Aquatic Vegetation of
Grace Lake (DOW 29-0071-00)
Hubbard County, Minnesota

July 24 and 25, 2006

Grace Lake, Hubbard County, MN. 2006

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Summary

An aquatic vegetation survey of Grace Lake (29-0071-00), Hubbard County, Minnesota, was conducted on July 24 and 25, 2007.

A total of 20 native aquatic plant taxa were recorded. Submerged plants occurred to a depth of 26 feet but were most common from shore to a depth of 15 feet, where 96 percent of sites contained vegetation. Common submerged plants included bushy pondweed (*Najas flexilis*), coontail (*Ceratophyllum demersum*), flat-stem pondweed (*Potamogeton zosteriformis*), Canada waterweed (*Elodea canadensis*), muskgrass (*Chara* sp.), and northern watermilfoil (*Myriophyllum sibiricum*). Approximately eight acres of bulrush (*Scirpus* spp.) were mapped.

Introduction

Grace Lake (DOW 29-0071-00) is located about 12 miles southeast of the city of Bemidji in northwestern Minnesota. It lies on the border of Beltrami and Hubbard counties (Fig. 1).

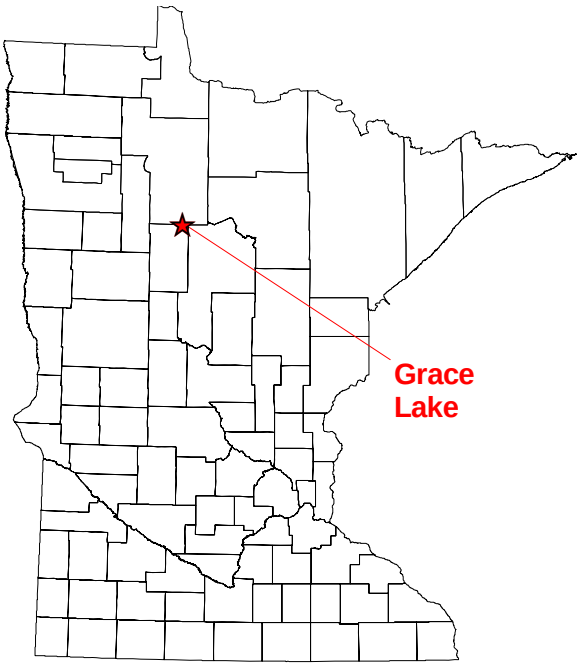


Figure 1. Location of Grace Lake in Hubbard and Beltrami Counties, MN.

Mississippi River Headwaters Watershed

Grace Lake is one of 144 lakes (with a surface area greater than 100 acres) within the Mississippi River Headwaters Watershed (Fig. 2). Major lakes within this watershed include Itasca, Bemidji, Cass, Winnibigoshish, Ball Club and Pokegama. Lakes in this watershed typically support healthy native aquatic plant populations. At least ten lakes (Fig. 2) in this watershed are known to contain the non-native, submerged plant, curly-leaf pondweed (*Potamogeton crispus*). To date, the non-native plant, Eurasian watermilfoil (*Myriophyllum spicatum*) has not been found within the watershed.

Grace Lake has a surface area of 877 acres, making it the 25th largest lakes in the watershed. The immediate watershed that includes Grace Lake (Fig. 3) is 5,966 acres for a watershed to lake ratio of 7:1. Flows to and from Grace Lake are intermittent. There are two inlets on the northwest corner of the lake that run during spring runoff and periods of heavy rains (DNR Fisheries Lake Files). The outlet on the southeast corner of the lake is currently dry but when outflow does occur, it runs southeast to Midge Lake, then north to Wolf Lake before entering into the Mississippi River (Fig. 2).

Land cover within the Grace Lake watershed is primarily agricultural and upland deciduous forest (Fig. 3). About 104 acres of wetland occur within the watershed, including a wetland area on the northwest side of the lake. The shoreline of Grace Lake is mostly forested but heavily developed with residential homes. There is a public boat launch on the west shore (Fig. 4).

The maximum recorded depth of Grace Lake is 42 feet and about 38 percent of the lake is 15 feet or less in depth. Water depths in the west half of the lake are mostly less than 30 feet and the deeper water sites occur in the eastern half (Fig. 4).

Grace Lake is a hard water, mesotrophic, or moderately nutrient enriched lake, with moderate water clarity as indicated by mid-summer Secchi disc readings between five and seven feet (DNR Lake Files).

Figure 2. Location of Grace Lake within the Mississippi River Headwaters Watershed and lakes known to contain the non-native plant, curly-leaf pondweed (*Potamogeton crispus*). Source: MnDNR Invasive Species Program.

