Aquatic Vegetation Survey of Long Lake (DOW 11-0142-00) Cass County, Minnesota

2007

Red fox along natural shoreline of Long Lake, Cass County, Minnesota. June 25, 2007

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Funding: Collection of the 2007 data was made possible by support from the Heritage Enhancement Fund and the Game and Fish Fund.

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This report should be cited as:
Perleberg, D. 2008. Aquatic vegetation of Long Lake (DOW 11-0142-00), Cass County, Minnesota, 2007. Minnesota Department of Natural Resources, Ecological Resources Division, 1601 Minnesota Dr., Brainerd, MN 56401. 24 pp.

Summary

Aquatic vegetation surveys of Long Lake (DOW #11-0142-00), Cass County, Minnesota, were conducted in late June and August, 2007.

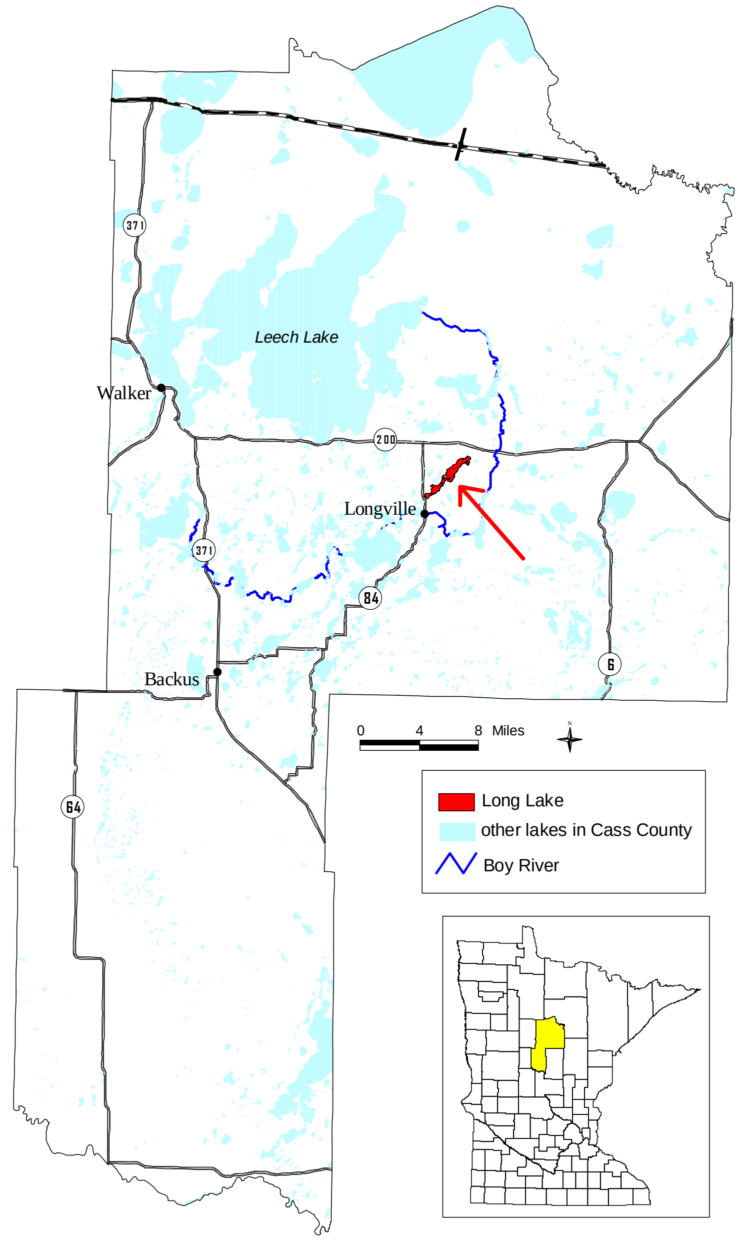
A total of 47 native aquatic plant taxa were recorded in Long Lake. Submerged plants occurred to a depth of 30 feet but were most common in the shore to 15 feet depth zone where 96 percent of the sample sites contained vegetation. The submerged plant community included leafy plants that are anchored to the lake bottom by roots as well as large algae and aquatic moss that may resemble leafy plants but are weakly anchored to the lake bottom or drift freely with the currents. Rooted submerged plants were most common in water depths of 15 feet or less while large algae and moss were most common in the 16 to 25 feet depth zone. Common submerged plants included pondweeds (*Potamogeton robbinsii, P. praelongus, P. amplifolius)*, Canada waterweed (*Elodea canadensis*), stonewort (*Nitella* sp.), and muskgrass (*Chara* sp.).

Floating-leaf plants occupied about 34 acres and were mostly located in protected bays. Common species were watershield (*Brasenia schreberi*), white waterlily (*Nymphaea odorata*) and yellow waterlily (*Nuphar variegata*).

About three acres of emergent plant beds were mapped and bulrush (*Scirpus* spp.) was found on sandy sites around the northern islands. One non-native emergent plant, yellow iris (*Iris psuedacorus*) was found on shore.

Introduction

Figure 1. Location of Long in Cass County, MN.



Long Lake (DOW# 11-0142-00) is located about one mile northeast of the city of Longville in Cass County, north-central Minnesota (Figure 1).

