Aquatic Vegetation of Edward Lake
Crow Wing County, Minnesota
(DOW 18-0305-00)
July 8, 9, 14, 26; August 2, 2004

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Summary

An aquatic vegetation survey of Lake Edward (18-0305-00), Crow Wing County, Minnesota, was conducted on July 8, 9, 14, 26 and August 2, 2004. Thirty-two native aquatic plant species were identified, making Lake Edward among the richest lake plant communities in the state. Plants were found distributed throughout the lake basin to a maximum depth of twenty-three feet, although most vegetation occurred in depths less than 16 feet. Most plant species were restricted to water depths from shore to ten feet deep and the shore to five feet depth zone contained the highest number of species. Extensive beds of emergents occurred around the lake to a depth of about five feet. Hardstem bulrush (*Scirpus acutus*) was found in 51 percent of the sites within that shallow zone. Common submerged plants included two large algae plants: muskgrass (*Chara* sp.), occurred mostly in shallow water and was found in 33 percent of the sites, and stonewort (*Nitella* sp.) which was found in 16 percent of the sites and was more common in deep water. Other common submerged species were bushy pondweed (*Najas flexilis*), found in 26 percent of the sites; coontail (*Ceratophyllum demersum* (16 percent), flatstem pondweed (*Potamogeton zosteriformis*) (11 percent), and clasping-leaf pondweed (*Potamogeton richardsonii*) (10 percent). A non-native submerged species, curly-leaf pondweed *(Potamogeton crispus)* was present in the lake but occurred in only two percent of the sites.

Introduction

Edward Lake (DOW 18-0305-00) is located north of the city of Brainerd in Crow Wing County, Minnesota, within the ecological region known as the Laurentian Mixed Forest Province (Fig. 1).

The lake lies at the southeastern edge of the Crow Wing River Watershed (Fig. 2). Edward Lake is relatively large with a surface area of about 2,032 acres. A channel on the south end of the lake drains to a wetland. Water flow continues south and west through a ditch and a series of lakes to the Gull River and then to the Crow Wing River. Within the minor watershed that includes Edward Lake, the majority of the upland is forested but also includes agricultural land and shrublands (Fig. 3).

Figure 1. Location of Lake Edward (18-0305-00), Crow Wing Co., MN

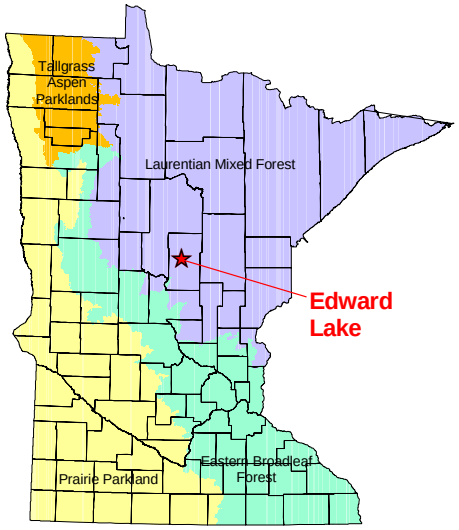
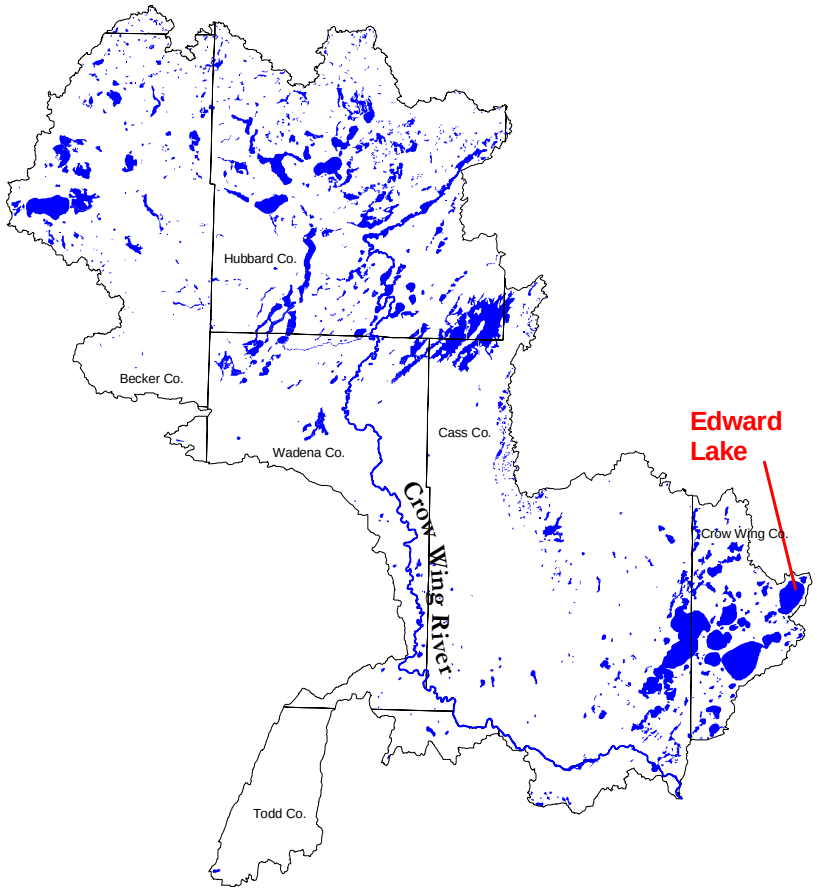


Figure 2. Location of Lake Edward (18-0305-00) in Crow Wing River Watershed.