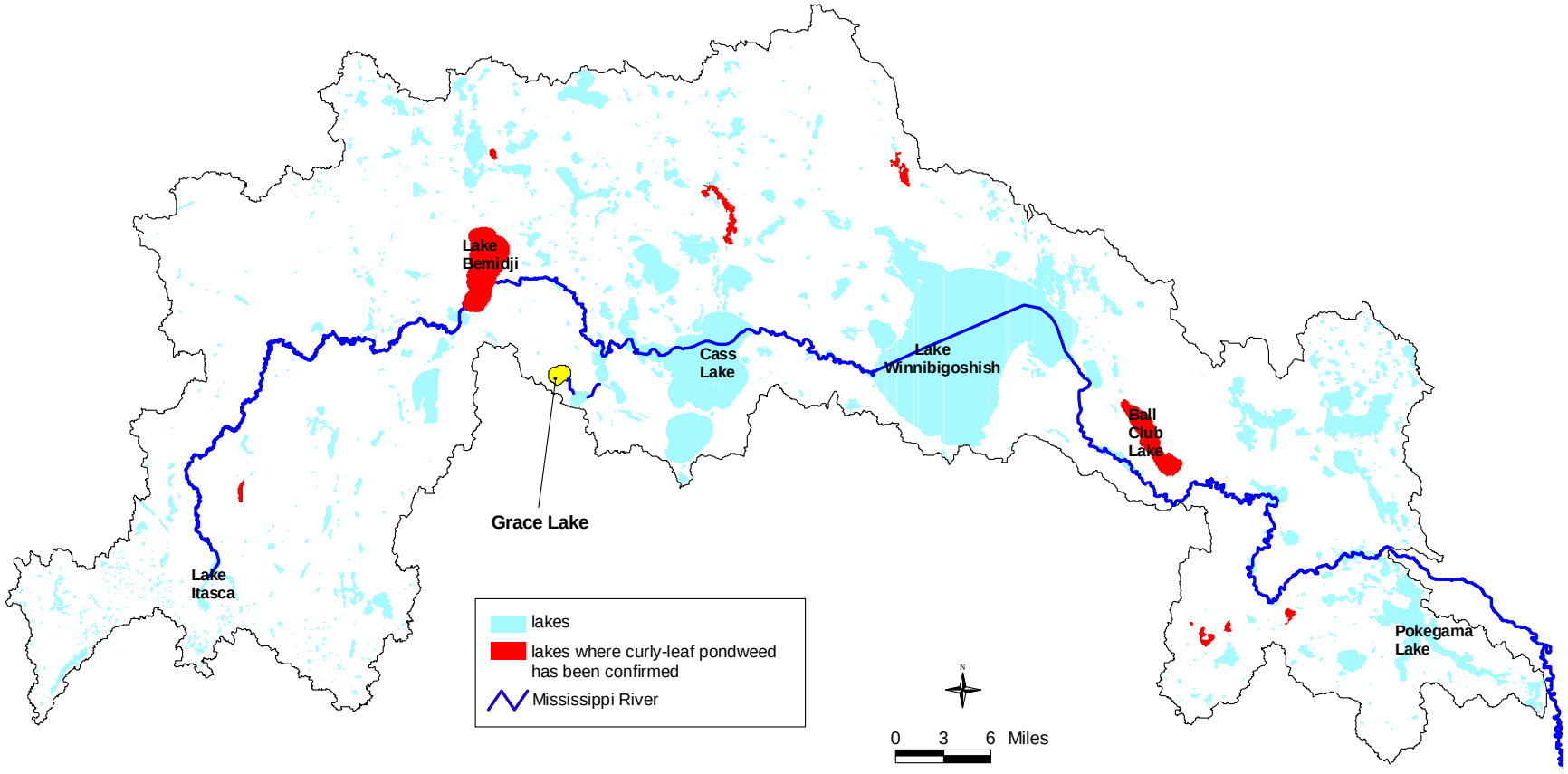
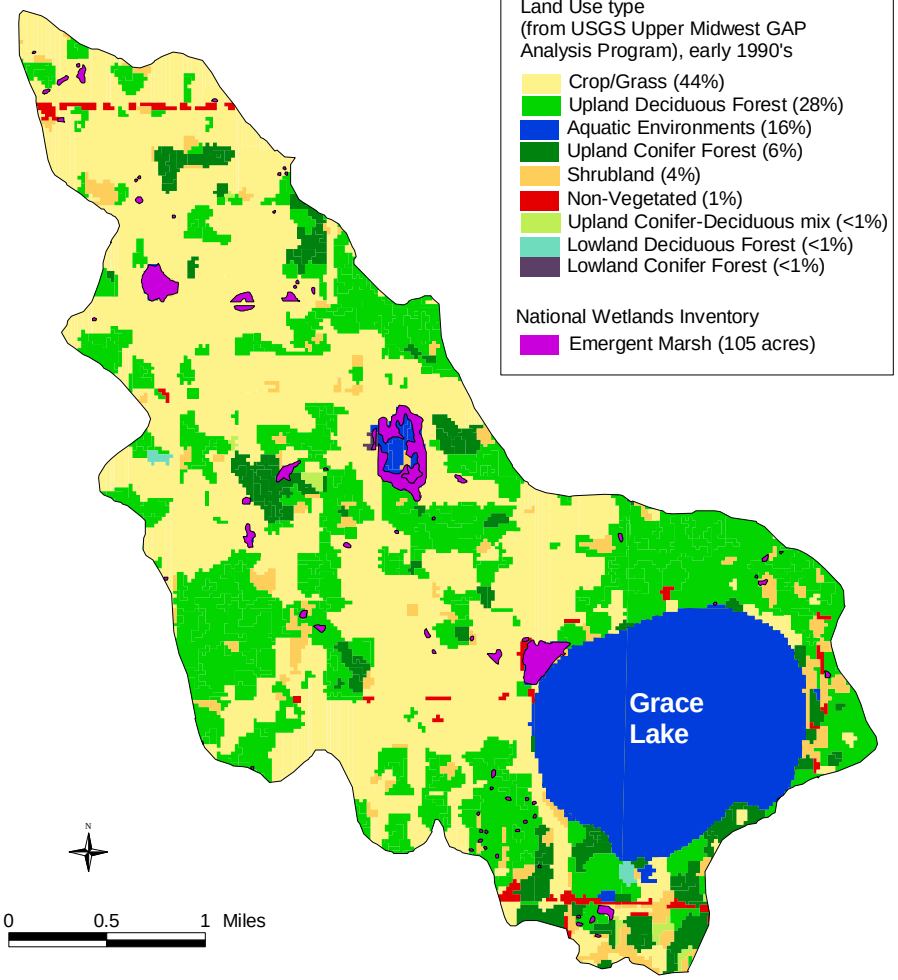


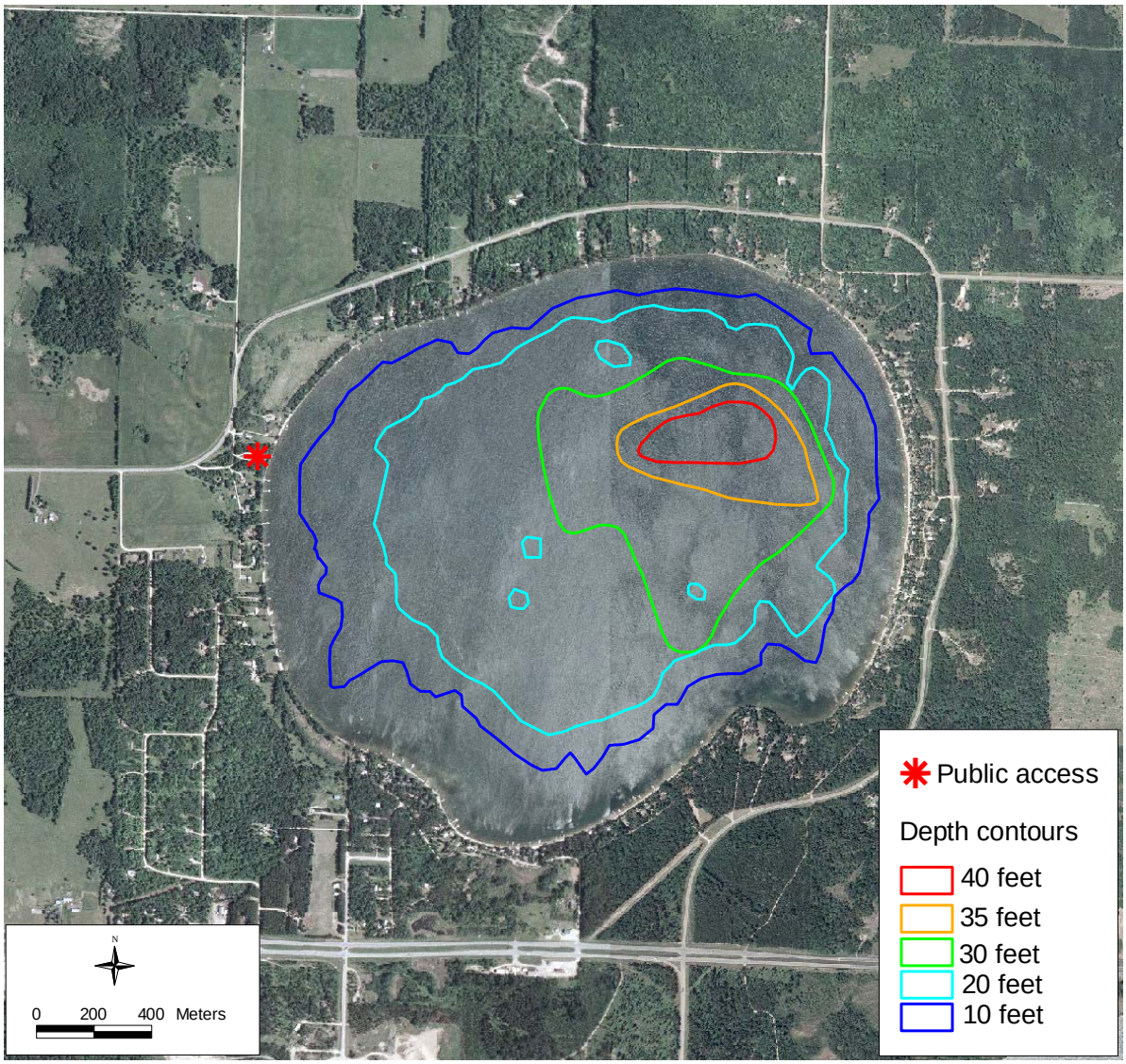
Figure 3. Land use within minor watershed that includes Grace Lake.