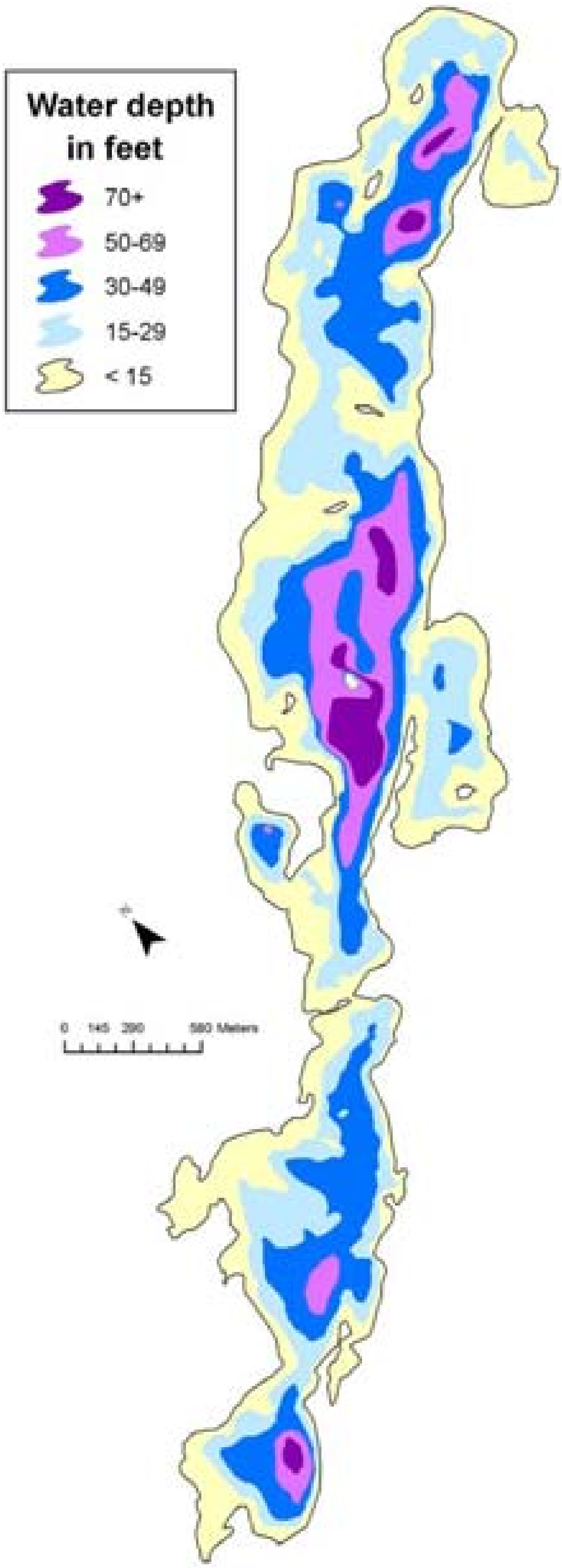
The lake occurs within the Boy River Watershed but is not directly connected to the Boy River. It is a glacial ice block lake with no major inlet or outlet and receives most of its inflow from precipitation and groundwater flow.

There are about 250 Cass County lakes that are at least 50 acres in size and Long Lake ranks 23rd with a surface area of 926 acres. As its name implies, it is one of the longest lakes in the county with about 14 miles of shoreline. Long Lake has a northeast to southwest orientation with four distinct basins and several small bays. It has a maximum depth of 115 feet and about 38 percent of the lake is less than 15 feet in depth (Figure 2).

The immediate watershed that includes Long Lake is approximately 3.2 square miles, resulting in a small (2:1) watershed to lake ratio (MPCA 2002). Land use in the watershed is predominately forested, which is typical for lakes in this region. The shoreline is heavily developed but forested land use, combined with numerous wetlands in the watershed, results in low phosphorus loading to the lake (MPCA 2002).

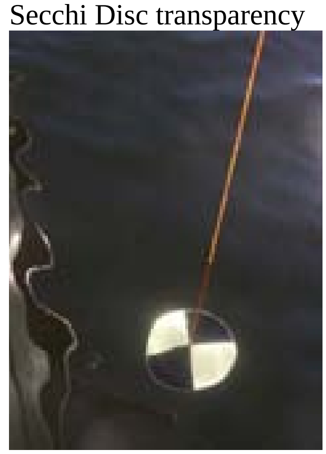
Water chemistry data for Long Lake are limited but a 2002 study described the lake water quality as better than reference lakes in the region, based on total phosphorus, chlorophyll-a and Secchi disc transparency (MPCA 2002). Long Lake is a mesotrophic, or moderately nutrient enriched lake (Skon 2005). It is a moderately soft water lake with a total alkalinity of 43 mg/L; the typical alkalinity range for lakes in this region in 40 to 140 mg/L (Skon 2005).

Figure 2. Depth contours of Long Lake.



The [Secchi disc](#) (Figure 3) transparency measures the depth to which a person can see into the lake and provides an estimate of the light penetration into the water column. 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. In Long Lake, between 1987 and 2007, water clarity, as measured by Secchi disc readings ranged from 15 to 26 feet, with a mean of 20 feet (MPCA 2007). Based on these Secchi disk measurements, aquatic plants are expected to grow to a depth of about 30 feet in Long Lake. Other factors that may influence the depth of plant growth include substrate types, wind fetch, and plant species composition.