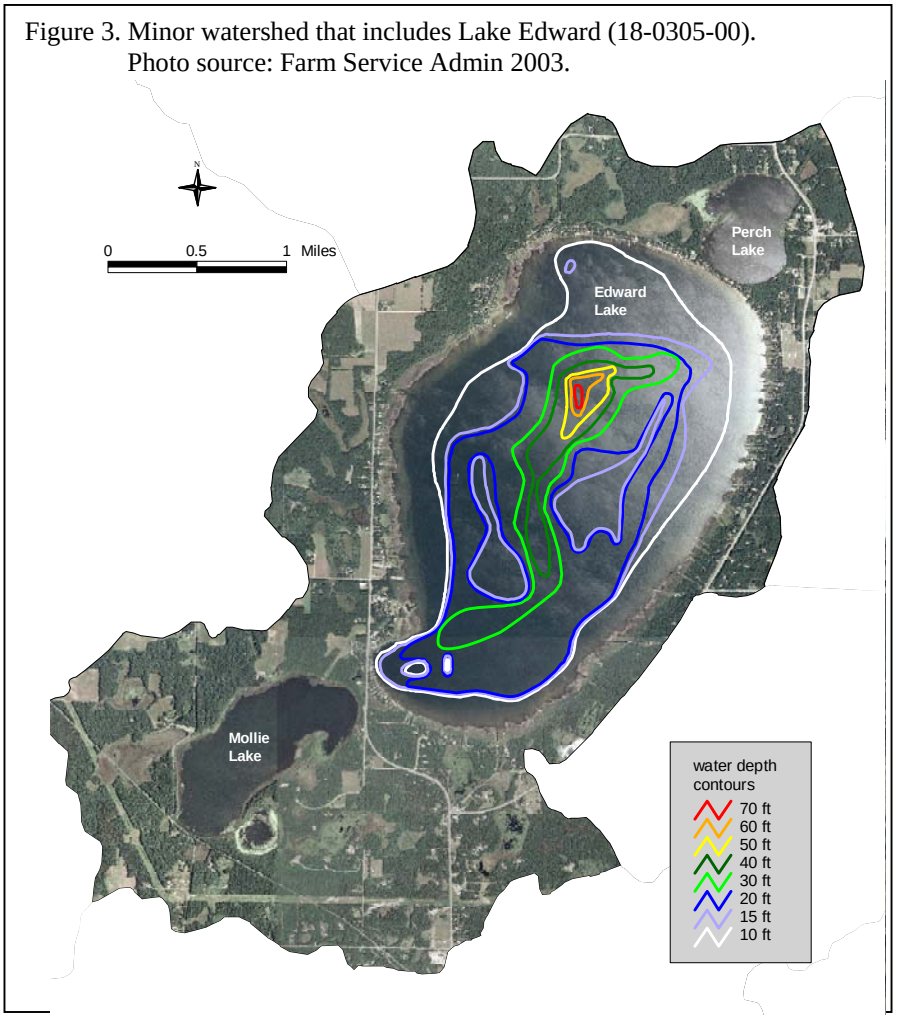


Edward Lake is heavily developed with residential homes around most of the shoreland. A public access is located on the west shore.

Edward Lake has a maximum depth of 75 feet but most of the lake is shallow, with nearly 60 percent less than 15 feet deep (Fig. 3). Lake bottom type in shallow water is predominantly sand.

The lake is described as oligotrophic (few nutrients) with high water clarity as indicated by the 2004 mean summer secchi depth of 14.7 feet (MPCA 2004).

Figure 3. Minor watershed that includes Lake Edward (18-0305-00).
Photo source: Farm Service Admin 2003.



Aquatic Vegetation Survey Objectives

The purpose of the 2004 survey of Edward Lake is 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

