Potamogeton zosteriformis, Potamogeton sp., Stuckenia pectinata*) (25%).

The non-native submerged plant, curly-leaf pondweed (*Potamogeton crispus*) has been present in Big Lake since at least 1973 and in 2004 it was found in 32% of the sites between shore and the 21 feet depth. Another non-native plant, Eurasian watermilfoil (*Myriophyllum spicatum*) was not found during the 2004 survey but was discovered in Big Lake and adjacent Mitchell Lake in 2007.

Introduction

Survey Lake Description

Big Lake (DOW 71-0082-00) is located within the City of Big Lake in Sherburne County, Minnesota. It lies in the southern portion of the Mississippi River - St. Cloud Watershed (Figure 1). The Mississippi River flows southeast through the watershed but is not directly connected to Big Lake.

Mitchell Lake lies north of Big Lake and a small channel connects the two lakes. Both lakes are land-locked seepage lakes and the primary inlets are storm sewers that capture runoff from the surrounding watershed (Klang et al 1996). There is a constructed outlet that drains from Mitchell to Beaudry Lake. Water levels are affected by groundwater flow and change slowly.

Land use and land cover within the sub-watershed that includes Big Lake is primarily agricultural, although a large portion adjacent to Big Lake itself is urban and residential (Figure 2). Several upland deciduous forest stands also remain. The City of Big Lake experienced significant population growth in the 1990s, a trend that continues as large tracts of farmland are

Figure 1. Location of Big Lake in the Mississippi River – St. Cloud Watershed.

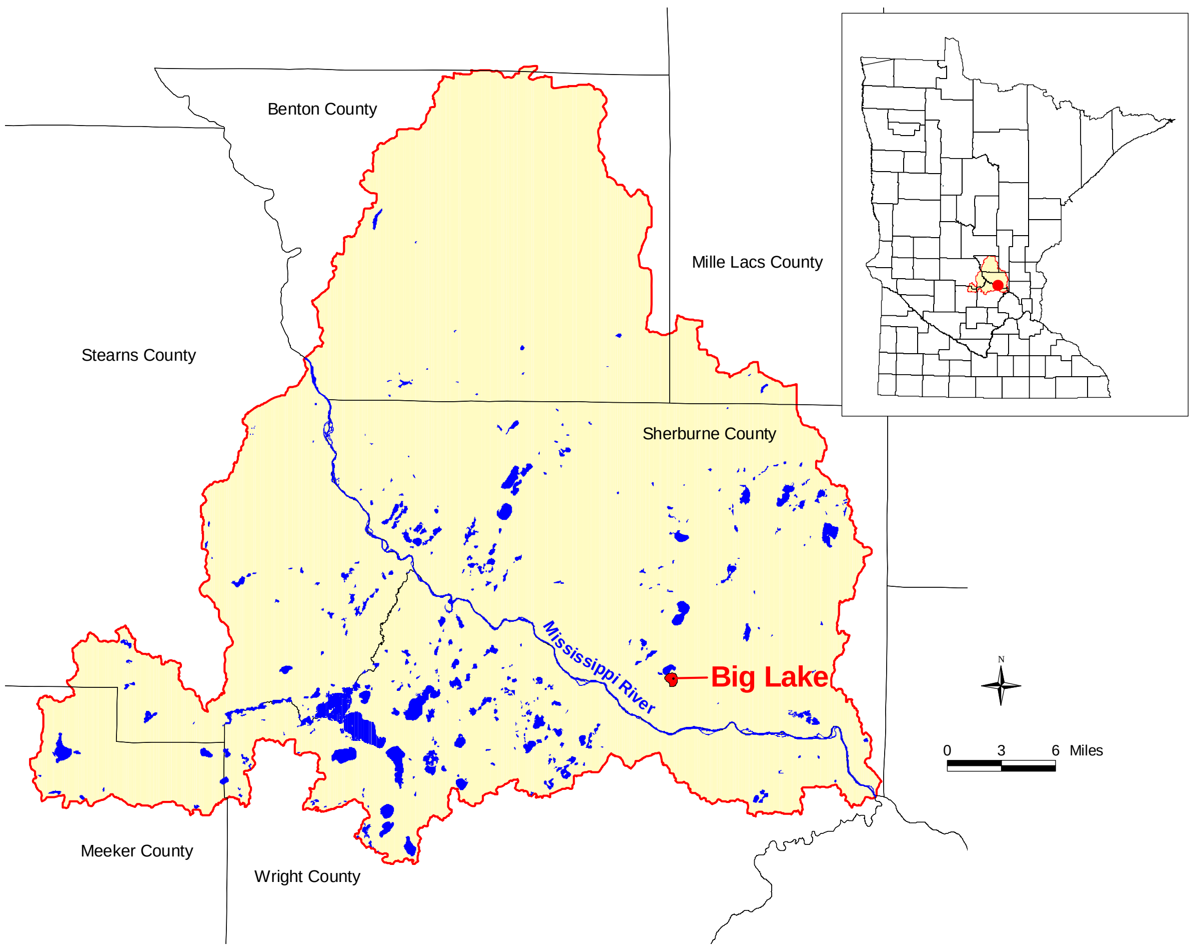
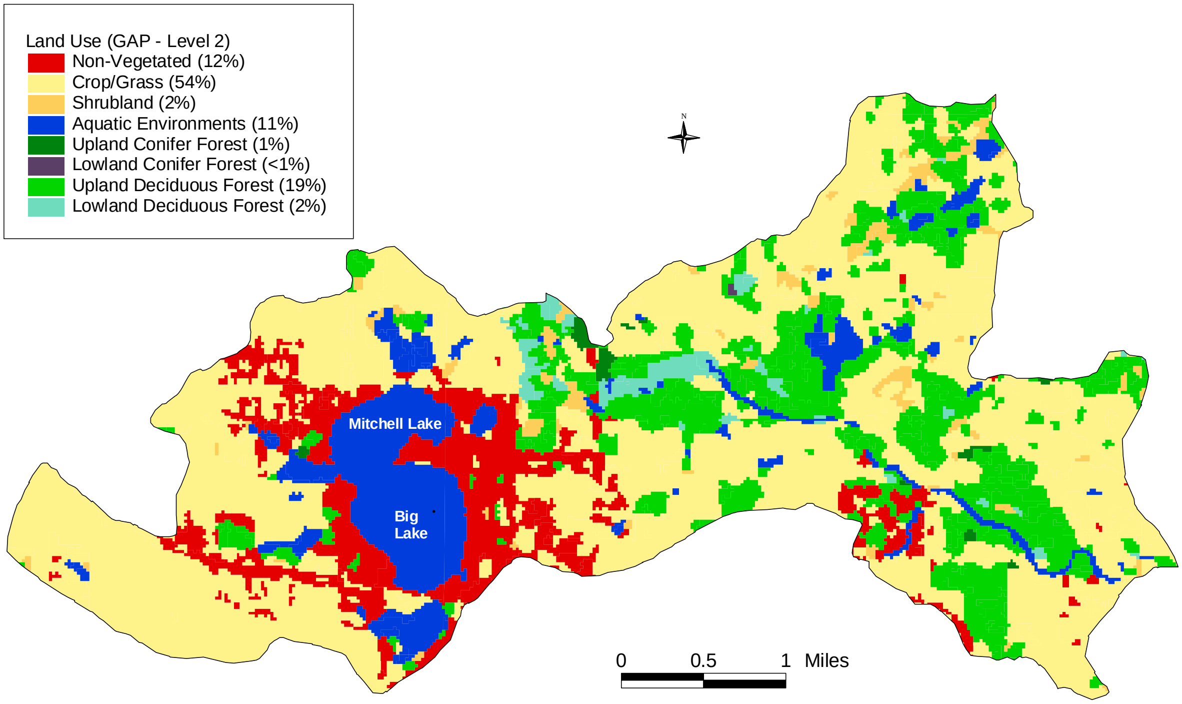