Figure 3. Measuring Secchi Disc transparency



Previous vegetation surveys of Long Lake were conducted in 1950, 1976 and 1993 (MnDNR Fisheries Lake Files). Aquatic plants have historically been recorded to a depth of 25 feet. At least 25 different native aquatic plant taxa have previously been recorded in the lake including bulrush (*Scirpus* spp.), wild rice (*Zizania palustris*), waterlilies (*Nuphar*, *Nymphaea*, *Brasenia*), Canada waterweed (*Elodea canadensis*), muskgrass (*Chara* sp.), bushy pondweed (*Najas flexilis*), coontail (*Ceratophyllum demersum*), and a variety of pondweeds (*Potamogeton* spp). Submerged pondweed growth was recorded in all the shoal areas and waterlilies and other species were found in the bays and other protected areas (MnDNR Fisheries Lake Files).

Objectives

The purpose of this vegetation survey was to provide a quantitative description of the 2007 plant community of Long 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

Mapping beds of floating-leaf and emergent vegetation

To avoid damage to plant beds, surveyors did not motor into emergent and floating-leaf plant beds. Surveyors mapped bulrush beds in the field with a Global Positioning System (GPS) receiver by motoring around the perimeter of each bed to record the approximate outline. Aerial photographs were used to delineate beds of wild rice and floating-leaved vegetation. Field surveys were conducted in August 2007 to verify plant community composition within major beds.

Lakewide vegetation survey

A lakewide vegetation survey was conducted using a point-intercept survey method (Madsen 1999). Survey waypoints were created using a Geographic Information System (GIS) computer program and downloaded into a GPS receiver. Survey points were spaced 40 meters (131 feet) apart, resulting in about 2.5 survey points per acre.

The survey was conducted on June 18, 19, 20, 21, 25, and 26, 2007 by two field crews, each consisting of one boat and two surveyors. The survey area included about 565 acres and included the area from shore to a depth of 30 feet. Within that depth range, a total of 1501 points were surveyed (Figure 4, Table 1).

Table 1. Sampling effort by water depth, Long Lake, 2007.

Depth interval in feet	Number of sample points
0 to 5	250
6 to 10	374
11 to 15	203
16 to 20	208
21 to 25	246
26 to 30	220
Total number of sample points	1501

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 sites, water depth was recorded in one-foot increments using a measuring stick in water depths less than eight feet and an electronic depth finder in depths greater than eight feet.

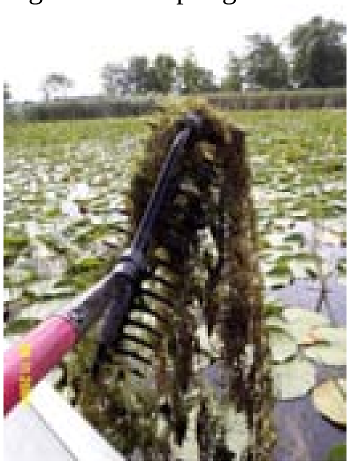
At each sample site where water depths was six feet and less, surveyors described the bottom substrate using standard substrate classes (Table 2).

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
boulder	Diameter over 10 inches

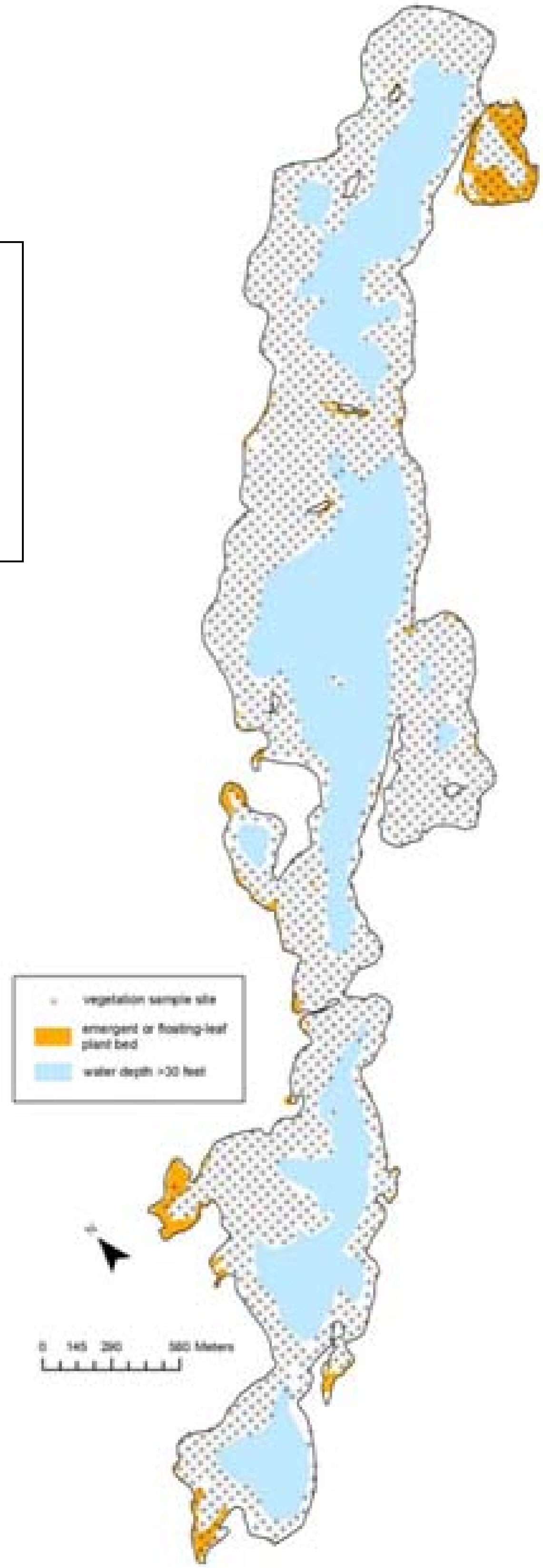
The surveyors recorded all plant species found within a one square meter sample site at the pre-designated side of the boat. A double-headed, weighted garden rake, attached to a rope was used to survey vegetation not visible from the surface (Figure 5).

