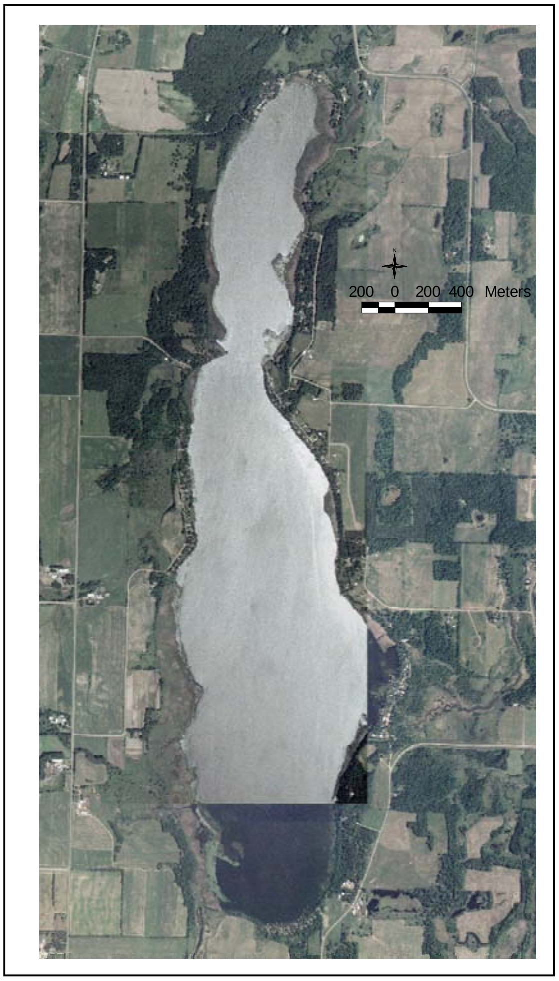
Aquatic Vegetation of Big Swan Lake
Todd County, Minnesota
(DOW 77-0023-00)
June 3, 4, 15, 2004



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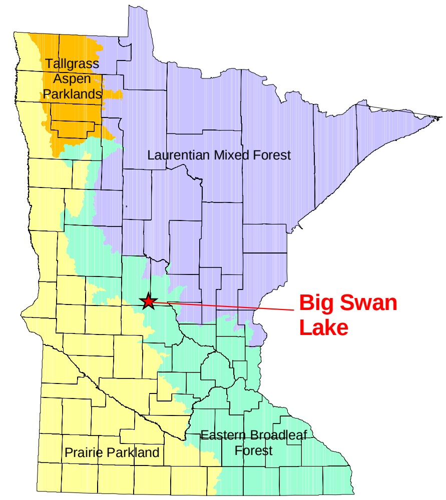
Summary

Big Swan Lake, (DOW 77-0023-00), Todd County, Minnesota is an example of a eutrophic lake where the non-native species, curly-leaf pondweed (*Potamogeton crispus*) dominates. Curly-leaf pondweed was present in 64 percent of the sample sites during the 2004 survey and was the most common species at all water depths sampled. Submerged plants were found to a depth of 24 feet but lower water clarity limits most native submerged vegetation to water depths of ten feet and less. Common native submerged plants include star duckweed (*Lemna trisulca*), muskgrass (*Chara* sp.), coontail (*Ceratophyllum demersum*), narrow-leaf pondweed (*Potamogeton* sp.) and flat-stem pondweed (*Potamogeton zosteriformis*).