Historical vegetation surveys

Previous vegetation surveys of Grace Lake were conducted in 1948, 1950, 1970, and 1989 (MnDNR Fisheries Lake Files). These surveys varied in methodology and types of data collected but collectively, they provide a general description of Grace Lake's aquatic plant communities. At least 10 different native aquatic plant taxa have previously been recorded in the lake including seven submerged, one floating-leaved, and two emergent plant taxa. Historically, the most common plant recorded was muskgrass (*Chara* sp.). Other plants found include coontail (*Ceratophyllum demersum*), northern watermilfoil (*Myriophyllum sibiricum*), a variety of pondweeds (*Potamogeton* spp.), bulrush (*Scirpus sp.*) and cattail (*Typha* sp.). Non-native plants have not been reported in the lake.

Figure 4. Depth contours of Grace Lake, Hubbard County. (based on 2006 data)



Objectives

The purpose of this vegetation survey was to provide a quantitative description of the 2006 plant population of Grace Lake. Specific objectives included:

1) Describe the shoal sediments of the lake
2) Estimate the maximum depth of rooted vegetation
3) Estimate the percent of the lake occupied by rooted vegetation
4) Record the aquatic plant species that occur in the lake
5) Estimate the abundance of common species
6) Develop distribution maps for the common species

Methods

Vegetation surveys of Grace Lake were conducted on July 25 and 26, 2006.

Floating-leaf and emergent vegetation

Surveyors mapped major beds of emergent vegetation by boating around the edge of each emergent plant bed and recording the boundary using a Global Positioning System (GPS) receiver.

Submerged vegetation survey

A Point-intercept survey method (Madsen 1999) was used to survey submerged vegetation. Survey waypoints were created using a Geographic Information System (GIS) computer program and downloaded into a GPS receiver. Survey points were spaced 70 meters apart, resulting in about one survey point per acre. Two field crews, each consisting of one boat and two or three surveyors, conducted the survey. In the field, surveyors infrequently found vegetation beyond a depth of 20 feet and therefore sampled all survey points between shore and 25 feet and only a selected number of points in deeper water. A total of 552 points were surveyed (Table 1, Fig. 5).

Table 1. Sampling effort by water depth, Grace Lake, 2006.

Depth interval in feet	Number of sample points
0 to 5	77
6 to 10	175
11 to 15	88
16 to 20	64
21 to 25	102
26 to 30	46
Total number of sample points	552

The GPS unit 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 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, attached to a rope was used to survey vegetation not visible from the surface (Fig. 6). Any additional plants located outside of sample sites were recorded as present in the lake.

At each sample site where water depth was six feet and less, surveyors described the bottom substrate using standard substrate classes (Table 2).

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
bolder	Diameter over 10 inches

Plant identification and nomenclature followed Crow and Hellquist (2000). Voucher specimens were collected for most plant species and are stored at the

Figure 5. 2006 vegetation survey sites on Grace Lake.

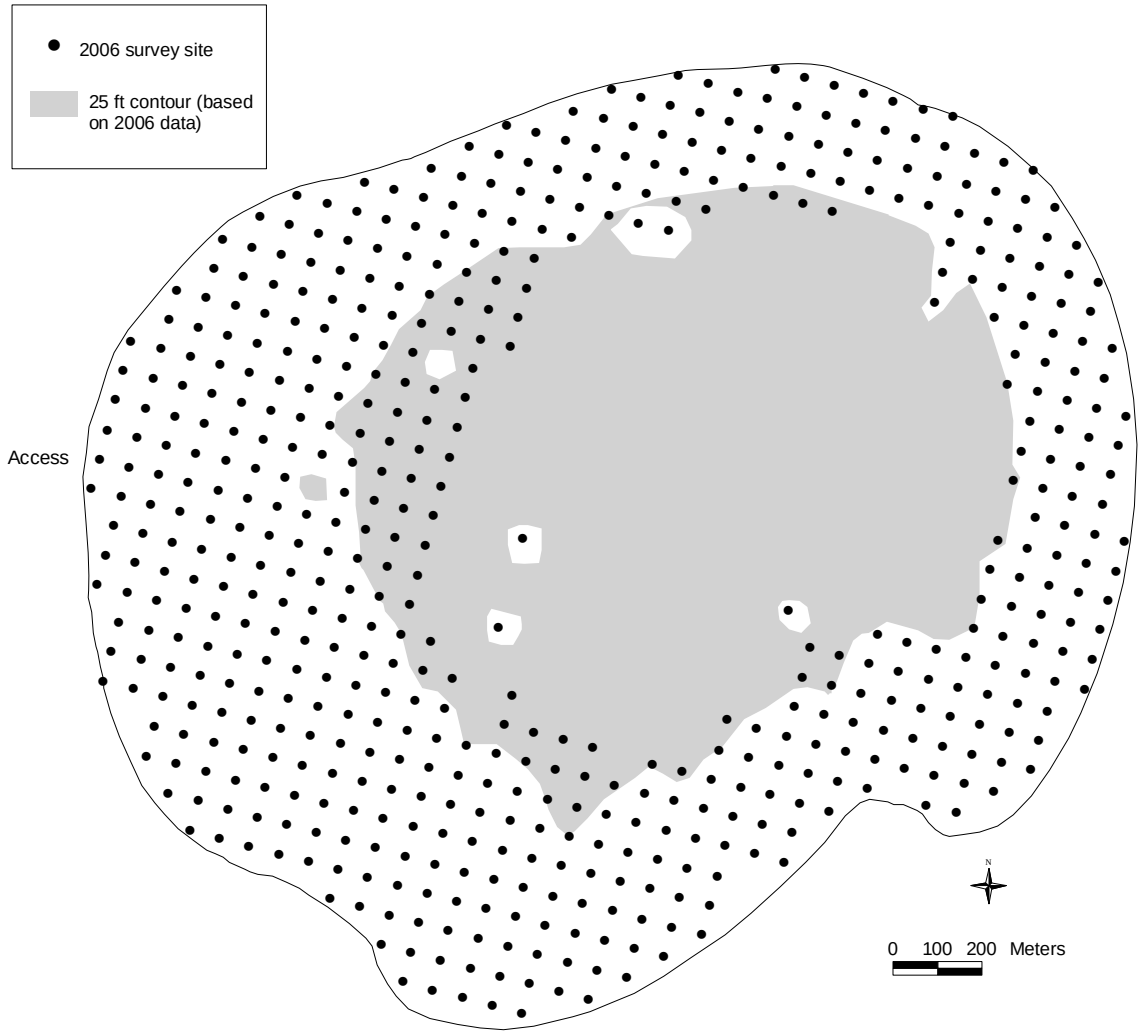


Figure 6. Sampling rake.