Figure 5. Sampling rake.



Plant identification and nomenclature followed Crow and Hellquist (2000). Voucher specimens were collected for most plant species and are stored at the MnDNR in Brainerd. In August 2007, surveyors re-visited shorelines of Long Lake to search for

Figure 4. Long Lake vegetation survey sites.



additional plant taxa that may have been overlooked during the Point-Intercept survey. Any additional plant taxa found were recorded as present but were not included in calculations of frequency.

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 30 feet and sampling points were also grouped by water depth and separated into six depth zones for analysis (Table 1).

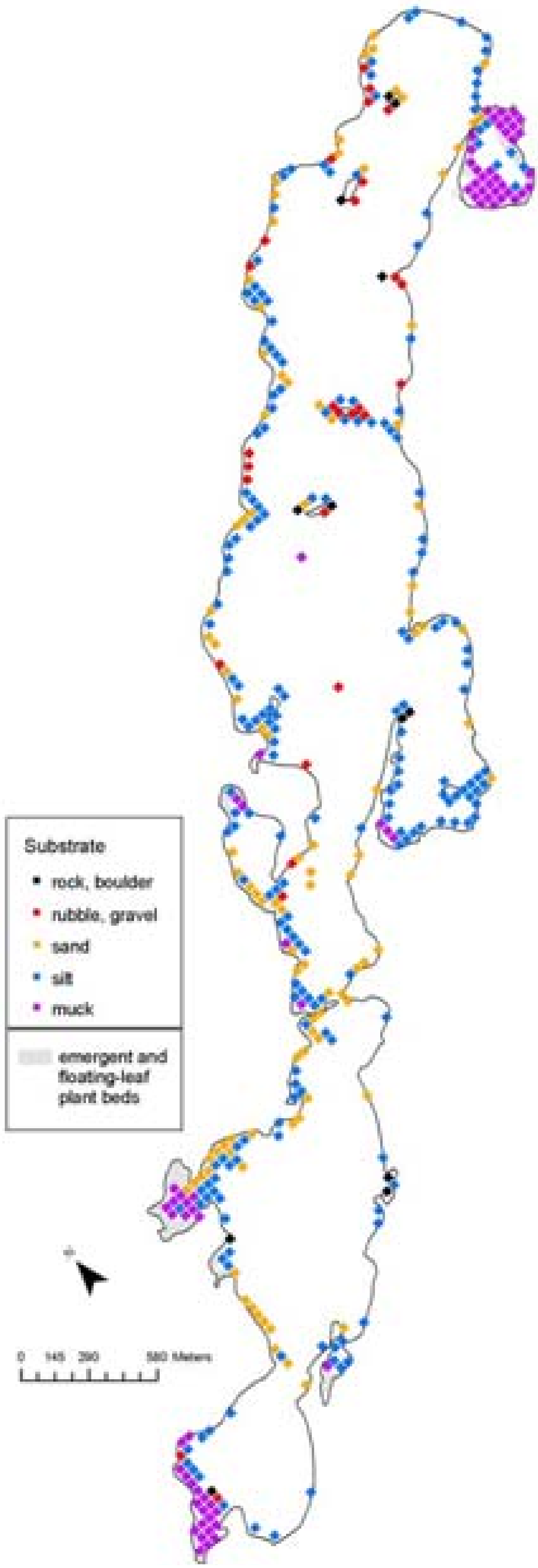
Example:

In Long Lake there were 1501 samples sites in the zone from shore to the 30 feet depth.

Robbin's Pondweed (*Potamogeton robbinsii*) occurred in 536 of those sites.

Frequency of Robbin's Pondweed in the shore to 30 feet depth zone =
536/1501 x 100 = 36%

Figure 6. Shoal sediments of Long Lake 2007.



Results

Shoal substrates

Shallow water substrates of Long Lake included sand, gravel, rubble, rock, boulder, silt and muck (Figure 6). Sand (Figure 7) was the most common substrate type in water depths from shore to three feet, where it was found in 40 percent of the sites. Silt was most common in water depths of four to seven feet, where it was found in 61 percent of the sites. Muck bottom was mostly found in protected bays and gravel, rubble, rock and boulder were scattered around the shoreline including sites near islands and along points.

Figure 7. Sandy shoreline of Long Lake.

Distribution of aquatic plants

Aquatic plants occurred around the entire lake perimeter and extended lakeward at least 200 meters in many areas (Figure 8). Vegetation beds were narrow along the southeast and northeast shores where water depths increased sharply from shore. Shallow areas such as bays and narrows contained the widest bands of vegetation. Emergent and floating-leaved plants were abundant in most bays and covered approximately 34 acres (Figure 8).

Figure 8. Vegetated sites in Long Lake.

Submerged plants were found to a water depth of 30 feet, the maximum depth sampled. This vegetated zone includes about two-thirds of the lake and within this area, 76 percent of the survey sites contained vegetation.

Plant occurrence was greatest in the shore to 15 feet depth zone, where 96 of the sites were vegetated (Figure 9). In water depths of 26 to 30 feet, only 28 percent of the sites contained plants. Searches with underwater cameras found a few scattered plants in water depths of 30 to 35 feet.

Number and types of plants recorded

A total of 47 aquatic plant taxa were recorded in Long Lake including 12 emergent, five floating-leaved, 25 submerged and five free-floating plant taxa (Table 3). Submerged plants included large algae, an aquatic moss, an aquatic fern and numerous flowering plants.