Introduction

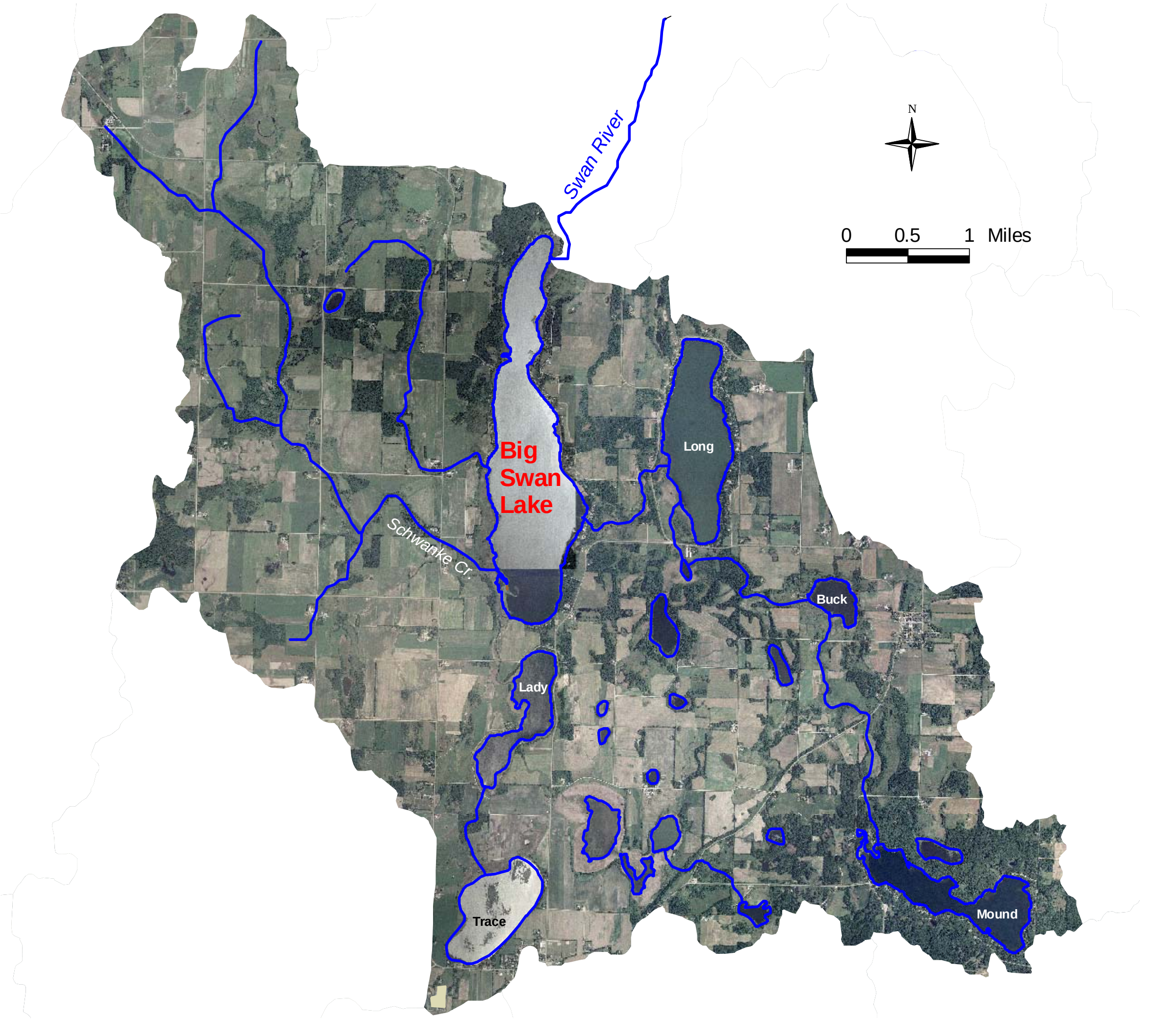
Figure 1. Location of Big Swan Lake, (77-0023-00) Todd Co., MN



Lake Description
Big Swan Lake (DOW 77-0023-00) is located about five miles west of the town of Swanville in Todd County, Minnesota. It occurs within the ecological region known as the Eastern Broadleaf Forest Province, which is the transition zone between the western prairie region and the true forested region to the northeast (Fig. 1). Prior to European settlement, the upland area around Big Swan Lake was predominantly forested with a mix of sugar maple, basswood and other hardwoods and some opening of tallgrass prairie.

Today, within the subwatershed that includes Big

Figure 2. Land use within the subwatersheds containing Big Swan Lake (77-0023-00) and Schwanke Creek.



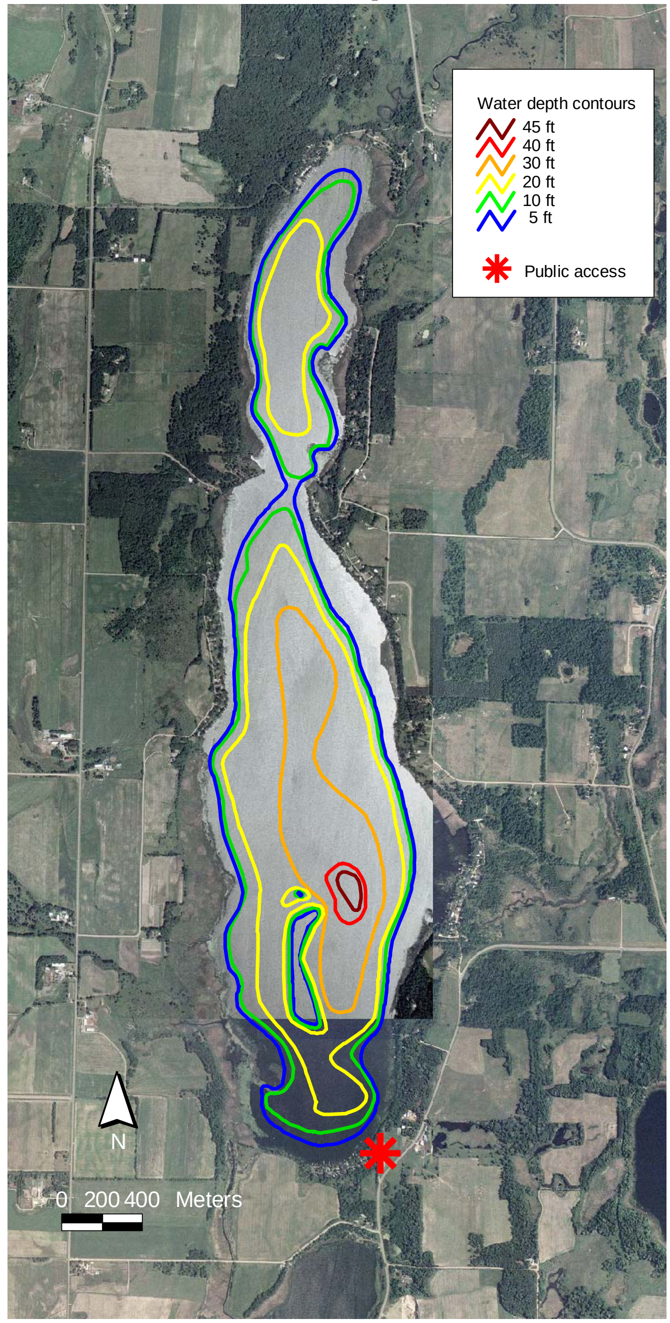
Swan Lake, about 65 percent of the area is classified as cropland or grassland, while only 11 percent is upland forest (Fig. 2.).