Aquatic Vegetation Survey Methods

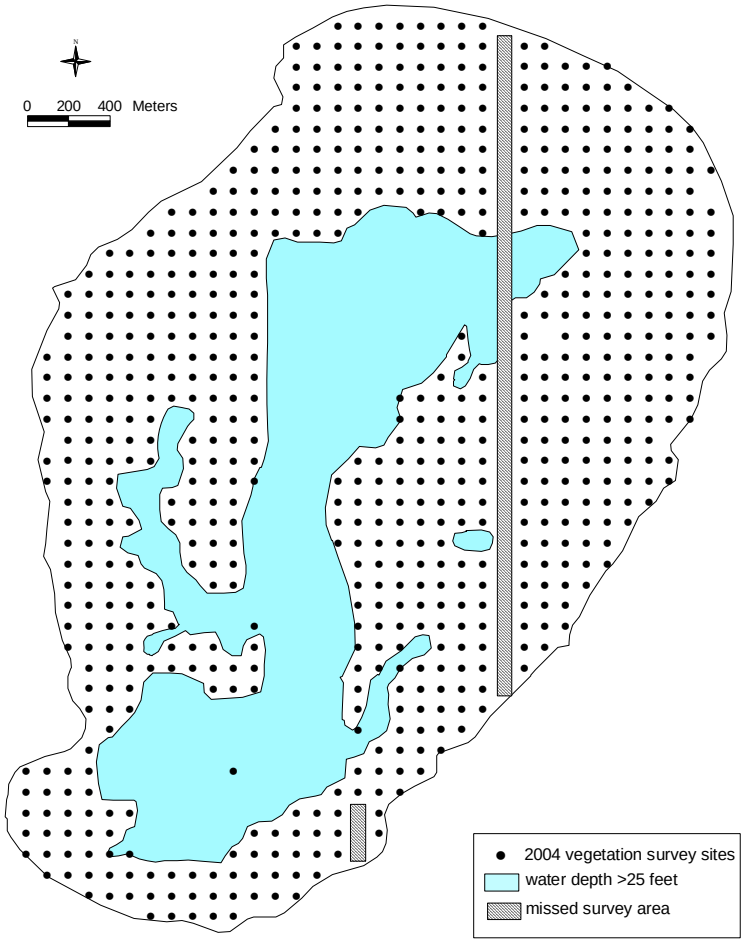
Point Intercept Survey

A Point-Intercept vegetation survey of Edward Lake was conducted on July 8, 9, 14, 26 and August 2, 2004 following the methodology described by Madsen (1999). Sample points were established in using ArcView GIS program using a 100 meter by 100 meter grid across the lake surface (Fig. 5). This resulted in a total of 917 potential samples site. Once the survey began, surveyors decided not to sample in depths greater than 25 feet because they consistently were not finding vegetation beyond the 25 feet depth. Also, about 30 potential sites were inadvertently

missed during the survey. As a result, 725 sites were actually sampled and 721 of those fell within the zone from shore to the 25 foot depth (Fig. 5).

Survey waypoints were created and downloaded into a Garmin GPS. 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 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. 6), attached to a rope was used to survey vegetation not visible from the surface. If curly-leaf pondweed (*Potamogeton crispus*) was present at a site, surveyors recorded whether or not it formed surface mats at that site.

Fig. 5. 2004 Vegetation sampling sites on Lake Edward (18-0305-00) Crow Wing Co., MN.



Nomenclature followed Crow and Hellquist (2000). Voucher specimens were collected for most plant species are are stored at the DNR in Brainerd.

Figure 6: Rake used to sample vegetation.

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 vegetated zone (0 to 25 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.

<u>Emergent vegetation mapping</u>

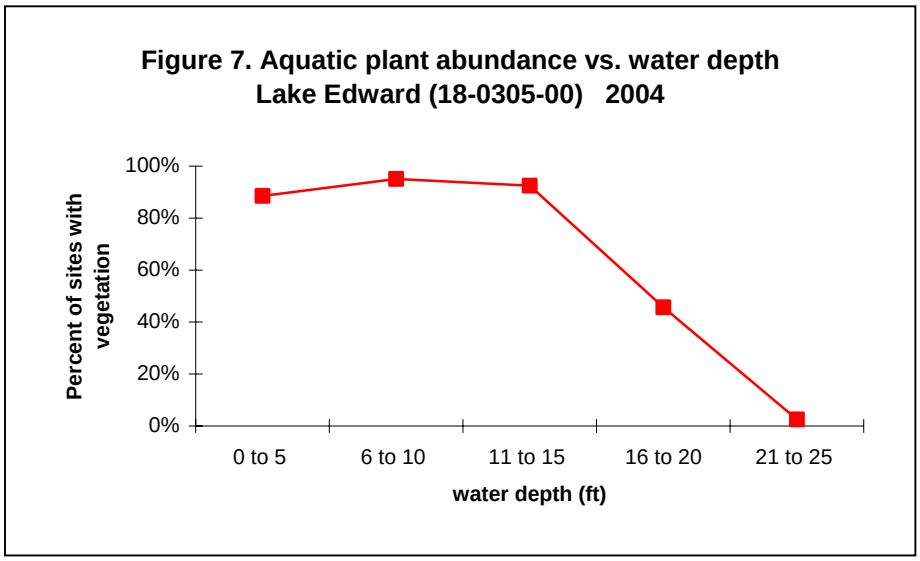
Beds of emergent vegetation were mapped by MnDNR Fisheries staff in 2002. Surveyors boated around the perimeter of each plant

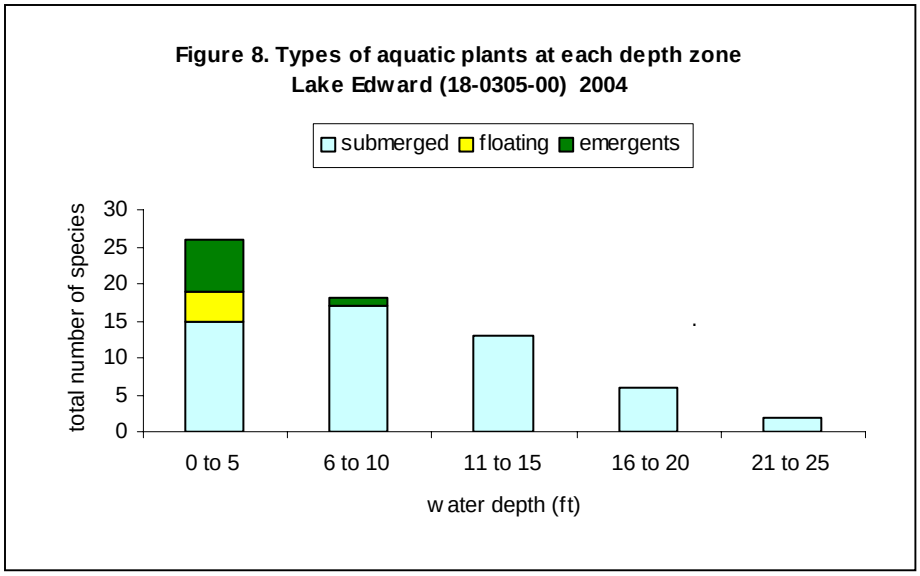
bed and marked the bed outline using a hand-held gps. Emergent plant species present in each bed were recorded along with an estimate of abundance.