MnDNR in Brainerd. 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 area from shore to 25 feet and sampling points were also grouped by water depth and separated into six depth zones for analysis (Table 1).

Example:

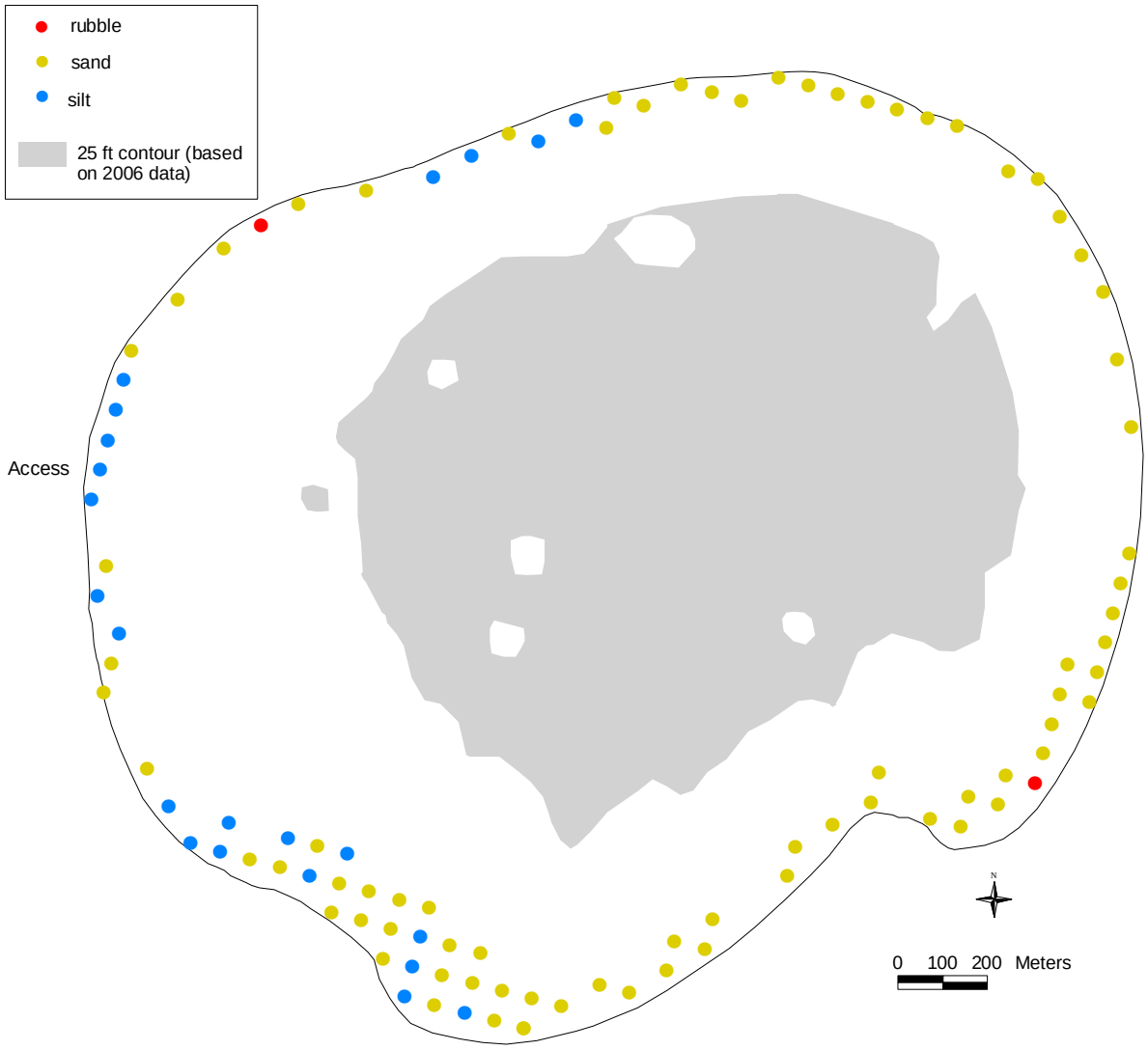
In Grace Lake there were 404 samples sites in the zone from shore to the 20 feet depth.
Bushy pondweed (*Najas flexilis*) occurred in 220 of those sites.
Frequency of bushy pondweed in the shore to 20 feet depth zone = 220/404 (*100) = 54 %

Results

Shoal substrates

The east shore of Grace Lake was primarily sand bottom while silt and sand occurred in the near-shore site of the west shore (Fig. 7).

Figure 7. Shoal sediments of Grace Lake, 2006.



Number and types of plants recorded
A total of 20 native aquatic plant taxa were recorded in Grace Lake including 15 submerged and five emergent taxa (Table 3).

Table 3. Frequency of aquatic plants in Grace Lake Point-intercept survey, July 2006.

* Frequency is the percent of sample sites in which a plant taxon occurred within the shore to 20 ft water depth.
**present – indicates plant taxa was observed outside of sample sites.

Life Form	Common Name	Scientific Name	Frequency of occurrence
Submerged	Bushy pondweed	*Najas flexilis*	54
	Coontail	*Ceratophyllum demersum*	44
	Flat-stem pondweed	*Potamogeton zosteriformis*	41
	Canada waterweed	*Elodea canadensis*	39
	Muskgrass	*Chara sp.*	21
	Northern watermilfoil	*Myriophyllum sibiricum*	20
	Freis pondweed	*Potamogeton freisii*	12
	White-stem pondweed	*Potamogeton praelongus*	7
	Illinois pondweed	*Potamogeton illinoensis*	7
	Narrow-leaf pondweed	*Potamogeton sp.*	5
	Sago pondweed	*Stuckenia pectinata*	7
	Clasping-leaf pondweed	*Potamogeton richardsonii*	5
	Variable pondweed	*Potamogeton gramineus*	1
	White Water Buttercup	*Ranunculus sp.*	1
	Water stargrass	*Heteranthera dubia*	<1
Emergent	Bulrush	*Scirpus sp.*	1
	Spikerush	*Eleocharis sp.*	<1
	Needle grass	*Eleocharis sp.*	<1
	Arrowhead	*Sagittaria sp.*	present
	Cattail	*Typha sp.*	present
Percent of sites with vegetation			77

Distribution of plants by water depth
Plants were found to a maximum depth of 26 feet in Grace Lake but beyond the depth of 20 feet, only one percent of the sites contained vegetation (Fig. 8). Plant occurrence was greatest in depths from shore to 15 feet, where vegetation was found in 96 percent of the sample sites (Fig. 8).

The highest number of plant taxa was found in shallow water, from shore to a depth of five feet (Fig. 9). Emergent plants were restricted to water depths of five feet and less. Submerged plants were found to a maximum depth of 26 feet but only two taxa occurred in depths greater than 20 feet (Fig. 9).

Figure 8. Plant abundance vs. water depth. Grace Lake, June 2006.