Big Swan Lake receives flow from Schwanke Creek to the west and several other minor tributaries (Fig. 2). Swan River flows from the north end of Big Swan Lake and eventually to the Mississippi River.

Big Swan Lake has a surface area of about 918 acres, which does not include the extensive areas of cattail marsh that occur along shore. The lake has a maximum depth of about 45 feet and about 44 percent of the lake is less than 15 feet deep (Fig. 3).

The lake is described as eutrophic (high nutrients) with low water clarity as indicated by the 1992 to 2004 mean summer Secchi depth of 6.7 feet (MPCA 2004). The lakeshore is mix of residential homes, agricultural land, wetlands and small woodlots. A state owned public access is on the southeast side of the lake.

Figure 3. Water depth contours of Big Swan Lk (77-0023-00) Photo source: FSA 2003. depth data:: MnDNR 1973.



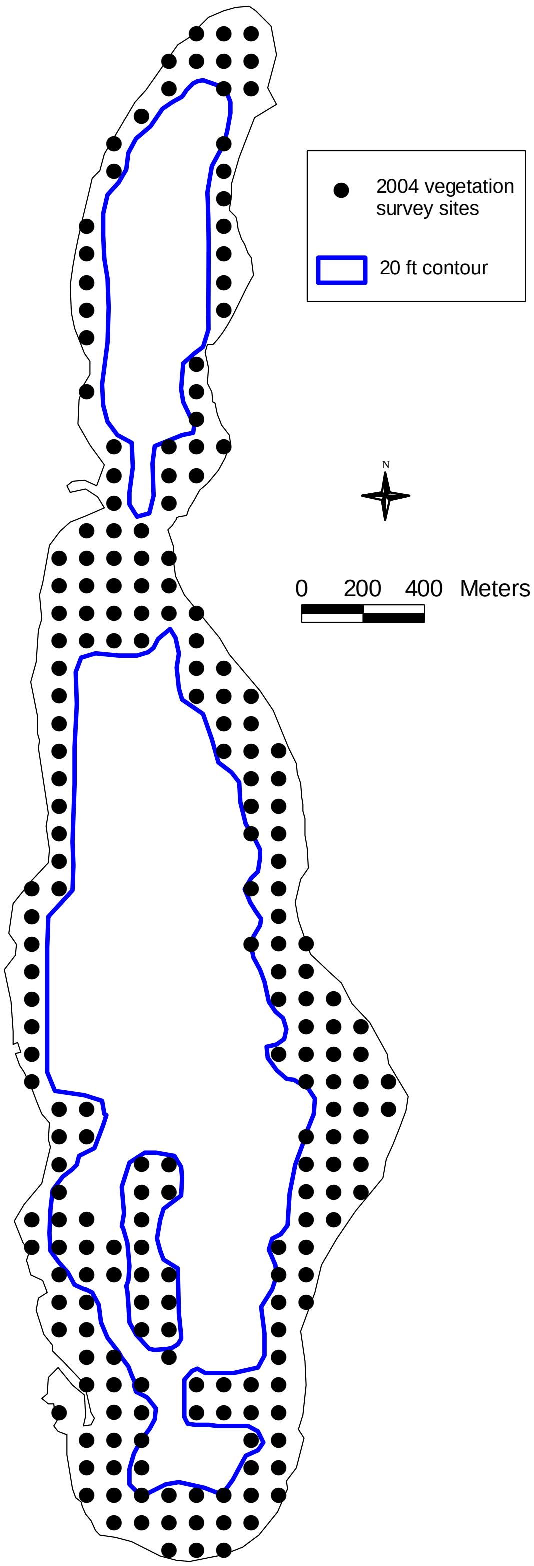
<u>Vegetation Survey Objectives</u>

The purpose of the 2004 survey of Big Swan 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

Data from the 2004 vegetation survey can be used to monitor annual changes in the native and non-native plant species composition and may also be used to guide vegetation management decisions.

Figure 4. 2004 Vegetation survey sites in Big Swan Lake (77-0023-00).



Methods

Point-Intercept Survey

A Point-intercept vegetation survey of Big Swan Lake was conducted on July 3, 4, and 15, 2004 following the methodology described by Madsen (1999). At a minimum, we wanted to sample 100 points within the vegetated zone and place sample points no further than 100 meters apart for mapping purposes. Sample points were established in using ArcView GIS program using a 90 meter by 90 meter grid across the lake surface. In the field, surveyors decided not to sample in depths greater than 25 feet because they consistently were not finding vegetation beyond the 24 feet depth. As a result, 219 sites were actually sampled (Fig. 4).

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, attached to a rope was used to survey vegetation not visible from the surface (Fig. 5). If curly-leaf pondweed (*Potamogeton crispus*) was present at a site, surveyors recorded whether or not it formed surface mats at that site.

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

Example:

- There were 219 sample sites.
- Curly-leaf pondweed occurred in 141 of those sample sites.
- Frequency of curly-leaf pondweed = 141 / 219 = 64 percent

Figure 5. Rake used to sample vegetation

Frequency was calculated for the entire sampled 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.