Results

Within the sampled zone from shore to 25 feet, 78 percent of the Lake Edward survey sites contained vegetation. Plants were found to a maximum depth of 23 feet, but were most commonly found in depths less than 16 feet, where nearly 90 percent of sites contained vegetation; only three percent of sites in depths from 20 to 25 feet were vegetated (Fig. 7).

A total of 32 different aquatic plant species were identified including seven emergent, four floating-leaved and 21 submerged species (Table 1). The greatest number of species occurred in the shore to five feet depth zone, where all life forms occurred, and fewer species were found with increasing water depths (Fig, 8).





Emergent plants

In 2002, approximately 310 acres were delineated as emergent vegetation in Edward Lake. A broad band of emergents extends around the majority of the lake and extend about 125 to 200 meters lakeward to a water depth of about five feet (Fig. 9).

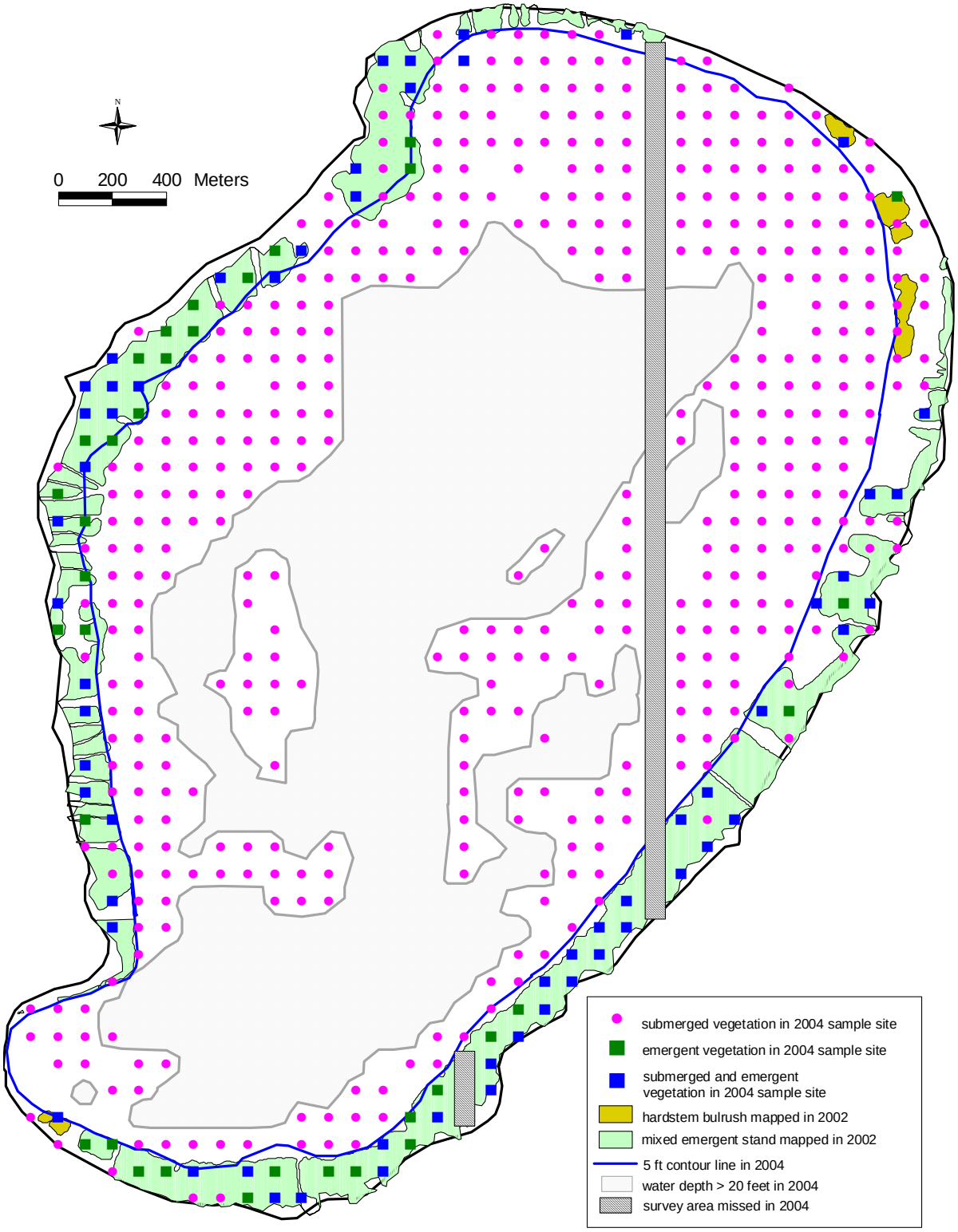
Table 1. Aquatic Plants of Edward Lake, Crow Wing County (DOW 18-0305-00) July 8, 9, 14, 26; August 2, 2004

Frequency calculated for vegetated zone (shore to 25 feet depth)
Frequency = percent of sites in which species occurred
721 sample sites