Figure 2. Land use within the Elk River sub-watershed that includes Big Lake.

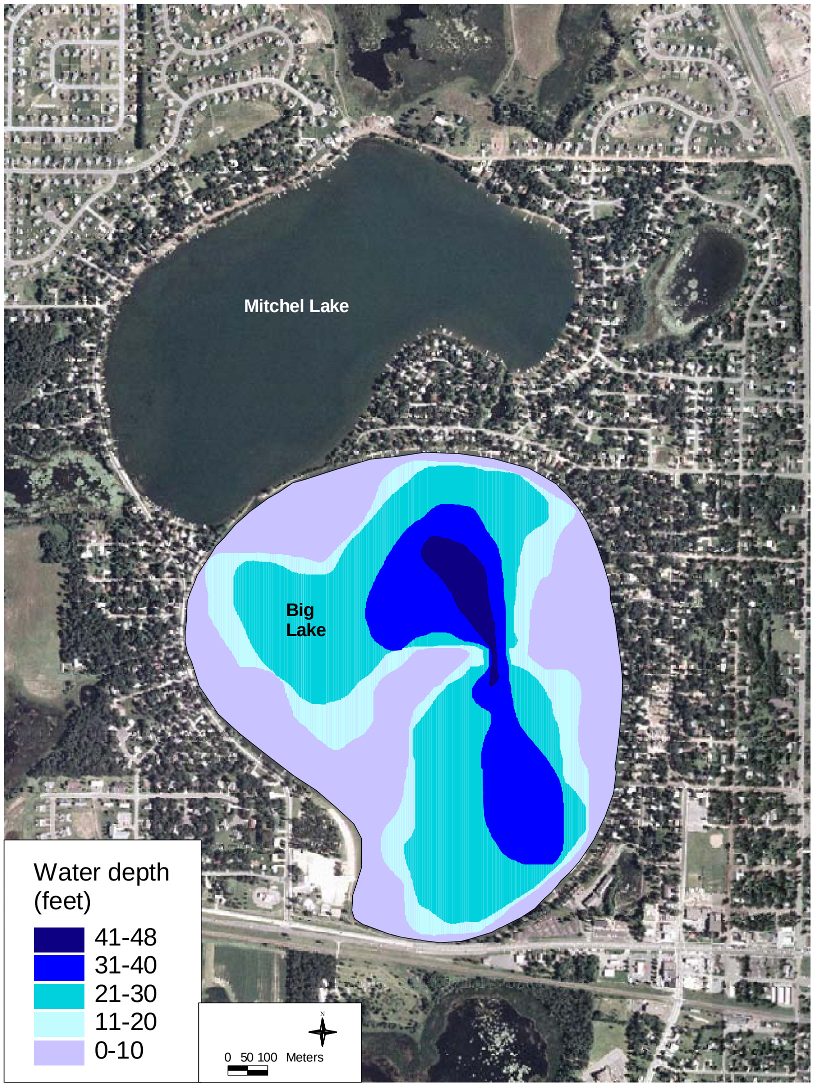


converted to residential developments. Urban land use within the watershed will increase as development continues at an expected high rate.