Emergent vegetation mapping

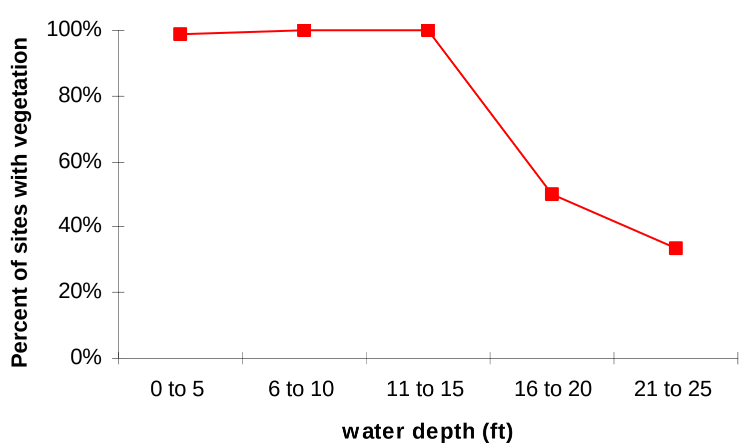
Beds of emergent and floating-leaf vegetation were mapped by MnDNR Fisheries staff in 2000 and 2001. Surveyors boated around the perimeter of each plant bed and marked the bed outline using a hand-held GPS. Emergent plant species present in each bed were recorded along with an estimate of abundance.

Results

Maximum depth of vegetation and distribution with water depth

In Big Swan Lake, plants occurred to a depth of 24 feet, but were most common in depths from shore to 15 feet where 99 percent of all sites contained vegetation (Fig. 6). In the zone from 16 feet to 20 feet, 50 percent of the sites were vegetated and from 21 to 24 feet, only 33 percent of the sites contained plants.

Figure 6. Frequency of plants vs. water depth. Big Swan Lake (77-0023-00), June 3,4, 15, 2004.



Types of aquatic plants found

Twenty-seven native aquatic plants species were located during the 2004 Big Swan Lake survey, including five emergent, three floating-leaved and 20 submerged species (Table 1). One non-native submerged species, curly-leaf pondweed (*Potamogeton crispus*) was identified in the lake.

The water depth zone from

Table 1. Aquatic Plants of Big Swan Lake, Todd County (77-0023-00)
June 3, 4, 15 2004

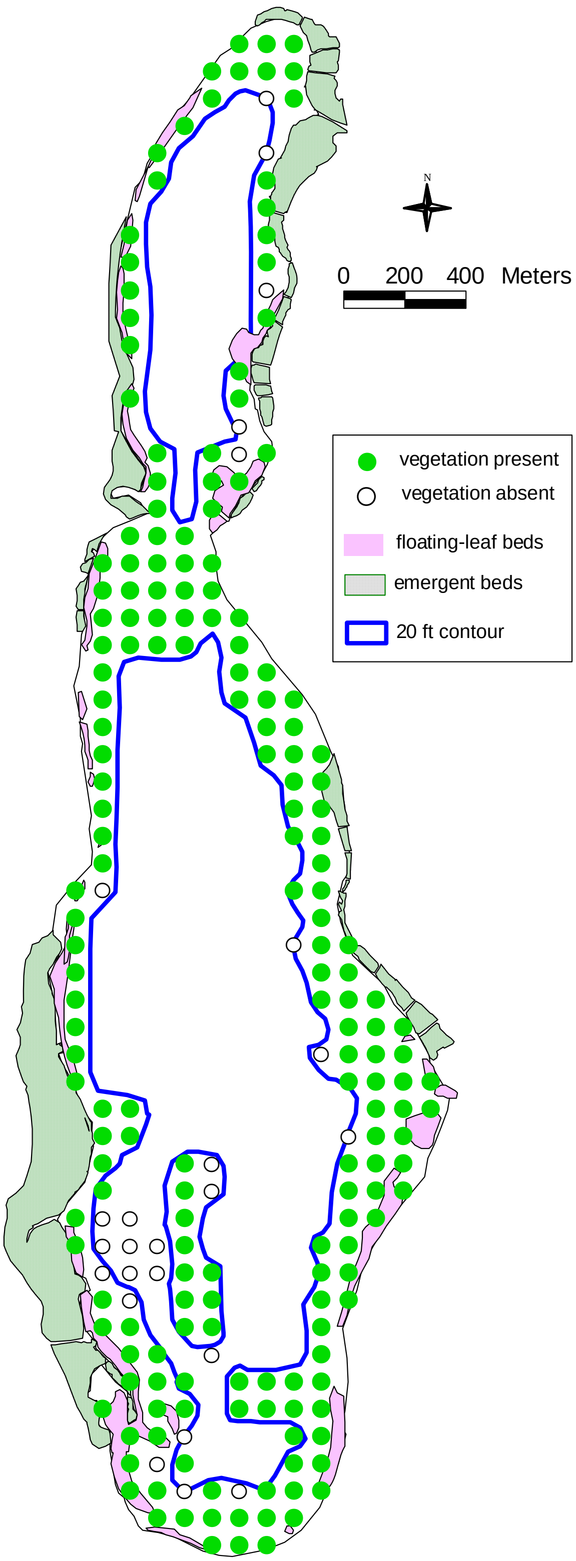
Frequency calculated for sampled zone (shore to 25 feet depth)
Frequency = percent of sites in which species occurred
219 sample sites