Figure. 9. Frequency of plants at each water depth interval.

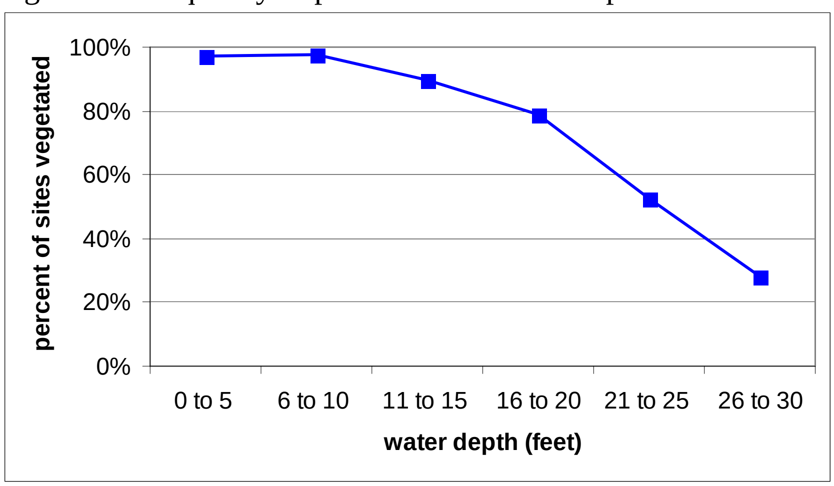


Table 3. Frequency of aquatic plants in Long Lake Point-intercept survey, 2007.
Frequency is the percent of sample sites in which a plant taxon occurred within the shore to 30 ft water depth.

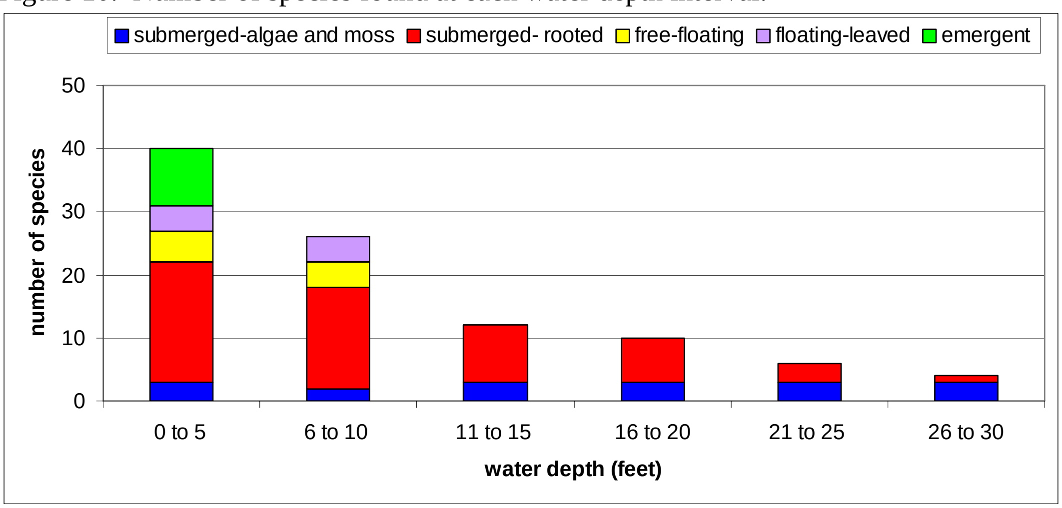
Life Forms			Common Name	Scientific Name	Frequency N = 1501
SUBMERGED	Rooted perennials	Broad-leaf plants	White-stem pondweed	*Potamogeton praelongus*	16
			Large-leaf pondweed	*Potamogeton amplifolius*	15
			Variable pondweed	*Potamogeton gramineus*	6
			Illinois pondweed	*Potamogeton illinoensis*	<1
		Grass-leaf plants	Robbin's Pondweed	*Potamogeton robbinsii*	36
			Flat-stem pondweed	*Potamogeton zosteriformis*	5
			Wild celery	*Vallisneria americana*	<1
			Water stargrass	*Zosterella dubia*	1
		Narrow-leaf plants	Narrow-leaf pondweed	*Potamogeton pusillus*	3
			Fries pondweed	*Potamogeton freisii*	<1
			Vasey's pondweed	*Potamogeton vaseyi*	<1
			Snail-seed pondweed	*Potamogeton spirillus*	present
		Dissected-leaf plants	Canada waterweed	*Elodea canadensis*	29
			Coontail	*Ceratophyllum demersum*	9
			White water buttercup	*Ranunculus aquatilis*	1
		Needle-leaf plants	Needlerush	*Eleocharis acicularis*	1
			Quillwort	*Isoetes sp.*	1
			Juncus	*Juncus sp.*	present
			Leafless water milfoil	*Myriophyllum tenellum*	1
			Creeping water buttercup	*Ranunculus flammula*	1
			Water bulrush	*Scirpus subterminalis*	1
	Annual		Bushy pondweed	*Najas flexilis*	1
	Algae and mosses		Stonewort	*Nitella sp.*	13
			Muskgrass	*Chara sp.*	10
			Water moss	*Not identified to genus*	11
FREE-FLOATING			Humped bladderwort	*Utricularia gibba*	2
			Intermediate bladderwort	*Utricularia intermedia*	1
			Lesser bladderwort	*Utricularia minor*	1
			Greater bladderwort	*Utricularia vulgaris*	1
			Star duckweed	*Lemna trisulca*	<1
FLOATING-LEAF			Watershield	*Brasenia schreberi*	5
			Yellow waterlily	*Nuphar variegata*	3
			White waterlily	*Nymphaea odorata*	3
			Floating-leaf pondweed	*Potamogeton natans*	1
			Floating-leaf burreed	*Sparganium sp.*	<1

Table 3 (continued). Frequency of aquatic plants in Long Lake Point-intercept survey, 2007.
* Frequency is the percent of sample sites in which a plant taxon occurred within the shore to 30 ft water depth.