Life Forms	Common Name	Scientific Name	Voucher	Frequency
SUBMERGED These plants grow primarily under the water surface. Upper leaves may float near the surface and flowers may extend above the surface. Plants are rooted or anchored to the lake bottom.	Muskgrass spp	*Chara sp*	x	33
	Bushy pondweed	*Najas flexilis*	x	26
	Coontail	*Ceratophyllum demersum*	x	16
	Stonewort	*Nitella sp.*		16
	Flatstem pondweed	*Potamogeton zosteriformis*	x	11
	Clasping-leaf pondweed	*Potamogeton richardsonii*		10
	Canada waterweed	*Elodea canadensis*		4
	Northern water milfoil	*Myriophyllum sibiricum*	x	4
	Variable pondweed	*Potamogeton gramineus*	x	4
	Greater bladderwort	*Utricularia vulgaris*	x	3
	White-stem pondweed	*Potamogeton praelongus*	x	2
	Curly-leaf pondweed	*Potamogeton crispus*	x	2
	Illinois pondweed	*Potamogeton illinoensis*	x	2
	Sago pondweed	*Stuckenia pectinata*	x	2
	Wild celery	*Vallisneria americana*		2
	Narrow-leaf pondweed	*Potamogeton sp.*	x	2
	Fries pondweed	*Potamogeton freisii*	x	1
	Large-leaf pondweed	*Potamogeton amplifolius*	x	1
	Star duckweed	*Lemna trisulca*		1
	Moss			<1
	White water buttercup	*Ranunculus sp.*		<1
FLOATING These plants are rooted in the lake bottom and have leaves that float on the water surface. Many have colorful flowers that extend above the water	Floating leaf pondweed	*Potamogeton natans*	x	<1
	White waterlily	*Nymphaea odorata*		present
	Yellow waterlily	*Nuphar variegata*		present
	Floating-leaf burreed	*Sparganium emersum*	x	present
EMERGENT These plants extend well above the water surface and are usually found in shallow water, near shore.	Hardstem bulrush	*Scirpus acutus*	x	12
	Spikerush	*Eleocharis sp*		2
	Needlerush	*Eloecharis acicularis*	x	1
	Bulrush	*Scirpus spp.*		1
	Narrowleaf cattail	*Typha angustifolia.*		<1
	Wild rice	*Zizania palustris*		<1
	Arrowhead/duck potato	*Sagittaria spp.*	x	<1

* present indicates plant was found during survey but did not occur within a specific sample site.

Figure 9. Emergent and submerged plants on Lake Edward (18-0305-00)



Emergent beds are not continuous on Lake Edward but are broken both by natural openings and by artificial cuts that have been created perpendicular to shore for boat access and other recreational use. During the 2004 point-intercept survey, emergents were occasionally found to seven feet (Fig. 8), but the majority occurred in the zone from shore to five feet where 51 percent of the sites contained emergents (Fig. 9).

Figure 10. Bulrush (*Scirpus* sp.)

Hardstem bulrush (*Scirpus acutus*) (Fig. 10) was the most common emergent plant found in 2004. Lakewide, it was found in 12 percent of the sample sites, but within the shore to five feet zone, it occurred in 44 percent of the sites (Fig. 11). It occasionally grew in pure stands but was often mixed with other emergent plants such as Narrowleaf cattail (*Typha angustifolia*), Three-square bulrush, arrowhead, spikerush, and wild rice.

Floating-leaved plants

Floating leaved plants did not form extensive beds on Lake Edward but were occasionally found along protected shores in water depths less than five feet (Fig. 8). Species found included floating-leaf pondweed

Figure 11: Frequency of common aquatic plants vs. water depth. Edward Lake (18-0305-00), July 8, 9, 14, 26; August 2; 2004.

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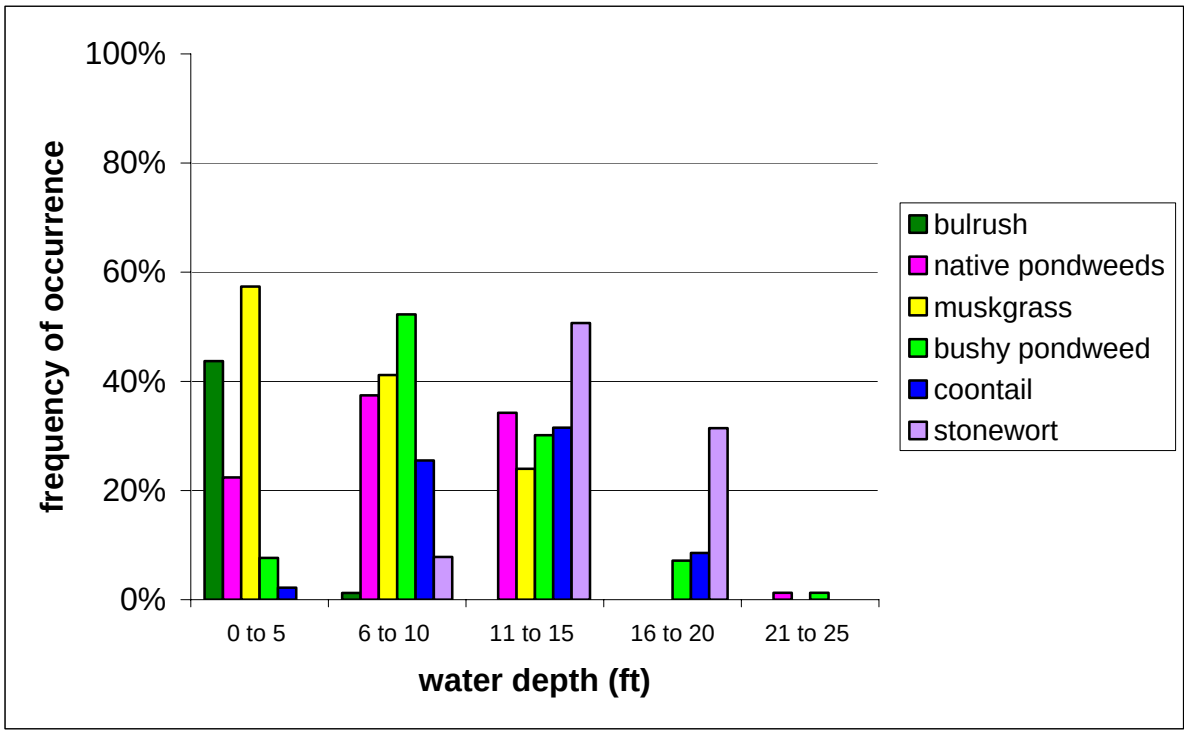


(*Potamogeton natans*), white waterlily (*Nymphaea odorata*), yellow waterlily (*Nuphar variegata*) and floating-leaf burreed (*Sparganium emersum*).