Life Forms	Common Name	Scientific Name	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 usually rooted or anchored to the lake bottom.	Curly-leaf pondweed	*Potamogeton crispus (v)*	64
	Star duckweed	*Lemna trisulca*	33
	Muskgrass	*Chara sp.*	23
	Coontail	*Ceratophyllum demersum*	23
	Narrow-leaf pondweed	*Potamogeton sp.*	19
	Flat-stem pondweed	*Potamogeton zosteriformis*	13
	Northern watermilfoil	*Myriophyllum sibiricum (v)*	6
	White water buttercup	*Ranunculus sp.*	6
	White-stem pondweed	*Potamogeton praelongus*	5
	Clasping-leaf pondweed	*Potamogeton richardsonii (v)*	5
	Sago pondweed	*Stuckenia pectinata*	3
	Greater bladderwort	*Utricularia vulgaris*	3
	Water stargrass	*Zosterella dubia*	2
	Water moss	*Drepanocladus sp. (v)*	2
	Illinois pondweed	*Potamogeton illinoensis (v)*	1
	Large-leaf pondweed	*Potamogeton amplifolius (v)*	1
	Water marigold	*Megaladonta beckii*	<1
	Wild celery	*Vallisneria americana*	<1
	Ribbon-leaf pondweed	*Potamogeton epihydrus (v)*	present*
	Marestail	*Hippuris vulgaris (v)*	present
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	Yellow waterlily	*Nuphar variegata*	7
	White waterlily	*Nymphaea odorata*	3
	Floating-leaf pondweed	*Potamogeton natans (v)*	present
EMERGENT These plants extend well above the water surface and are usually found in shallow water, near shore.	Bulrush	*Scirpus acutus** (v)*	20
	Wild Rice	*Zizania palustris (v)*	3
	Cattail	*Typha sp.*	1
	Cane	*Phragmites australis*	<1
	Arrowhead	*Sagittaria sp. (v)*	present

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

** Scirpus acutus was identified in the lake but it is not known if all bulrush were S. acutus. Therefore, SCS = Scirpus sp. was entered in database.

Figure 7. Distribution of aquatic plants in Big Swan Lake (77-0023-00) June 2004.



to five feet contained the most species and number of species found decreased with increasing water depth (Fig. 6). Emergents, floating and seven of the submerged species were restricted to this shallow depth zone. Only five submerged species were found in depths greater than ten feet. In depths greater than 15 feet, only two submerged species were found.

Emergent and floating-leaved plants

Emergent species occupy the shallowest zone, from wet, moist shoreline soils to approximately five feet deep. Emergent species help minimize shoreline erosion by stabilizing soils and dissipating wave action.

The most common emergent species in Big Swan Lake were Cattail *(Typha sp.)* and Bulrush *(Scirpus spp.)*. Extensive cattail stands occur along the northeast and southwest shores and large bulrush beds are found in both the south and north basins of Big Swan Lake (Fig. 7).

Floating-leaved plants occurred at several locations around the lake to a depth of about five feet (Fig. 7). Yellow waterlily (*Nuphar variegata*) occurred in seven percent of the sample sites while white waterlily (*Nymphaea odorata*) was found in three percent. Within the zone from shore to five feet, floating-leaved species were found in 18 percent of the sample sites.

Non-native submerged species

Curly-leaf pondweed (*Potamogeton crispus*) (Fig. 8) is a non-native submerged species that was confirmed in Big Swan Lake during the 2004 survey, but has likely been present in the lake for several years. This species has been present in Minnesota since at least 1910 (Moyle and Hotchkiss

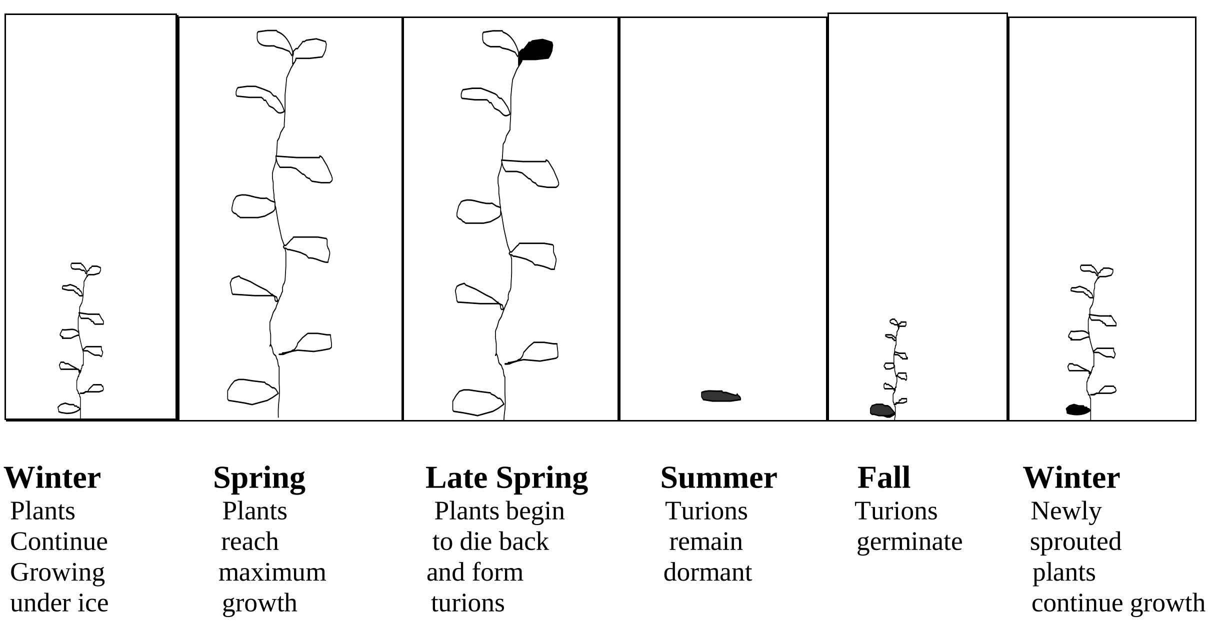
1945) and is now found in at least 700 Minnesota lakes (Invasive Species Program 2005). It is closely related to native pondweeds, such as flatstem pondweed, but it has a unique life cycle that, in some lakes gives it a competitive advantage over the native species.