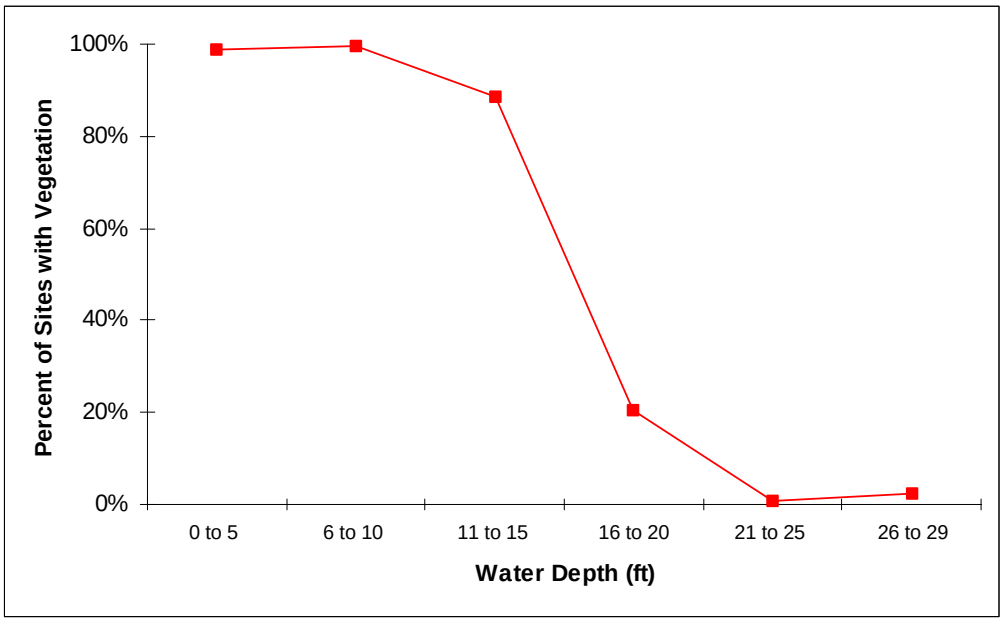
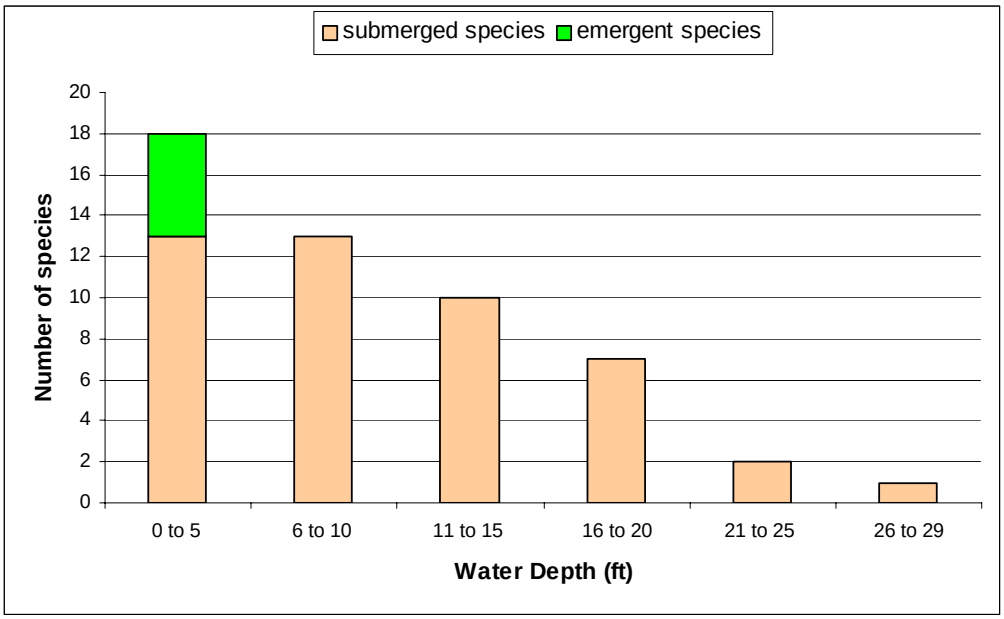


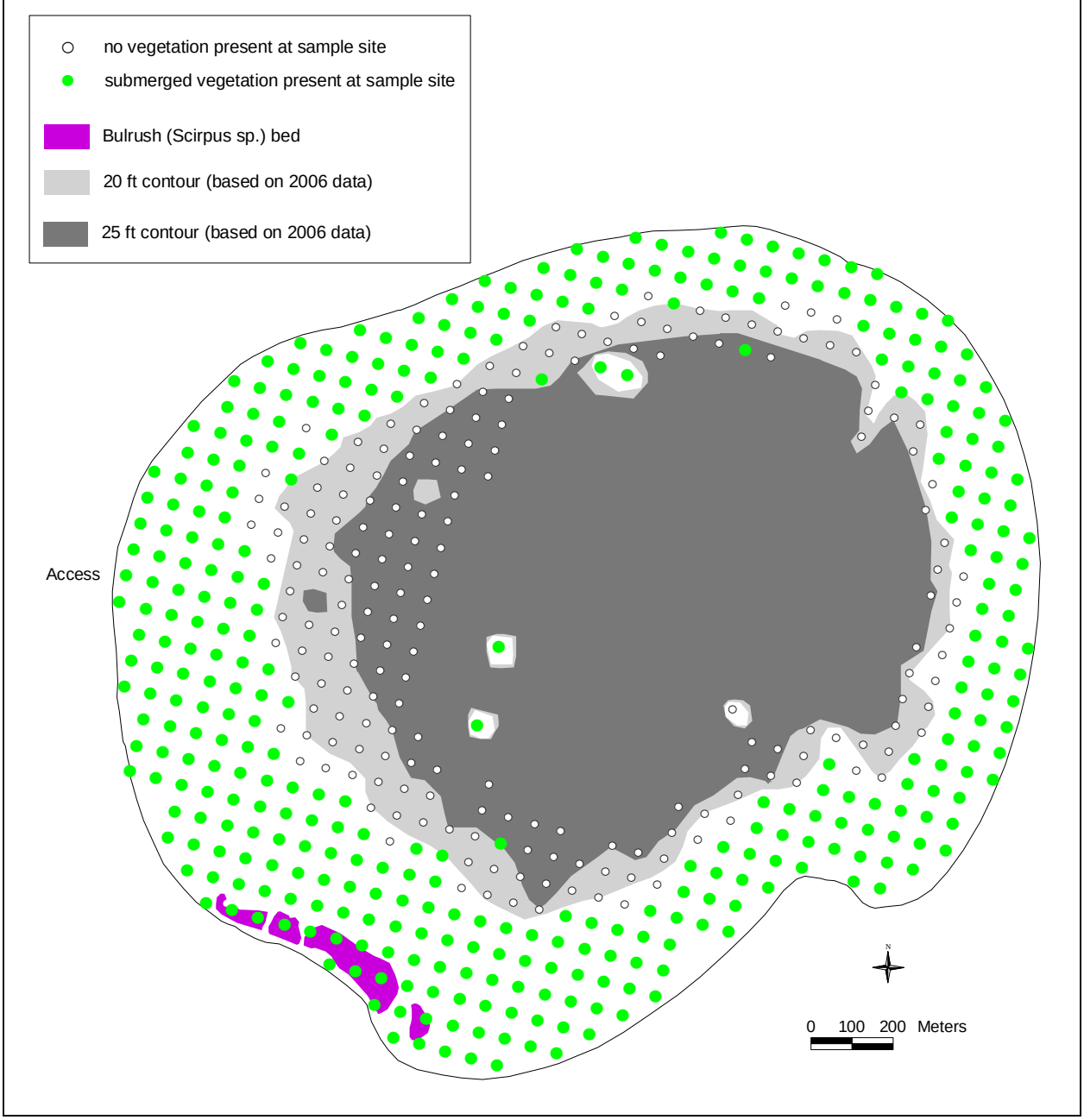
Figure 9. Number of plant taxa vs. water depth. Grace Lake, 2006.