Life Forms	Common Name	Scientific Name	Frequency N = 1501
EMERGENT	Arrowhead	*Sagittaria latifolia*	2
	Spikerush	*Eleocharis sp.*	1
	Wild Rice	*Zizania palustris*	<1
	Bulrush	*Scirpus acutus*	<1
	Horsetail	*Equisetum sp.*	<1
	Broad-leaf cattail	*Typha latifolia*	<1
	Three-way sedge	*Dulichium arundinaceum*	<1
	Giant cane	*Phragmites australis*	present
	Yellow iris	*Iris pseudacorus*	present
	Narrow-leaf cattail	*Typha angustifolia*	present
	Giant burreed	*Sparganium eurycarpum*	present
	Sweet flag	*Acorus calamus*	present

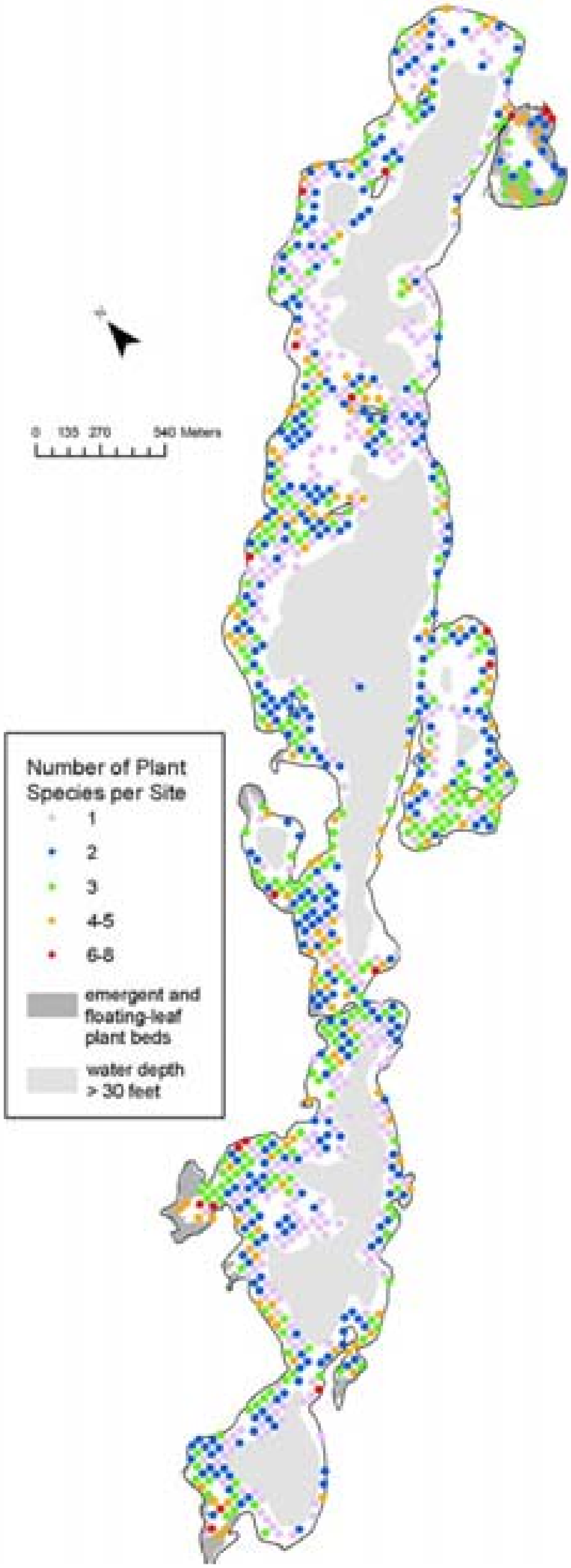
Diversity of plants by water depth
The number of plant taxa was greatest in shore to five feet depth zone and decreased with increasing water depth (Figure 10). Emergent plants occurred in water depths of five feet and less and floating-leaf plants were restricted to water depths less than 10 feet. Rooted submerged plants were primarily restricted to depths of 15 feet and less and submerged algae and moss were the most common plant types found beyond the 20 feet depth.

Figure 10. Number of species found at each water depth interval.



The number of plant taxa found in each one square meter sample site ranged from zero to eight. Sites near shore, in shallow water, contained the greatest number of plant taxa and in water depths greater than 15 feet, most sites contained one or no taxa (Figure 11).