Big Lake is round in outline with a surface area of 251 acres and a maximum depth of 48 feet. At least 48 percent (110 acres) of the lake is less than 15 feet deep (Figure 3). The Big Lake shoreline is completely developed except for a grassy shoulder highway right-of-way on the south shore. A city park, including a lake public access and swimming beach, is located on the southwest shore.

Big Lake is classified as mesotrophic (moderate nutrients) with midsummer water clarity averaging about 11.5 feet between 2000 and 2007 (MPCA 2007). The Secchi disc (Figure 4) transparency measures the depth to which a person can see into the lake and provides a rough estimate of the light penetration into the water column. Water clarity fluctuates throughout the season and between years. As a general rule, sunlight can penetrate to a depth of two times the Secchi depth and aquatic plants can grow to a depth of one and half times the Secchi depth. Based on Secchi disk measurements alone, aquatic plants are expected to grow to about 17 feet in Big Lake. Other factors that may influence the depth of plant growth include substrate type, wind fetch, and plant species composition.

Figure 3. Depth contours of Big Lake and immediate shoreline development.



Vegetation Survey Objectives

The purpose of the 2004 survey of Big Lake was 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

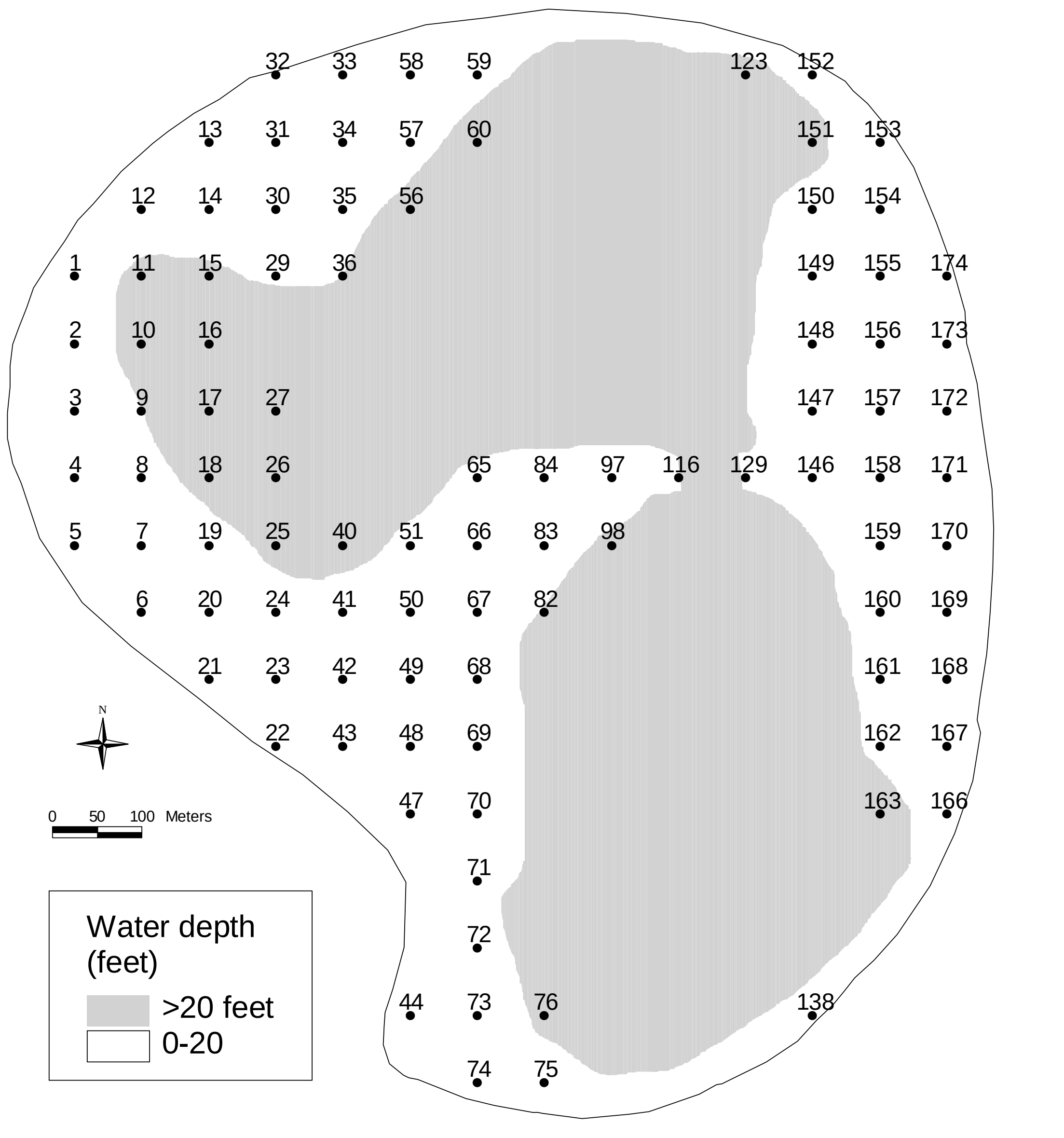
Figure 4. Measuring Secchi Disc transparency

Methods

Point-Intercept Method

A Point-Intercept vegetation survey of Big Lake was conducted on June 8 and June 10, 2004 following the methodology described by Madsen (1999). At a minimum, we wanted to sample about 100 points within the vegetated zone and place sample points no further than 100 meters apart for mapping purposes. 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 24 feet because they consistently were not finding vegetation beyond depths of 21 feet. As a result, 98 sites were actually sampled with 85 of those falling within the vegetated zone from shore to the 21 feet depth (Table 1).