Distribution of plants

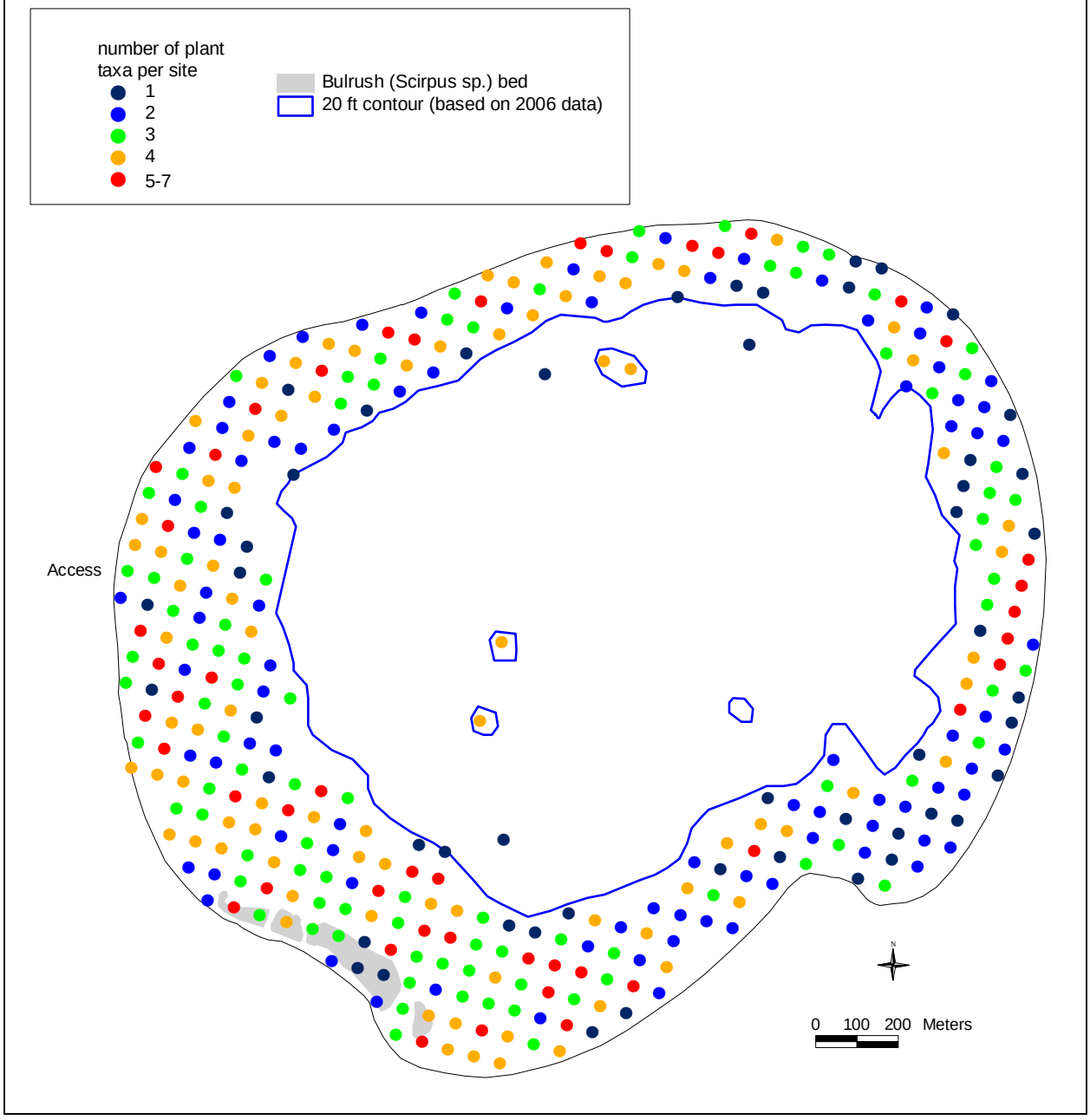
Submerged plants were well distributed around the perimeter of Grace Lake to a depth of about 20 feet (Fig. 10). The west side of the lake contained the broadest band of shallow water and submerged plants occurred up to 400 meters from shore. Approximately eight acres of emergent bulrush beds were found on the southwest shore (Fig. 10).

Figure 10. Distribution of aquatic plants in Grace Lake, June-July 2006.



The number of different plant taxa found at each survey site ranged from zero to seven and most areas of the lake contained a mixture of different plant taxa (Fig. 11).

Figure 11. Number of plant taxa found at each sample site. Grace Lake, June 2006.



Submerged plants

The most common submerged plants included bushy pondweed (*Najas flexilis*), coontail (*Ceratophyllum demersum*), flat-stem pondweed (*Potamogeton zosteriformis*), Canada waterweed (*Elodea canadensis*), muskgrass (*Chara* sp.), and northern watermilfoil (*Myriophyllum sibiricum*). (Table 3).

Figure 12. Bushy pondweed (*Najas flexilis*)

Bushy pondweed (*Najas flexilis*) (Fig. 12) is unique because it is one of the few annual submerged species in Minnesota and must re-establish every year from seed. The seeds and foliage of this plant are an important duck food and beds of this plant provide good fish cover.

In Grace Lake, bushy pondweed occurred in 54 percent of the sample sites (Table 3) and was most common in depths of fifteen feet and less (Fig. 13). It was well distributed around the lake (Fig. 14).

Figure 13. Distribution of common submerged species by water depth, Grace Lake, June 2006.