Figure 11. Number of plant taxa found at each sample site. Long Lake, 2007



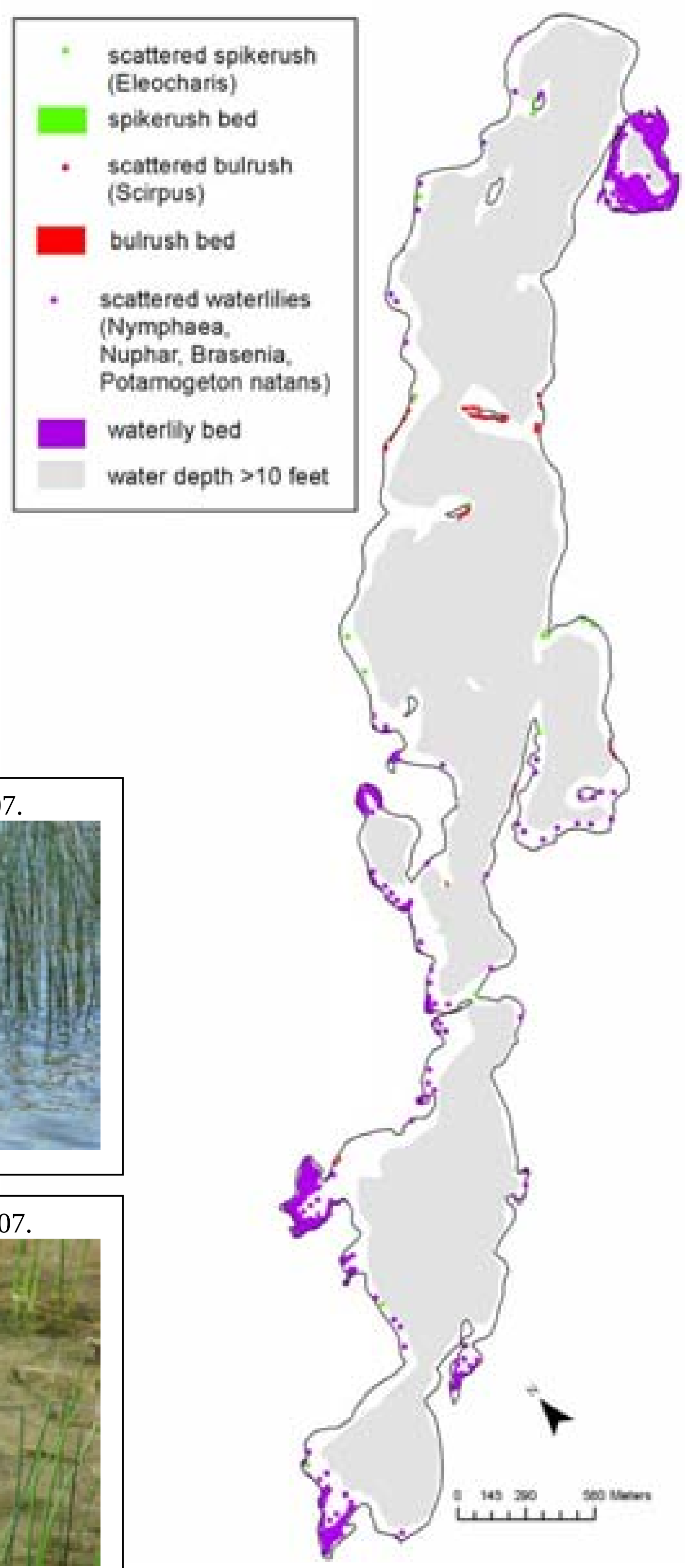
Emergent and floating-leaf plants
Emergent aquatic plants offer shelter for insects and young fish as well as food, cover and nesting material for waterfowl, marsh birds and muskrats. Waterlily beds provide similar benefits and also provide shade for fish and frogs. The root systems of emergent and floating-leaf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

Approximately three acres of emergent plants were delineated and [bulrush](#) (*Scirpus*) (Figure 12) and spikerush (*Eleocharis*) (Figure 13) were the most common emergent plants. Bulrush plants occurred to a maximum depth of seven feet and the largest bulrush stands occurred on the sandy shoals in the north basin (Figure 14).

Figure 12. Bulrush bed in Long Lake, 2007.

Figure 13. Spikerush bed in Long Lake 2007.

Figure 14. Emergent and floating-leaf plants of Long Lake, 2007.



Other emergent plants occurred at scattered locations around the lake and included wild rice (*Zizania palustris*) (Figure 15), arrowhead (*Sagittaria latifolia*) (Figure 16), and burreed (*Sparganium eurycarpum*) (Figure 17). Many of these emergent plants occupied the transitional zone between upland and lake and some taxa extended into the water up to a depth of six feet.

Figure 15. Wild rice (*Zizania palustris*)

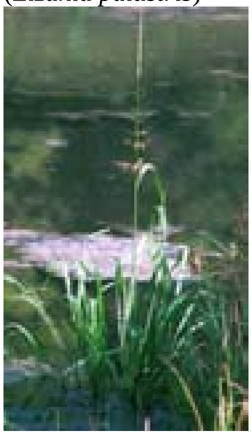
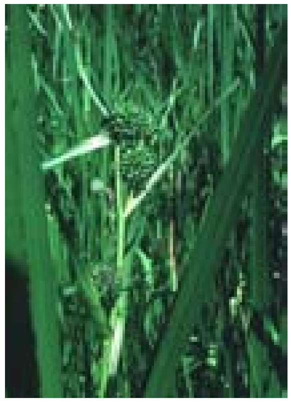


Figure 16. Arrowhead (*Sagittaria latifolia*)

Figure 17. Burreed (*Sparganium eurycarpum*)



One non-native plant, yellow iris (*Iris pseudacorus*) (Figure 18) was found at several sites along the north shore. Yellow iris closely resembles the native blue-flag iris (*Iris versicolor*) and is easiest to recognize in flower in early summer. Yellow iris is a popular garden plant and if planted near wetlands, it can spread locally. Although its flower may be considered attractive, this non-native should not be planted along lakeshores because it may out compete native wetland plants.