Figure 8. Curly-leaf pondweed (*Potamogeton crispus*) (photo source: Univ of Florida Center for Aquatic and Invasive Plants

Curly-leaf pondweed is actually dormant during late summer and begins new growth in early fall (Fig. 9). 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).

In Big Swan Lake, curly-leaf pondweed was the most abundant species, occurring in 64 percent of the sample sites (Table 1). Curly-leaf was widespread in distribution around Big Swan Lake and formed surface mats at 38 percent of the sites (Fig. 10) at depths from four to 15 feet. It was found from shore to a depth of 23 feet and was most frequent in depths from six to 15 feet, where it occurred in 95 percent of the sample sites (Fig. 11). At each depth interval, curly-leaf pondweed was the most abundant species (Fig. 11).

Figure 9. Life cycle of Curly-leaf pondweed (Potamogeton crispus).



Native submerged and free-floating species

Star duckweed (*Lemna trisulca*) is a free-floating species that often occurs submerged near the lake bottom but it does not anchor to the substrate and can float freely with the current. This was the most common native species within Big Swan Lake and was found in 33 percent of the sample sites (Table 1). It was found to a depth of 24 feet, deeper than any other plant species in the lake. Star duckweed was most abundant in depths from shore to five feet where it occurred in 51 percent of the sites (Fig. 11).

Muskgrass (*Chara* sp.) is a macroscopic, or large, algae that is common in many hardwater Minnesota lakes. It has 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 invade open areas of lake bottom where it can act as a sediment stabilizer. In Big Swan Lake, muskgrass was found in 23 percent of the survey sites (Table 1) but was restricted to depths of ten feet and less. It was most frequent in water depths up to five feet (Fig 11).

Coontail (*Ceratophyllum demersum*) grows entirely submerged and is adapted to a broad range of lake conditions, including turbid water. Coontail is perennial and can overwinter as a green plant under the ice and then begins new growth early in the spring. It is loosely rooted to the lake bottom and spreads primarily by stem fragmentation. In Big

Figure 10. Distribution and abundance of curly-leaf pondweed (Potamogeton crispus) in Big Swan Lake, Todd Co. (77-00-2300), June 3, 4, 15, 2004.