Submerged plants

Submerged plants were present at all depths to 23 feet in Edward Lake and the greatest number of species occurred in the depth zone from six to ten feet, where 17 of the 21 species were found; only two species were in depths beyond 19 feet (Fig. 8).

Figure 12. Bed of Muskgrass (*Chara* sp.)

Muskgrass (*Chara* sp.) (Fig. 12) dominated the submerged plant community, occurring in 33 percent of the sample sites between shore and 25 feet (Table 1). It was most common in shallow water up to five feet and was not found beyond the 14 feet depth (Fig. 11). Muskgrass is an algae that grows in large colonies and resembles higher plants. Unlike higher plants, it does not form true roots, stems or flowers. It is a "pioneer" species and is often one of the first species to invade bare areas of lake bottom. Muskgrass grows well on sandy or sandy-silty lake bottoms and can withstand moderate to heavy wave activity. In Lake Edward, muskgrass grows as a low-growing "carpet" along the lake bottom and does not typically reach the water surface.

Figure 13.Bushy pondweed (*Najas flexilis*)

Bushy pondweed (*Najas flexilis*) (Fig. 13) was also common in Lake Edward and was found in 26 percent of the sample sites (Table 1). Bushy pondweed is unique because it is one of the few submerged plants that is an annual and begins growth each year from seed. This species was most common in the depth zone from six to 15 feet (Fig. 11) and its heaviest distribution was in the west and north ends of the lake while muskgrass was more concentrated in the east and north ends (Fig. 14).

Coontail (*Ceratophyllum demersum*) is the most common submerged plant in Minnesota and in Lake Edward, it occurred in 16 percent of the sample sites (Table 1). Coontail is adapted to low light levels and was most often found in depths from 11 to 15 feet (Fig. 11) but did not reach the surface at these depths. This plant could be found around the entire lake but was most often found in the north half of the lake (Fig. 14).

Stonewort (*Nitella* sp.) is another large algae that was common in Lake Edward, occurring in 16 percent of the sample sites (Table 1). It is similar in appearance to muskgrass, but is often found in deeper water. In Lake Edward, it was the most common species in the 11 to 20 feet depth zone (Fig. 11) and was most often found in the east half of the lake (Fig. 14).

Fig. 13. Distribution of common submerged plants in Lake Edward (18-0305-00). 2004.