Figure 5. Survey point locations.



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 square sample site at the 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 6). If curly-leaf pondweed (*Potamogeton crispus*) was present at a site, surveyors recorded whether or not it formed surface mats at that site.

Table 1. Sampling effort by water depth in Big Lake, 2004.

Depth interval in feet	Number of Sample points
0 to 5	8
6 to 10	48
11 to 15	7
16 to 20	17
21	5
22 to 25	10
26 to 27	3
Total	98

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

Frequency was calculated for the entire vegetated zone (shore-21 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, 16 to 20 feet and 21 to 25 feet.

Figure 6. Rake used to sample vegetation.

Example:

In Big Lake there were 85 samples sites in the zone from shore to the 21 feet depth.

Muskgrass (*Chara* sp.) occurred in 36 of those sites.

Frequency of muskgrass in the shore to 21 feet depth zone = 36/85 (*100) = 42 %

Results / Discussion

Number and types of plants recorded
Eleven submerged native aquatic plant taxa were identified in Big Lake (Table 2). No emergent, free-floating or floating-leaf plants were recorded. One non-native invasive species, curly-leaf pondweed *(Potamogeton crispus)* was observed during the survey.

Table 2. Aquatic Plants of Big Lake, Sherburne County (DOW 71-0082-00) June 8 and 10, 2004

Frequency of occurrence calculated for vegetated zone (shore to 21 feet depth)
85 sample sites

Plant group	Common name	Scientific Name	Frequency
	Muskgrass spp	*Chara sp (v)*	42
Non-native	Curly-leaf pondweed	*Potamogeton crispus*	32
	Coontail	*Ceratophyllum demersum*	29
	Bushy pondweed	*Najas sp. (v)*	29
	Northern water milfoil	*Myriophyllum sibiricum*	26
Broad-leaf pondweeds	Variable pondweed	*Potamogeton gramineus (v)*	15
	Illinois pondweed	*Potamogeton illinoensis*	11
	White-stem pondweed	*Potamogeton praelongus (v)*	2
Narrow-leaf pondweeds	Narrow-leaf pondweed	*Potamogeton sp. (v)*	14
	Flat-stem pondweed	*Potamogeton zosteriformis (v)*	12
	Sago pondweed	*Stuckenia pectinata (v)*	2
	Water stargrass	*Zosterella dubia (v)*	4

V = voucher specimen collected

Distribution of vegetation by water depth
Vegetation was found to a maximum depth of 21 feet but plant occurrence was greatest in depths less than 11 feet where 98% of the sites contained vegetation (Figure 7). Native submerged plants were found to a maximum depth of 19 feet. Curly-leaf pondweed was found to a depth of 21 feet and was also found at each lower depth interval sampled (Figure 8).

The vegetated zone was as narrow as 70 to 100 feet in some areas of the lake, such as the north and south shores where water depths increase rapidly from shore, and as wide as 1500 feet in areas along the west shore where shallow zones extend to near the middle of the lake (Figure 9).

Figure 7. Plant abundance vs. water depth. Big Lake, 2004.

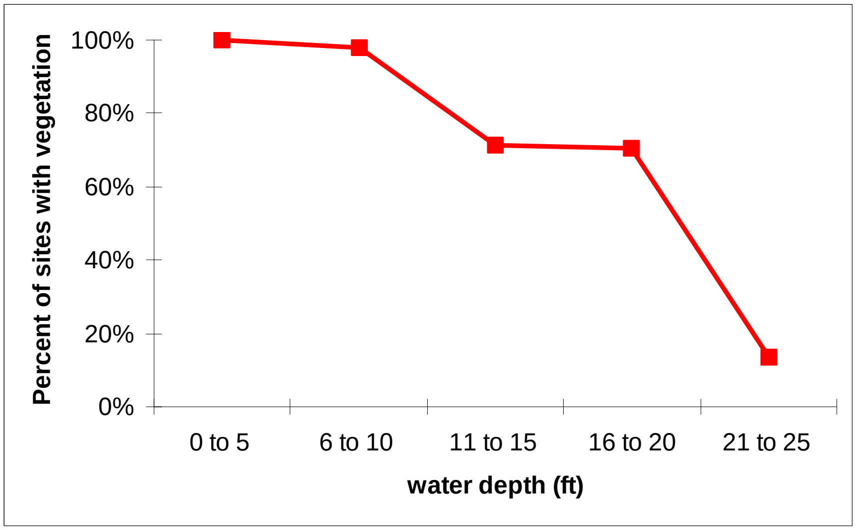
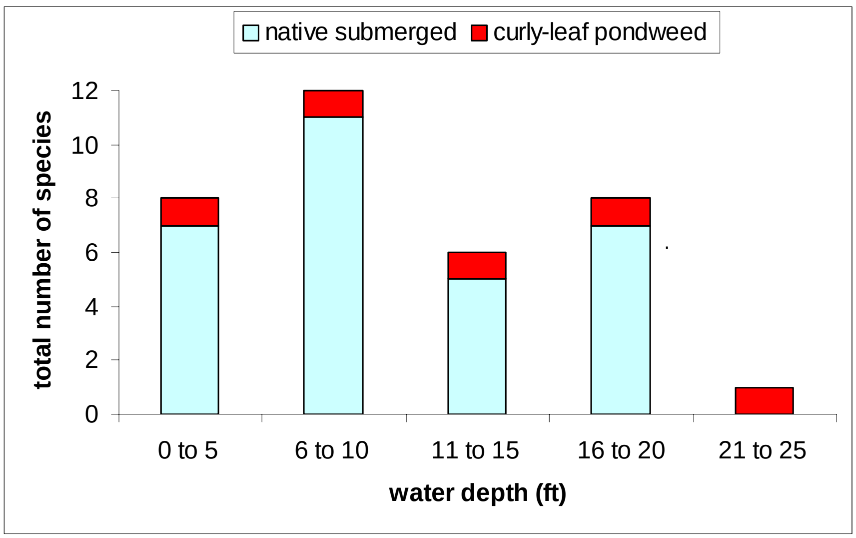