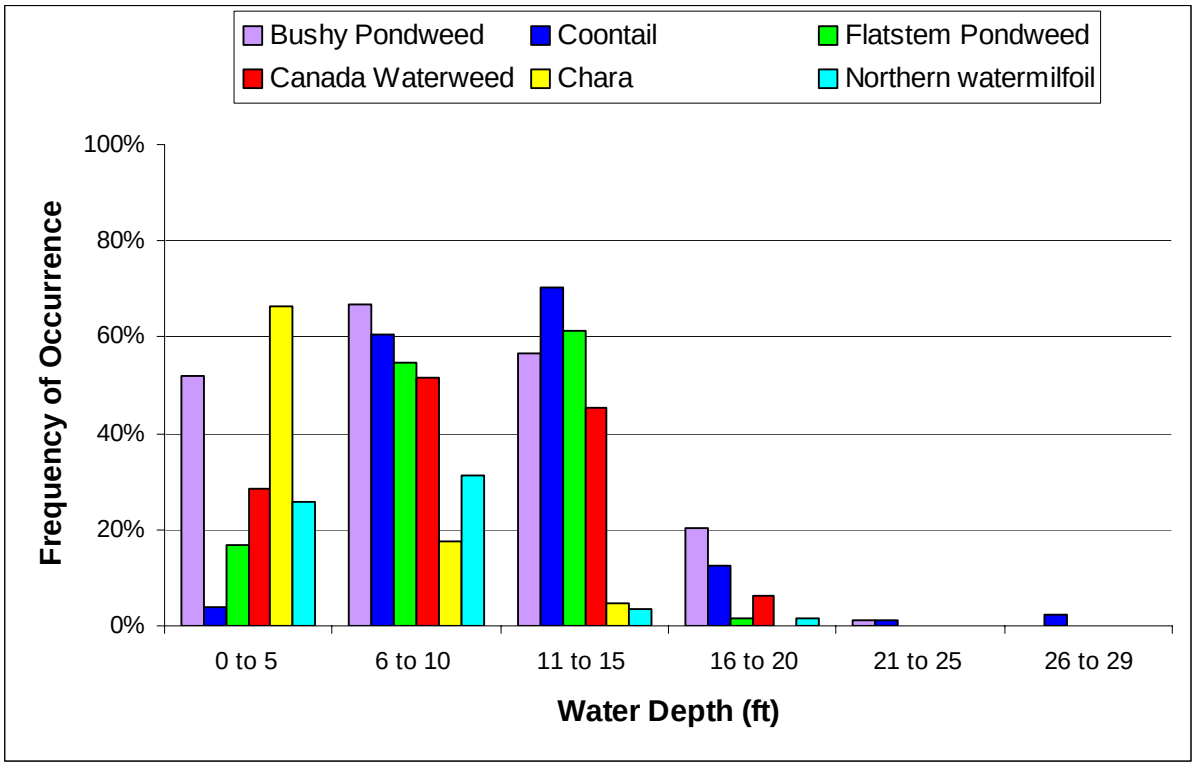
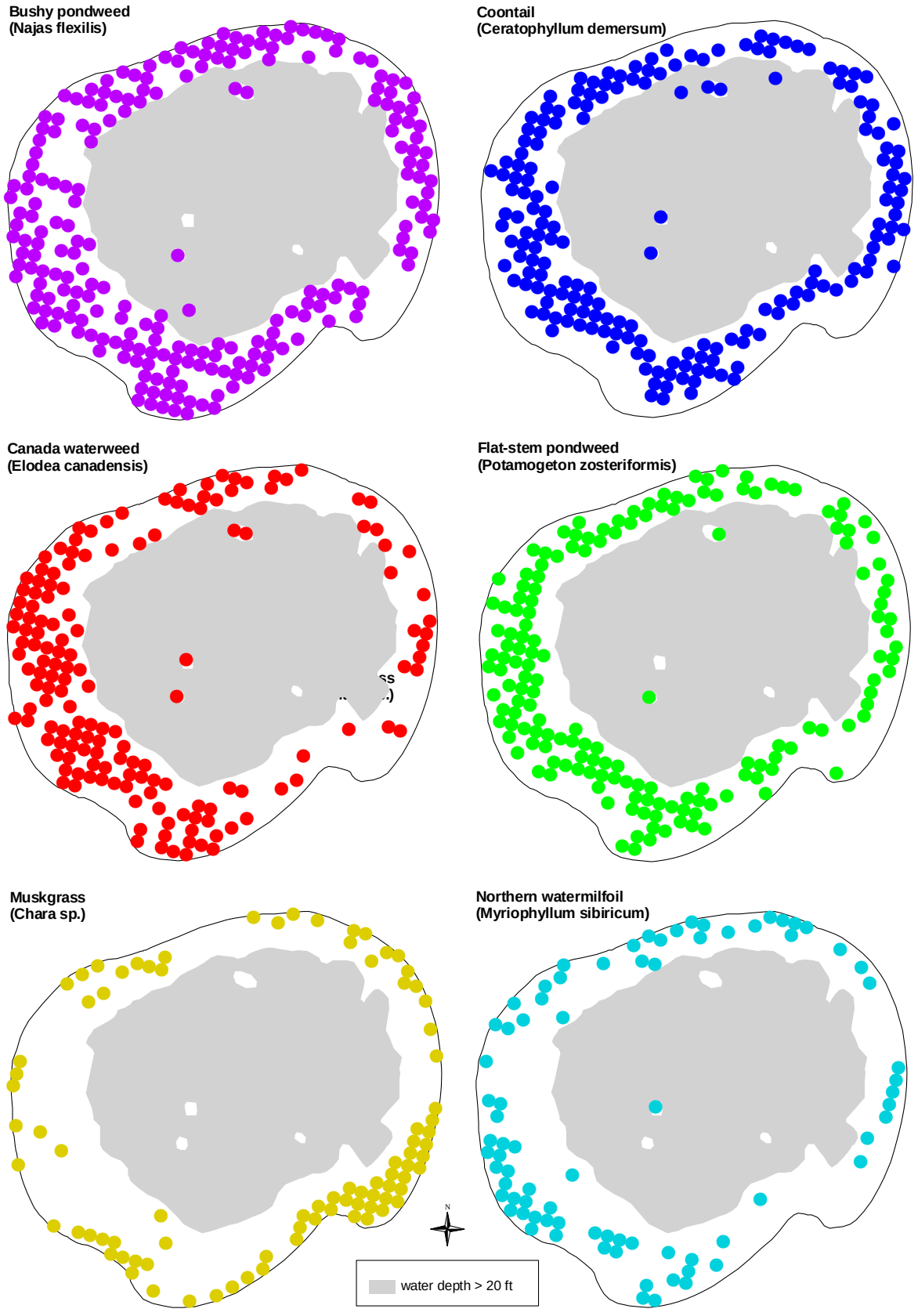


Figure 14. Distribution of common submerged plant groups, Grace Lake, June 2006.

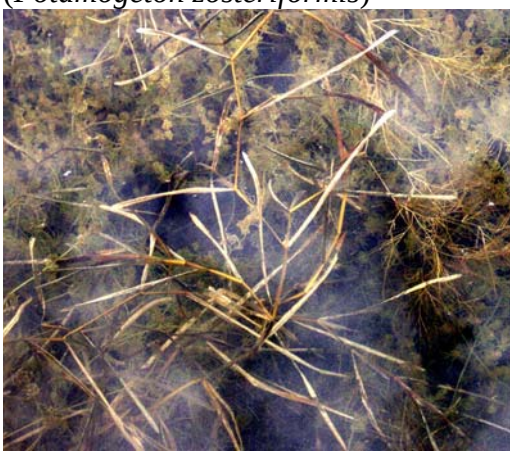


Coontail (*Ceratophyllum demersum*) (Fig. 15) is the most common submerged flowering plant in Minnesota lakes. It grows entirely submerged and is adapted to a broad range of lake conditions, including turbid water. Coontail is a perennial and can overwinter as a green plant under the ice and then begins new growth early in spring. 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.

Figure 15. Coontail (*Ceratophyllum demersum*)

In Grace Lake, coontail occurred in 44 percent of all survey sites (Table 3) and was most frequent in depths of six to 15 feet, where it occurred in at least 60 percent of sites (Fig. 13) and occurred throughout the vegetated zone (Fig. 14). Coontail was the only species found in depths greater than 25 feet. Because it is only loosely rooted to the lake bottom it may drift between depth zones (Borman et al. 1997) and is often found at depths greater than other species.