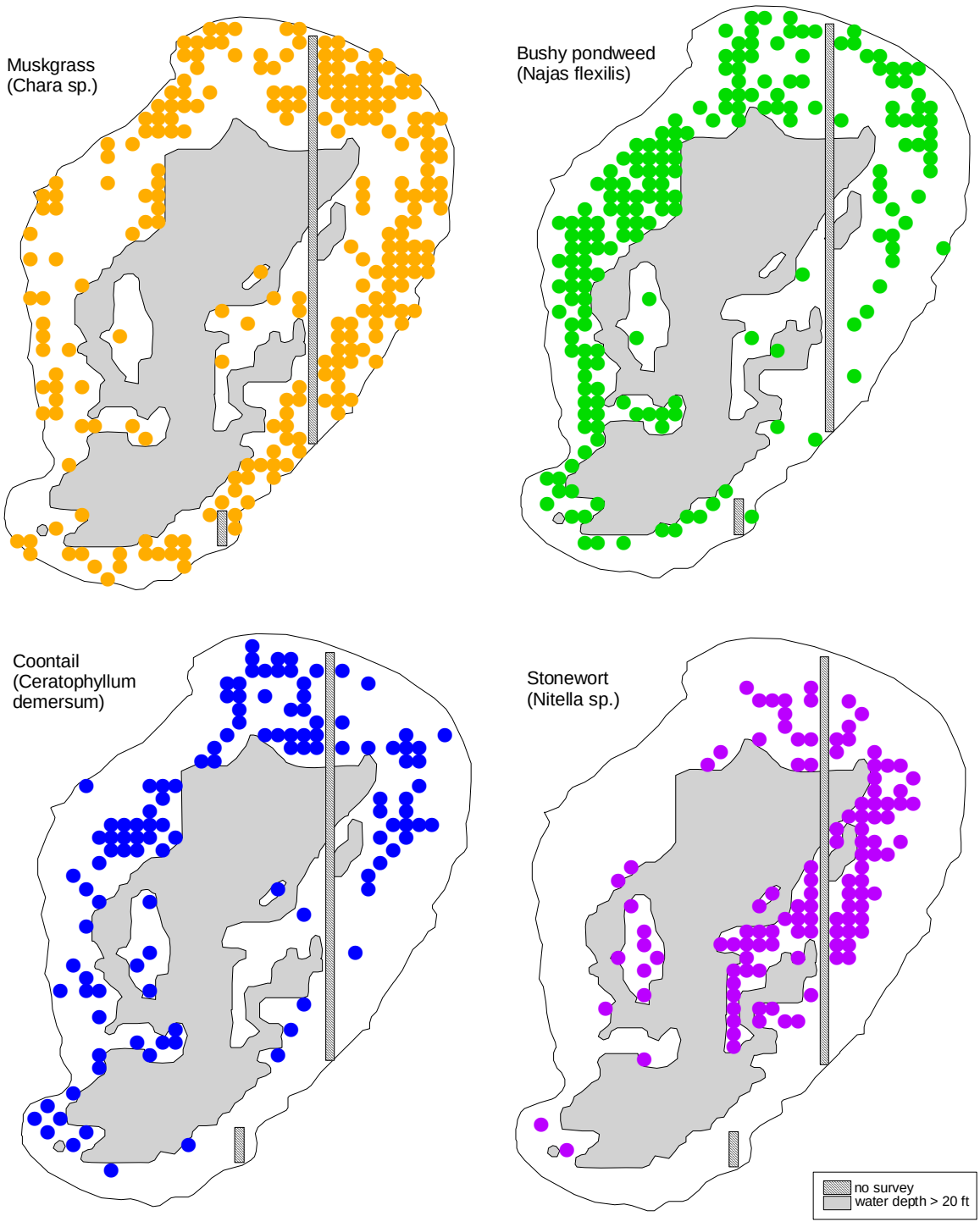
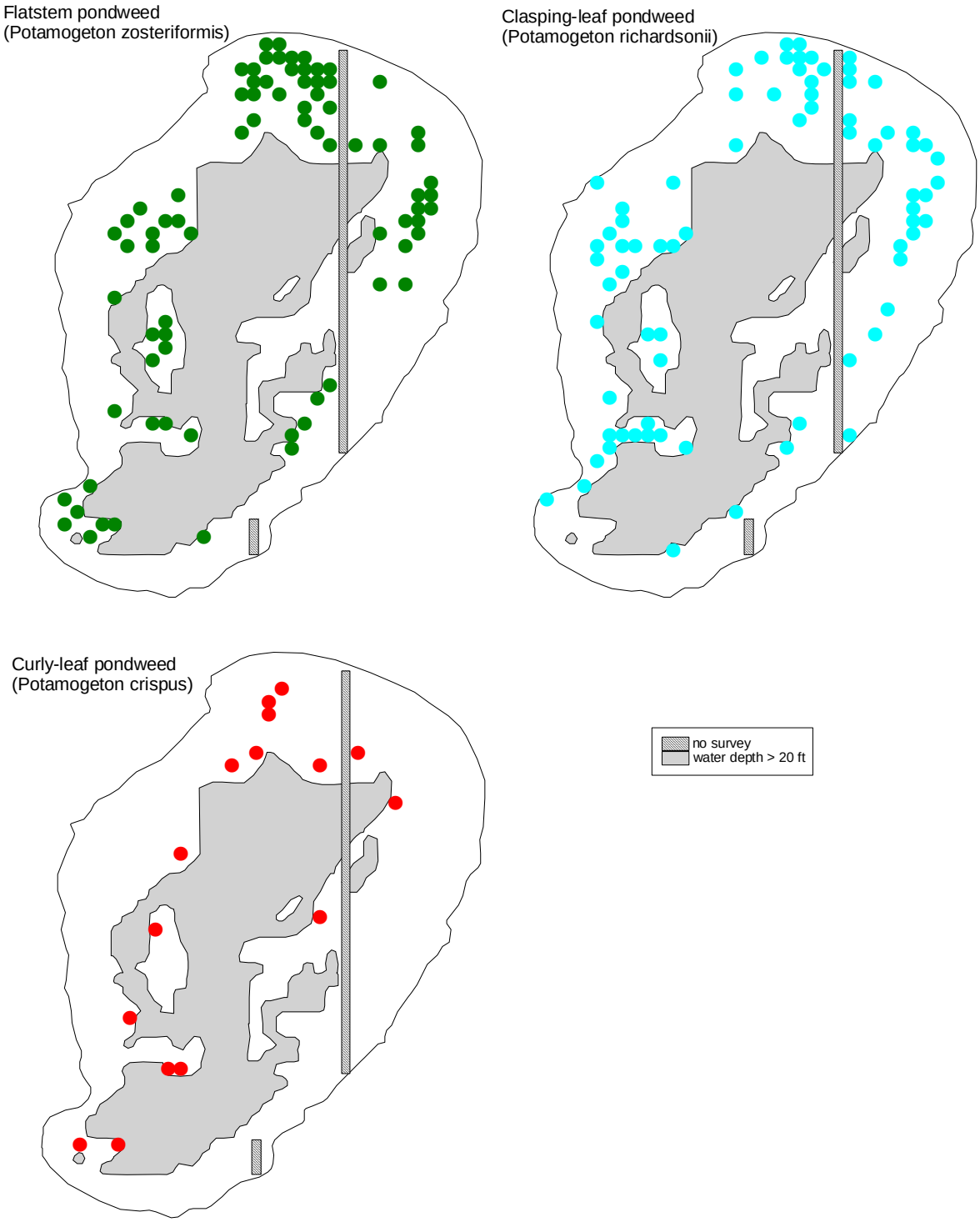


Figure 14. Distribution of native and non-native pondweed in Lake Edward (18-0305-00). 2004.