Figure 8.Number of plant taxa vs. water depth. Big Lake, 2004



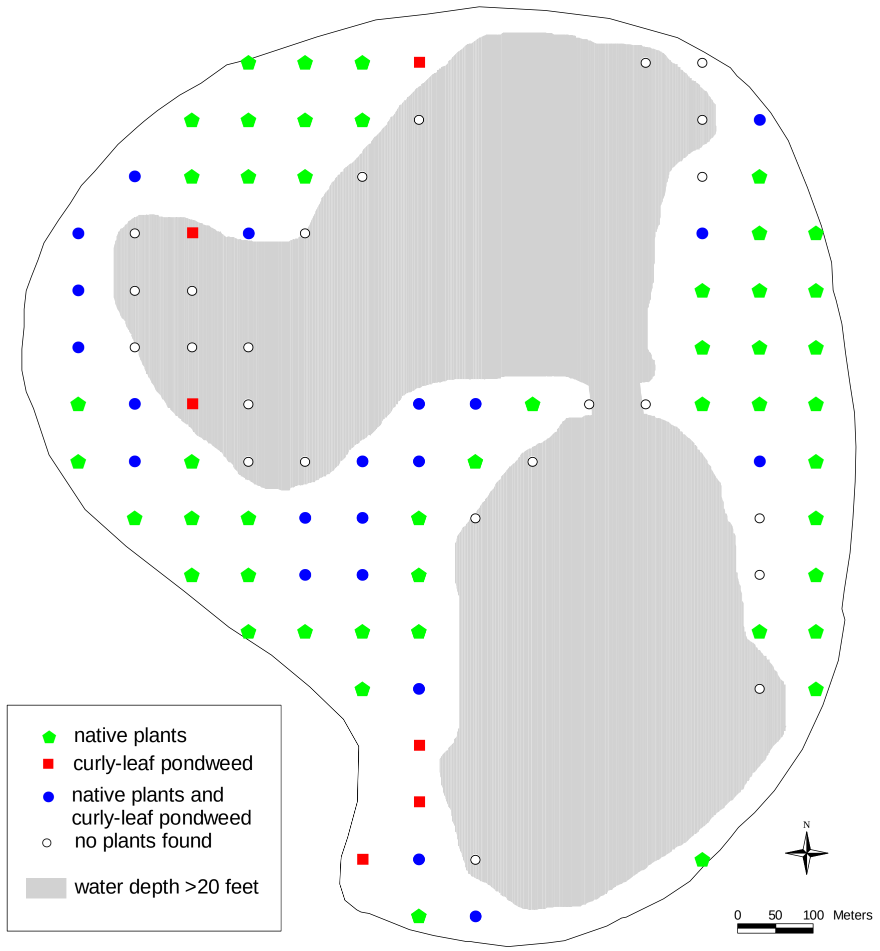


Figure 9. Survey sites where vegetation was found.

The most common groups of plants found were muskgrass *(Chara sp.)*, curly-leaf pondweed (*Potamogeton crispus*), coontail (*Ceratophyllum demersum*), bushy pondweed *(Najas sp.),* broad-leaf pondweeds (*Potamogeton illinoenis, P. gramineus, P. praelongus*), Northern watermilfoil *(Myriophyllum sibiricum)*, and narrow-leaf pondweeds (*Potamogeton zosteriformis, Stuckenia pectinata*, and *Potamogeton* sp.). The occurrence of each plant group varied by location in the lake (Figure 10) and by water depth (Figure 11).

Figure 10. Distribution of common aquatic plant groups in Big Lake, 2004.