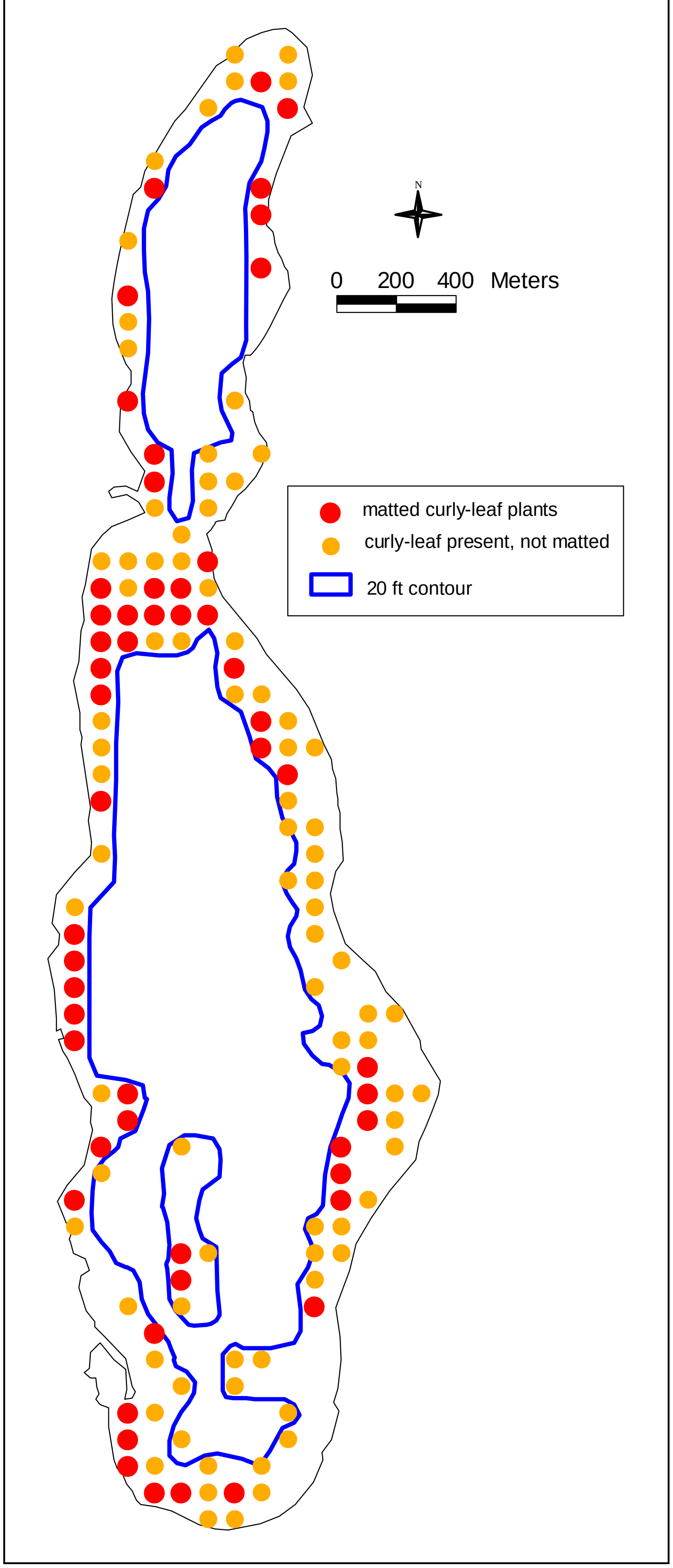
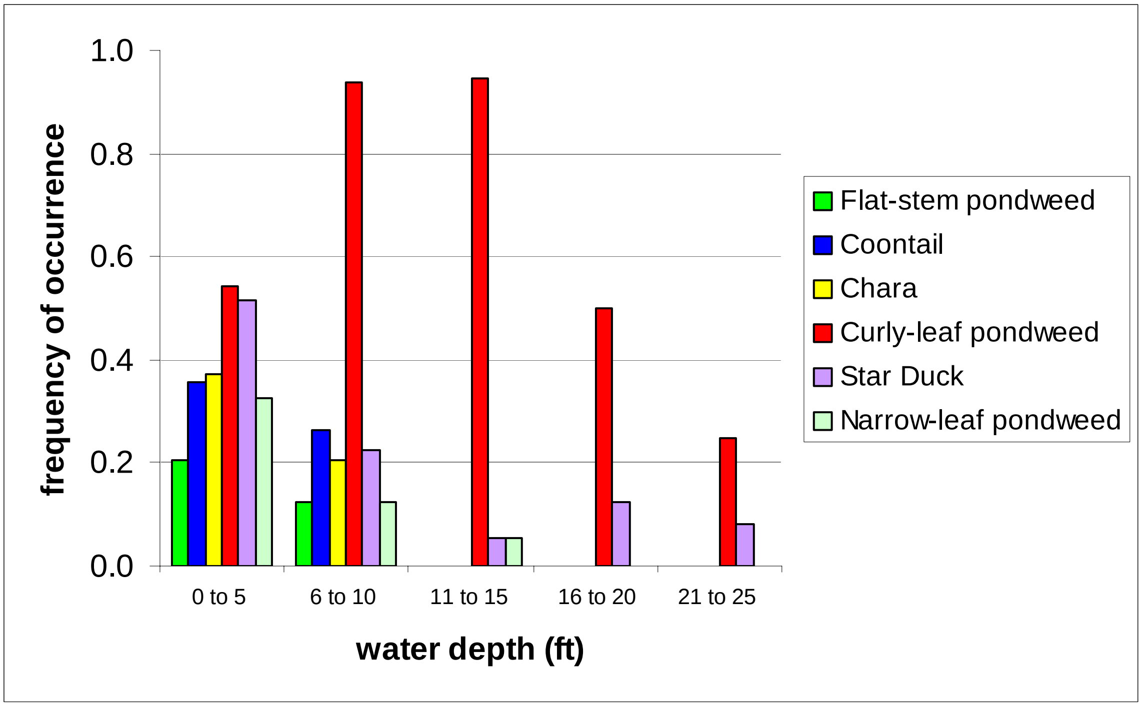


Figure 11. Frequency of common aquatic plants vs. water depth. Big Swan Lake, Todd Co. (77-0023-00), June 3, 4, 15, 2004.