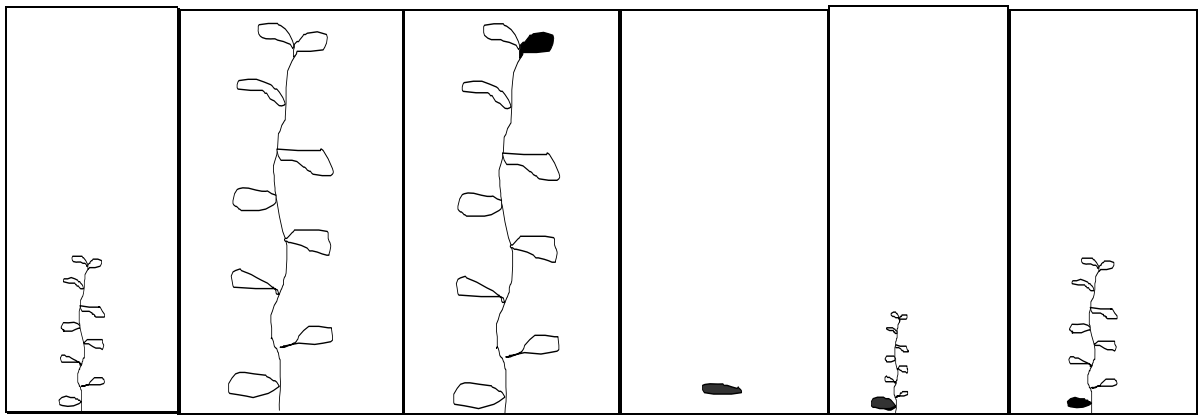
Pondweeds (*Potamogeton* spp.) were another important group of submerged plants in the lake. There are over 30 different species of pondweeds that are native in Minnesota and nine of them were found in Lake Edward. Flatstem pondweed (*P. zosteriformis*) and clasping-leaf pondweed (*P. richardsonii*) were the most abundant and were found in 11 and 10 percent of the sample sites, respectively (Table 1). These species were common in depths less than 16 feet (Fig. 11) had very similar distributions around the lake (Fig. 15).

All other submerged species occurred in less than five percent of the sample sites (Table 1) but, collectively, they make up an important component of the plant community.

Curly-leaf pondweed (*Potamogeton crispus*) is a non-native submerged species that was confirmed in Lake Edward during the 2004 survey. This species 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). It is closely related to native pondweeds, such as flatstem and clasping-leaf, but it has a unique life cycle which, in some lakes, gives it a competitive advantage over native species.

Curly-leaf pondweed is actually dormant during late summer and begins new growth in early fall (Fig. 16). 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 16. Life cycle of Curly-leaf pondweed (*Potamogeton crispus*).



Winter	**Spring**	**Late Spring**	**Summer**	**Fall**	**Winter**
Plants Continue Growing under ice	Plants reach maximum growth	Plants begin to die back and form turions	Turions remain dormant	Turions germinate	Newly sprouted plants continue growth

In some Minnesota lakes, curly-leaf pondweed has become the dominant submerged species, particularly in lakes with low clarity where many native species cannot grow. In such lakes, curly-leaf may form nuisance surface mats in early summer.

Curly-leaf pondweed was found in only two percent of the Lake Edward sample sites. While some curly-leaf plants may have been missed because the survey was conducted in mid-summer, after the time when the plant naturally dies back, it still does not appear to be a common plant in the lake.

Discussion

Clear water and a broad zone of shallow water provide ideal conditions for aquatic plants in Lake Edward. The variety of life forms provide multiple benefits to the lake and its fish and wildlife communities. Aquatic plants provides critical habitat for fish and invertebrates, buffer the shorelines from wave action, and stabilize sediments and utilizes nutrients that would otherwise be available for filamentous algae. While the non-native species, curly-leaf pondweed, has been identified in the lake, the abundance of native species may help buffer against its potential negative impacts.

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, may result in nuisance algal levels that contribute to decreased water clarity. If Lake Edward water clarity decreases, some native plant species may decline, while curly-leaf pondweed (which is adapted to low light levels) may increase.
- **Snow cover**
  Curly-leaf pondweed, in particular, may fluctuate in abundance in response to snow cover. Many native submerged plants also 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, 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 wild rice (*Zizania aquatica*) and bushy pondweed (*Najas flexilis*) 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. Although Lake Edward has extensive beds of emergent vegetation, these

stands are very sensitive to human activities. Bulrush plants spreads by rhizomes during periods of low water and once they are destroyed it is difficult to establish new stands by planting. Protecting the remaining areas of bulrush on Lake Edward is critical. For information on rules and regulations pertaining to aquatic plant management: Aquatic Plant Management (or contact your local DNR office).

- **Shoreland management activities**
  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.

Literature Cited

Catling, P.M. and I. Dobson. 1985. The biology of Canadian weeds. 69. Potamogeton crispus L. Canadian Journal of Plant Science 65:655-668.

Crow, G.E. and C.B. Hellquist. 2000. Aquatic and wetland plants of Northeastern North America. 2 volumes. The University of Wisconsin Press.

Hotchkiss, N. 1932. Marsh and aquatic vegetation of Minnesota and its value to waterfowl. U.S. Dept. of Agriculture. Bureau of Biological Survey. Division of Food Habits. Washington D.C.

Invasive Species Program. 2005. Invasive Species of Aquatic Plants and Wild Animals in Minnesota: Annual Report for 2004. Minnesota Department of Natural Resources, St. Paul, MN. http://files.dnr.state.mn.us/ecological_services/invasives/annualreport.pdf

Madsen, J. D. (1999). "Point intercept and line intercept methods for aquatic plant management." *APCRP Technical Notes Collection* (TN APCRP-M1-02). U.S. Army Engineer Research and Development Center, Vicksburg, MS. www.wes.army.mil/el/aqua

MPCA. 2004. Minnesota Pollution Control Agency website. Lake Water Quality Assessment Program. http://www.pca.state.mn.us/water/clmp/clmpSearchResult.cfm?lakeid=18-0305

Moyle, J.B. and N. Hotchkiss. 1945. The aquatic and marsh vegetation of Minnesota and its value to waterfowl. Minnesota Department of Conservation. Technical Bulletin 3. 122 pp.