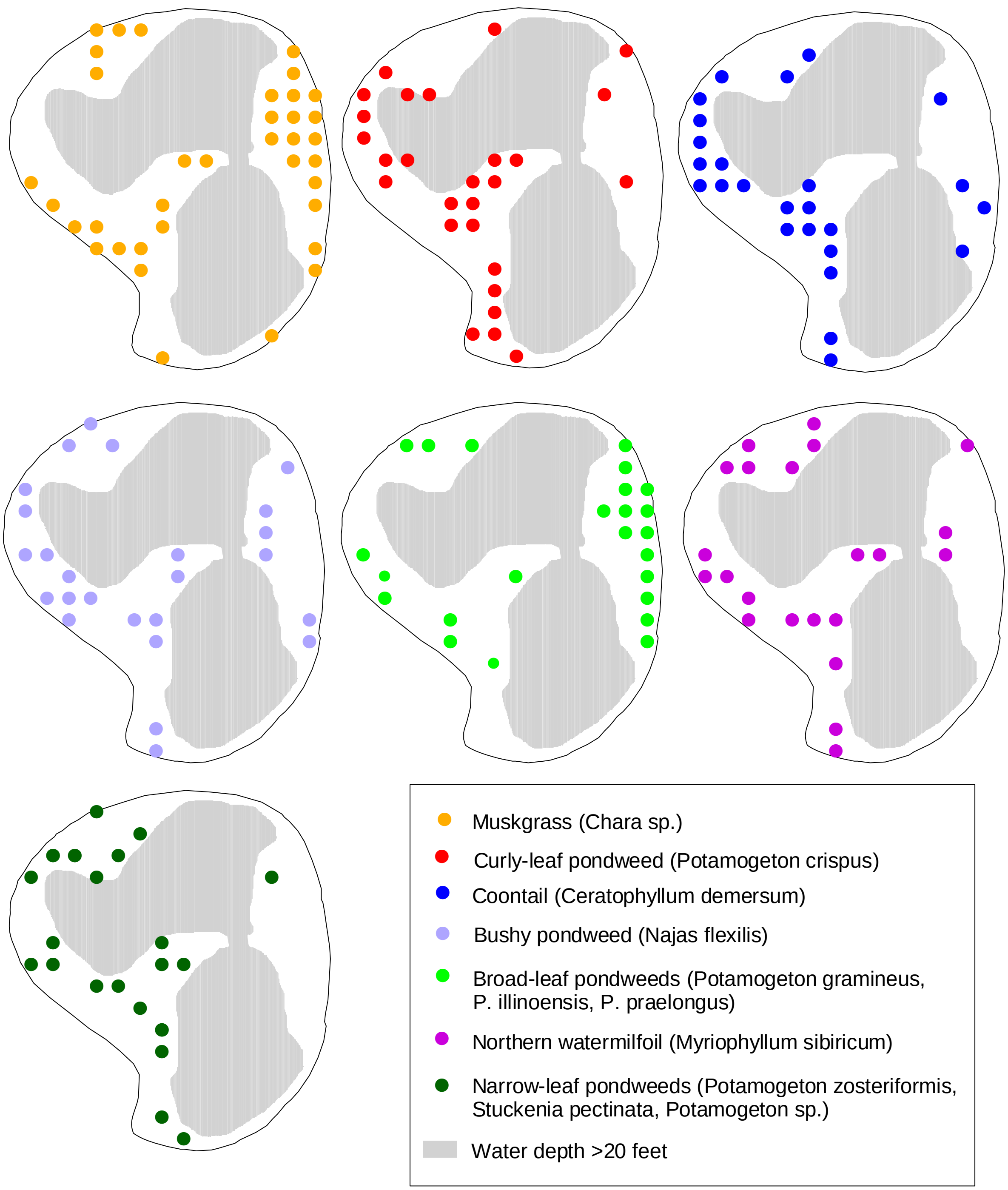


Figure 11. Abundance of common species vs. water depth.
Big Lake (71-0082-00) Sherburne Co., MN June 8,10, 2004.

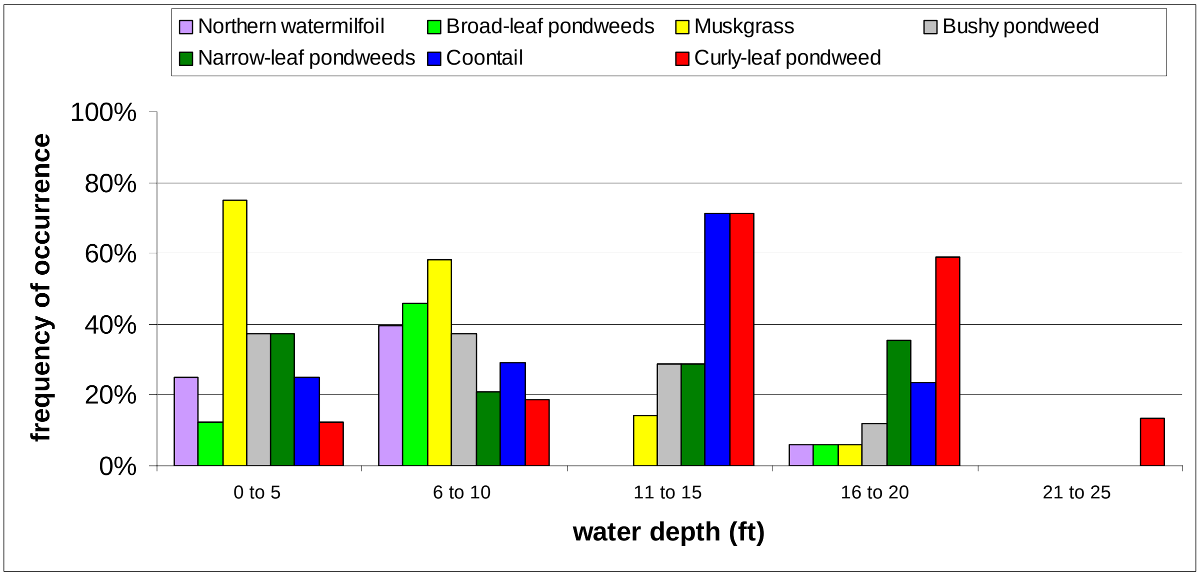


Figure 12. Muskgrass *(Chara sp.)*

Muskgrass (*Chara* sp.) is a large submerged algae that grows anchored to the lake bottom and often forms large underwater beds (Figure 12). Typically found in clear, hard water, muskgrass is light-green to grey-green in color, with a brittle texture due to mineral deposits on it leaf surfaces. Muskgrass releases a strong musky odor when crushed.