Figure 16. Flat-stem pondweed (*Potamogeton zosteriformis*)



Nine different native submerged "pondweed" (*Potamogeton spp.*) taxa occurred in Grace Lake Flat-stem pondweed (*Potamogeton zosteriformis*) was the most common pondweed found and is named for its flattened, grass-like submerged leaves (Fig. 16). Pondweeds form "cigar-shaped" fruits that emerge above the water surface and are a favorite duck food. Pondweeds are anchored to the lake bottom by rhizomes and overwinter by winter buds.

Flat-stem pondweed occurred in 41 percent of the sample sites (Table 3). It occurred around the entire lake (Fig. 14) but was most common in depths of six to 15 feet (Fig. 13).

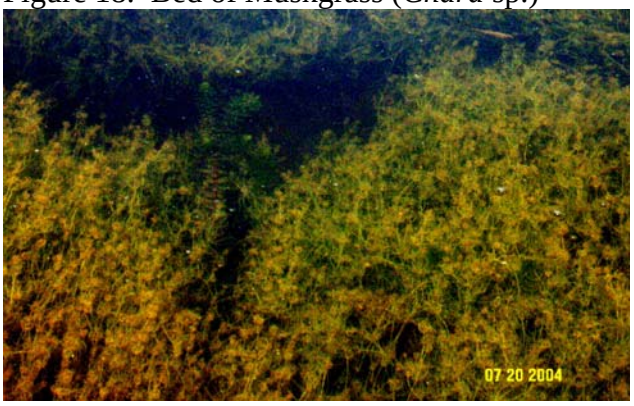
Figure 17. Canada waterweed (*Elodea canadensis*) (photo by Vic Ramey, U of Florida)

Canada waterweed (*Elodea canadensis*) (Fig. 17) is a rooted, perennial submerged species that is widespread throughout Minnesota and is adapted to a variety of conditions. It is tolerant of low light and prefers soft substrates. This species can over winter as an evergreen plant and spreads primarily by fragments. The branching stems of this plant can form thick underwater plant beds that are valuable habitat for a variety of fish and invertebrates.

In Grace Lake, flat-stem pondweed occurred to a depth of 22 feet (Fig. 14). It was found in 39 percent of all sample sites and was most common in depths less than 16 feet (Fig 13).

Muskgrass (*Chara* sp.) (Fig. 18) is a macroscopic, or large, algae that is common in many hard water Minnesota lakes. It has a brittle texture and a characteristic "musky" odor. Because this species 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 species to colonize open areas of lake bottom where it can act as a sediment stabilizer. Beds of muskgrass can provide important habitat for fish spawning and nesting.

Figure 18. Bed of Muskgrass (*Chara* sp.)



In Grace Lake, muskgrass occurred in 21 percent of the survey sites (Table 3) and was primarily found in depths less than six feet (Fig. 13). It was one of the only plants found along the sandy, southeastern shore (Fig. 14).

Northern watermilfoil (*Myriophyllum sibiricum*) (Fig. 19) is a perennial, rooted submerged plant with spike-like flowers that extend above the water surface. The numerous finely divided leaves of this plant provide habitat for aquatic invertebrates and fish. Northern watermilfoil is often mistaken for the non-native invasive Eurasian watermilfoil (*Myriophyllum spicatum*), which was not found in Grace Lake. Northern watermilfoil has 5-10 leaflet pairs compared to 12-21 leaflet pairs for Eurasian watermilfoil. Northern watermilfoil prefers soft sediments of clearer water lakes (Borman et al. 1997).

Figure 19. Northern watermilfoil (*Myriophyllum sibiricum*).

Northern watermilfoil occurred in 20 percent of the Grace Lake survey sites (Table 3) and was most frequent in depths of 10 feet and less (Fig. 13).

Emergent plants

Emergent aquatic plants offer shelter for insects and young fish as well as food, cover and nesting material for waterfowl, marsh birds and muskrats. The root systems of emergent and plants act to stabilize the lake bottom and beds of these plants help buffer the shoreline from wave action.

Figure 20. Bulrush (Scirpus sp.)

In 1989, a survey conducted by DNR Fisheries reported Bulrush (*Scirpus* sp.) (Fig. 19) as "abundant" in Grace Lake. In 2006, bulrush was the most common emergent plant found in the lake but was only found on the southwest shore and covered an area of about eight acres (Fig. 10). While it is difficult to know the actual historical extent of bulrush in the lake, the mapping conducted in 2006 now provides a baseline from which future changes can be monitored.

Discussion

The types and amounts of aquatic vegetation that occur within a lake are influenced by a variety of factors including water clarity, water chemistry, water depth, substrate and wave activity. Shallow areas (less than 16 feet in depth) of Grace Lake support an abundant and diverse native aquatic plant community that in turn, provides critical fish and wildlife habitat and other lake benefits. (Click here for more information on: value of aquatic plants).

Data collected in 2006 can be used to monitor changes that may occur in the plant community, such as an increase in a particular species or a change in the depths at which individual species occur. Monitoring change in the aquatic plant community can be helpful in determining whether changes in the lake water quality are occurring and for estimating the quality of vegetation habitat available for fish and wildlife communities.

In general, factors that may lead to change in the aquatic plant communities include:

- Change in water clarity
  If water clarity in Grace Lake decreases, submerged vegetation may be restricted to shallower water.
- Change in water level
  Many aquatic plants are adaptable to water level fluctuations and in low water years, aquatic plants may expand in distribution. The extent and duration of these distribution changes can be difficult to predict.
- Snow and ice cover
  Many submerged plants have the ability to grow under the ice, especially if there is little snow cover and sunlight reaches the lake bottom. In years following low snow cover, and/or a reduced ice-over period, some 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.
- Invasive species

Non-native species have **not** been documented in Grace Lake but if they invade the lake, they may directly or indirectly impact the native plant community. Non-native plant species, such as Eurasian watermilfoil (*Myriophyllum spicatum*) or curly-leaf pondweed (*Potamogeton crispus*) may form dense surface mats that may shade out native plants. The impact of these invasive species varies among lakes but the presence of a healthy native plant community may help mitigate the harmful effects of these exotics. Lake users should be sure to clean all aquatic plants from their watercraft and drain all water before moving to another lake.

- 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 flexilis*) and wild rice (*Zizania palustris*) are annuals and are dependant on the previous years seed set for regeneration.
- Aquatic plant management activities
  Humans can impact aquatic plant communities directly by destroying vegetation with herbicide or by mechanical means. For information on the laws pertaining to aquatic plant management, click here: MnDNR APM Program or contact your local DNR office. Motorboat activity in vegetated areas can be particularly harmful for species such as bulrush and wild rice. Shoreline and watershed development can also indirectly influence aquatic plant growth if it results in changes to the overall water quality and clarity. Herbicide and mechanical control of aquatic plants can directly impact the aquatic plant community. Limiting these types of activities can help protect native aquatic plant species.

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Canada waterweed (pg. 23) Vic Ramey, U of Florida. Copyright Univ. of Florida 1993. At Univ. of Florida Center for Aquatic Plants: http://aquat1.ifas.ufl.edu/welcome.html