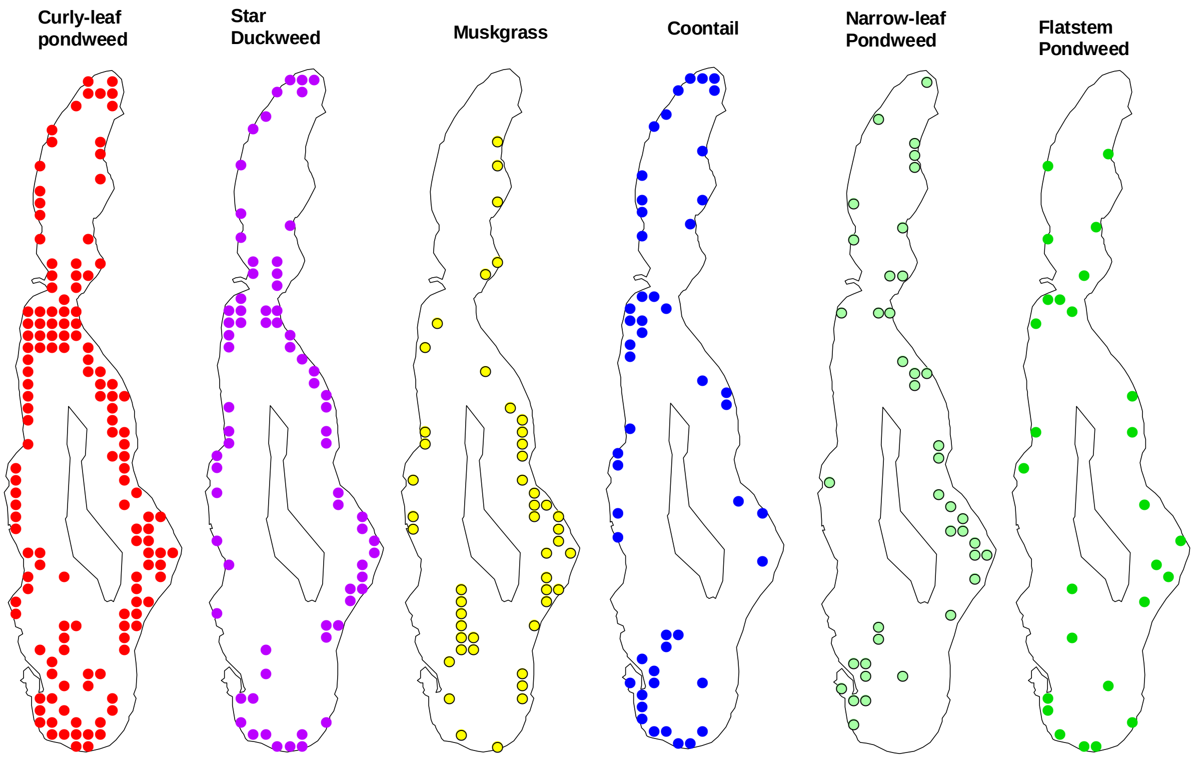
Swan Lake it occurred in 23 percent of the sites (Table 1). It was also restricted to depths of 10 feet and les and was most common in depths of five feet and less (Fig. 11).

Narrow leaf pondweed (*Potamogeton* sp.) is a rooted, perennial submerged plant with small, thin leaves. Leaves grow entirely below the water surface but flowers extend above the water. This plant also overwinters as rhizomes and winter buds. There are several different types of pondweeds that are included in this general group and without fruit or flowers they are difficult to distinguish. Narrow-leaf pondweeds were found in 19 percent of the sample sites in Big Swan Lake (Table 1). This plant occurred to a depth of 15 feet, but was most common in depths of five feet and less (Fig. 11).

Flat-stem pondweed (*Potamogeton zosteriformis*) is a rooted, perennial submerged plant with flattened, grass-like leaves. Depending on water clarity and depth, it may reach the water surface in areas of lakes and its flower stalk may extend above the water. It overwinters by rhizome and winter buds and does not grow well in turbid lakes. In Big Swan Lake, it was found in 13 percent of the sites surveyed in 2004 (Table 1), occurring to a maximum depth of ten feet but most frequent in depths less than six feet (Fig. 11).

Distribution maps for curly-leaf pondweed and the five most common submerged species are shown in Fig. 12.

Figure 12. Distribution of common submerged plants, Big Swan Lake, Todd County, (77002300), June 3, 4, 15, 2004.



Discussion

Light availability is one of the greatest factors that influences submerged vegetation. Curly-leaf pondweed may be able to dominate the plant community of Big Swan Lake because it reaches it maximum growth in early spring, before water clarity declines in the lake. Additionally, curly-leaf pondweed is better adapted to lower clarity than are many of the native plant species. The native submerged plants that are common in the lake are most abundant in shallow waters in depths less than six feet, where adequate sunlight reaches the lake bottom. The lake supports a relatively high number of native species but they are present in low abundance compared to the non-native curly-leaf pondweed.

Once introduced into a lake, curly-leaf pondweed does not always become the dominant species. For example, curly-leaf has been present in Mound Lake, to the southeast of Big Swan (Fig. 2) for at least 20 years but it occurs in only eight percent of the sample sites (Perleberg, 2005). One factor that may contribute to the low abundance of curly-leaf in Mound Lake is a more abundant native plant community, which may be due in part to higher water clarity related to a relatively intact shoreland buffer zone of forested land around Mound Lake.

Management of curly-leaf pondweed alone will not likely result in a healthy native plant community in Big Swan Lake. Water clarity will likely need to increase before native plant species can grow more abundantly.

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

- **Change in water clarity**
  Light availability is a significant factor limiting plant distribution and abundance. The amount of light available to submersed aquatic plants is typically dependent on both water clarity and depth. Excess nutrients, such as elevated phosphorus levels, often result in nuisance algal levels that contribute to decreased water clarity. If Big Swan Lake water clarity increases, submerged aquatic plant growth would be expect to increase also.
- **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, particularly 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.
- **Aquatic plant management activities**
  Herbicide and mechanical control of aquatic plants can directly impact the aquatic plant community. Monitoring these control activities can help insure that non-target species are not negatively impacted.
- **Shoreland management activities**
  Water quality improvements that lead to increased water clarity would benefit the submerged aquatic plant community. Information is available on how 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. A strip of shoreline vegetation provides a buffer zone between the lake and developed residential areas. Benefits include minimizing soil erosion from wave action while the plants uptake excess nutrients that may otherwise flow into the lake. Information on restoring shoreland buffer zones can be found at: lakescaping and shoreline restoration.

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