On the 2004 survey, muskgrass occurred in 42% of the sites surveyed (Table 2). It was widespread in distribution (Figure 10) and was the most common plant found in shore to ten feet depth zone (Figure 11).

Muskgrass benefits lakes in several ways. It stabilizes lake bottom sediments, resulting in clearer water and less erosion. Muskgrass provides beneficial cover for fish, as well as the aquatic insects that bluegills, smallmouth and largemouth bass feed upon.

Figure 13. Coontail (*Ceratophyllum demersum*)

Coontail (*Ceratophyllum demersum*) (Figure 13) is the most common submerged flowering plant in Minnesota. This perennial grows entirely submerged and is adapted to a broad range of lake conditions, including turbid water. It is often found growing in deeper water than other native species because it is more tolerant of low light conditions.

In Big Lake, coontail occurred in 29% of the sites sampled (Table 2) with distribution throughout the lake basin (Figure 10). It was found to a depth of 18 feet, and was one of the most common plants in the 16 to 20 feet depth zone (Figure 11). Coontail provides important cover for young fish, including bluegills, perch, largemouth bass and northern pike. It also supports aquatic insects beneficial to both fish and waterfowl.

Bushy pondweed (*Najas sp.*) (Figure 14) is one of the few native submerged plants that is an annual, growing from seed each year. This species reaches maturity later in the summer than some perennials and its distribution may vary annually depending on the previous years' seed set. It grows entirely submerged as a low, bushy plant in shallow water and as a long-stemmed, wavy plant in deep water.

Figure 14. Bushy pondweed *(Najas sp.)*

In Big Lake, bushy pondweed was found in 29% of the survey sites (Table 3) and was distributed throughout the shallow zone (Figure 10). It was found to a depth of 16 feet but was most common in depths of 10 feet and less (Figure 11).

Bushy pondweed provides important ecological benefits. Waterfowl, especially mallards, feed upon entire plants, while young largemouth bass and northern pike seek refuge in its thick cover.

Northern watermilfoil (*Myriophyllum sibiricum*) (Figure 15) occurred in 26% of the Big Lake survey sites (Table 2) and was found at numerous sites around the lake (Figure 10). It commonly occurred in water depths up to ten feet, although one plant was found growing in the 17 feet depth (Figure 11).

This perennial submerged species prefers soft substrates and is not tolerant of turbidity. Like coontail, it has finely dissected leaves but can be distinguished by its feather-shaped leaves that are characteristics of watermilfoil plants. Northern watermilfoil is native to Minnesota and provides valuable cover for fish and aquatic invertebrates.

Figure 15. Northern watermilfoil (*Myriophyllum sibiricum*)

Northern watermilfoil is often mistaken for the non-native invasive Eurasian watermilfoil (*Myriophyllum spicatum*). Northern watermilfoil has 5-10 leaflet pairs compared to 12-21 leaflet pairs for Eurasian watermilfoil. Eurasian watermilfoil was not found in Big Lake during the 2004 survey but in 2007 it was discovered in the lake.

"Pondweed" is a common name for submerged aquatic plants in the Potamogeton plant family and in Big Lake there were three main groups of pondweeds that can be described by their leaf shape: broad-leaf, narrow-leaf and curly-leaf. Pondweeds are rooted, perennial plants that grow submerged except for the flower and fruit stalks which emerge out of the water. Some species may also form floating-leaves. Waterfowl feed on the fruits and tubers of these plants and pondweed foliage is important fish cover.

Figure 16. A broad-leaf pondweed or "cabbage" (*Potamogeton*) with cigar-shaped fruit

Broad-leaf pondweeds in Big Lake include variable pondweed (*P. gramineus*), Illinois pondweed (*P. illinoensis)*, and white-stem pondweed (*P. praelongus*). These rooted, perennial plants with wide leaves are often called "cabbage" plants by anglers. The fruits of pondweeds are a favorite duck food and the broad leaves provide food and shelter for fish. These plants are primarily submerged but many will form floating leaves in shallow water (Figure 16).

Figure 17. Narrow-leaf pondweed (*Potamogeton sp.*)

Broad-leaf pondweeds were found in 28% of the Big Lake sites. They occurred throughout the lake and, along with muskgrass, were one of the main plant types along the eastern shore (Figure 10). Most broad-leaf pondweeds are not tolerant of turbidity and prefer clear water lakes. In Big Lake they were mostly restricted to depths less than 11 feet (Figure 11).

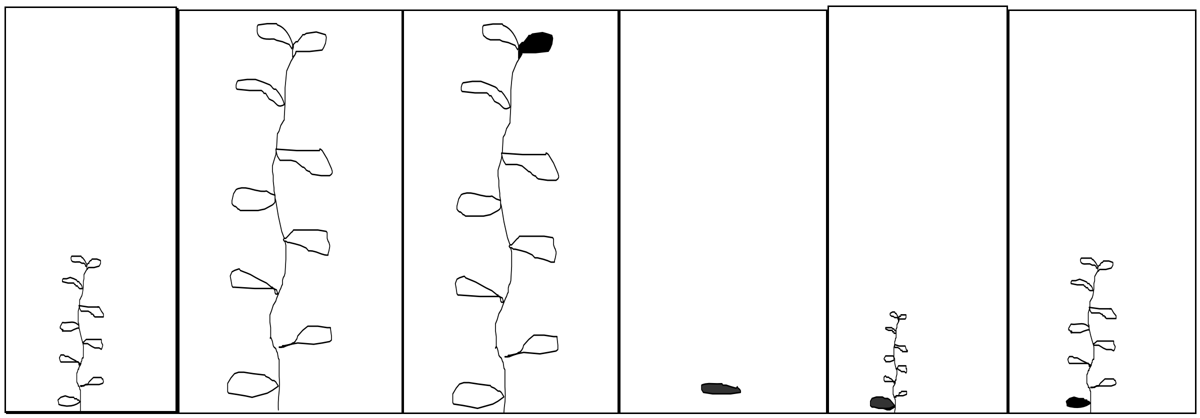
Narrow-leaf pondweeds (Figure 17) found in Big Lake include flat-stem pondweed (*Potamogeton zosteriformis*), sago pondweed (*Stuckenia pectinata*) and narrow-leaf pondweed (*Potamogeton* sp.). Twenty-five percent of all sites contained at least one narrow-leaf pondweed (Table 2). Narrow-leaf pondweeds were present from shore to a depth of 19 feet (Figure 11) and were mostly found on the west side of the lake (Figure 10).

Figure 18. Turions forming at tips of curly-leaf plants

Curly-leaf pondweed (*Potamogeton crispus*) (Figure 18) was found in 32% of the Big Lake sites (Table 2) and was distributed throughout the lake basin (Figure 10). It was most common in depths of 11 to 20 feet (Figure 11). No curly-leaf surface mats were observed during the survey.

Curly-leaf pondweed is a non-native, submerged plant that has been present in Minnesota since at least 1910

Figure 19. Life cycle of Curly-leaf pondweed (*Potamogeton crispus*).



(Moyle and Hotchkiss 1945) and is now found in at least 700 Minnesota lakes (Invasive Species Program 2005). It has been present in Big Lake since at least 1973 (MnDNR Fisheries Lake Files).

Like many native submerged plants, it is perennial but it 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 (Figure 19). Winter foliage is produced and continues to grow under ice (Wehrmeister and Stuckey 1978). Curly-leaf reaches its maximum growth in May and June. 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).

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.

Historical and Current Plant Communities of Big Lake

Comparison of current and historical vegetation surveys of Big Lake is difficult because historical data are limited and survey methods have varied. However, a general review of historical data of Sherburne County lakes in general, and Big Lake specifically, indicates some changes in the plant community of Big Lake.

Surveys of selected Sherburne County lakes were conducted in the 1920's and shoreline emergent plants that were commonly found included broad-leaf cattail (*Typha latifolia*), arrowhead (*Sagittaria* spp.), and rushes (*Scirpus* spp. and *Eleocharis* spp.) (Hotchkiss 1932). In 1949, bulrush (*Scirpus acutus*) (Figure 20) was reported as common in Big Lake and a 1957 survey described an extensive bulrush bed that extended well out into Big Lake on the shallow point jutting out from the west shore (MnDNR Lake Files). A few bulrush plants have been reported in recent years but no extensive beds remain on the lake. Bulrush naturally spread by rhizome (Figure 21) during low water years. These plants are particularly susceptible to human disturbance and once removed, can be difficult if not impossible to reestablish. Emergent shoreline plants are valuable not only as habitat, but because their root systems help stabilize the shoreline. As Big Lake became increasingly developed, bulrush stands may have been intentionally removed or damaged by recreational boat use. Emergent shoreline plants were likely removed and replaced by turf lawns.

Figure 20. Bulrush (*Scirpus*) was historically common in parts of Big Lake.

Figure 21. Bulrush (*Scirpus*) spreading by rhizome during low water year.

Many of the native submerged species that were commonly found in 2004 are also reported as common in historical surveys. However, several species that were historically common, such as the broad-leaf pondweeds: white-stem pondweed *(Potamogeton praelongus)* and clasping-leaf pondweed *(Potamogeton richardsonii)* appear to have declined. Broadleaf pondweeds such as clasping-leaf pondweed provide excellent habitat for a number of fish desirable species, including panfish, northern pike, muskellunge. These broadleaf pondweeds are less tolerant to turbidity than species such as curly-leaf pondweed (Nichols 1999) and their decline in lakes may be associated with decreased water clarity.

Big Lake, with a small watershed area to surface ratio (2:1), is especially vulnerable to land use impacts in the surrounding area. Additional commercial and residential developments often result in non-point pollution to nearby lakes, through runoff from impervious surfaces (parking lots, roads, driveways) and phosphorus found in lawn fertilizers. Given the high level of urbanization occurring in Sherburne County, and particularly in this watershed, consideration needs to be given to minimizing non-point pollution using effective land use and shoreline management practices. Implementing these measures may help protect water quality and aquatic vegetation. Native vegetation provides critical habitat for fish and invertebrates, buffers the shorelines from wave action, and stabilizes sediments and utilizes nutrients that would otherwise be available for algae.

The 2004 vegetation survey gives a "snapshot" of Big Lake conditions. Data collected during the 2004 survey can be compared to future quantitative surveys of Big 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.

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