Figure 18. Yellow iris (*Iris psuedacorus*)

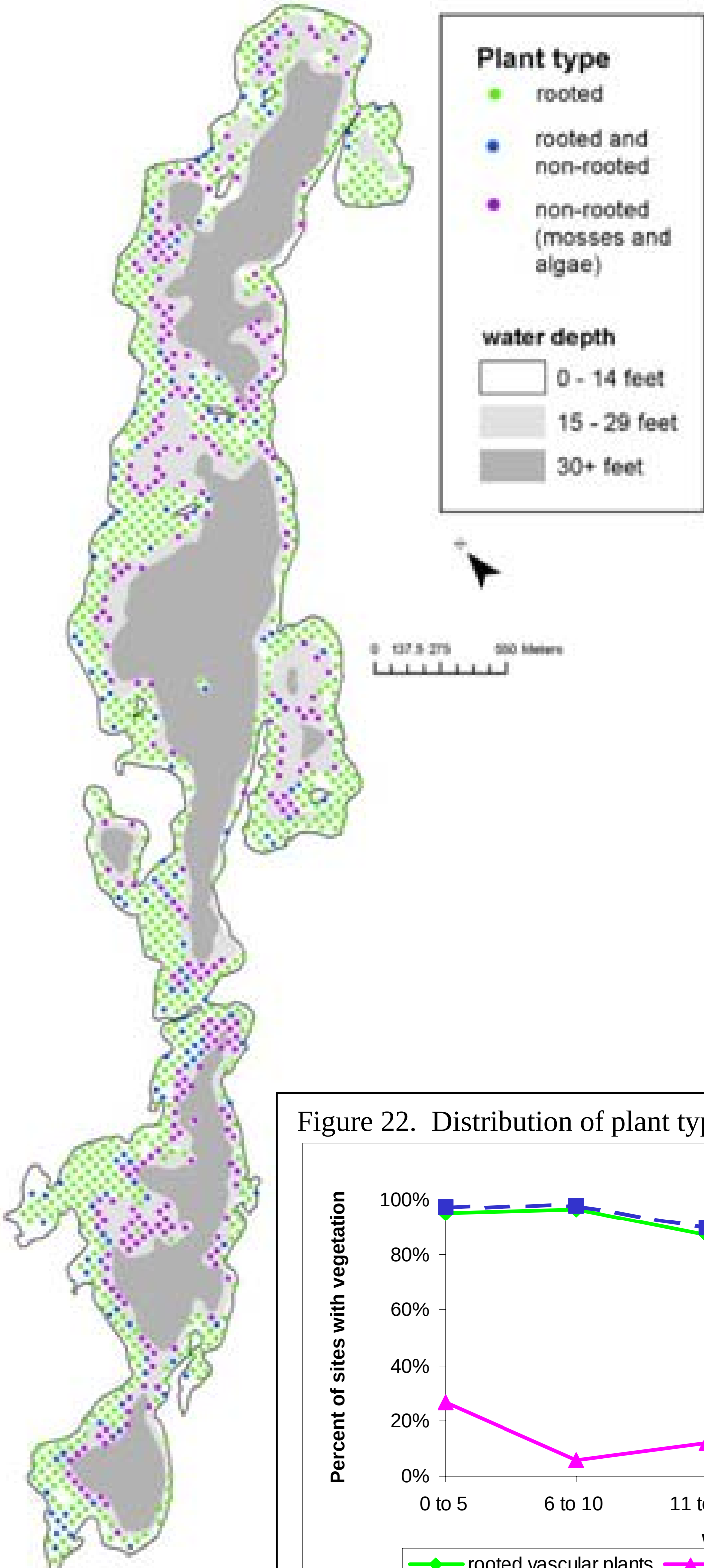
About 34 acres of floating-leaf plant beds were mapped (Figure 14) and the most common species were watershield (*Brasenia schreberi*) (Figure 19), white waterlily (*Nymphaea odorata*) (Figure 20), and yellow waterlily (*Nuphar variegata*) (Figure 21). Because surveyors avoided motoring into floating-leaf plant beds, the frequency values obtained for these taxa (Table 3) were lower than the actual occurrence. Frequency values for floating-leaf taxa represent the occurrence of these taxa only within the sites that were surveyed. Waterlily beds often contained scattered bulrush plants as well as submerged plants and were often associated with muck sediments.

Figure 19. Watershield (*Brasenia schreberi*)

Figure 20. White waterlily (*Nymphaea odorata*)

Figure 20. Yellow waterlily (*Nuphar variegata*)

Figure 21. Distribution of common submerged plant groups, Long Lake, June 2007.



Submerged plants

Submerged plants occurred in 63 percent of Long Lake sample sites. The plant community included leafy plants that are anchored to the lake bottom by roots as well as large algae and aquatic moss that may resemble leafy plants but are weakly anchored to the lake bottom or drift freely with the currents.

Leafy, rooted plants were most common in water depths of 15 feet or less while large algae and moss were most common in water depths greater than 15 feet (Figures 21, 22).

Common plant taxa included pondweeds (*Potamogeton robbinsii, P. praelongus, P. amplifolius)*, Canada waterweed (*Elodea canadensis*), muskgrass (*Chara* sp.), stonewort (*Nitella* sp.) and watermoss. Each of these taxa occurred in at least 10 percent of all sites. Occurrence of each of these taxa varied across water depths (Figure 23).

Figure 22. Distribution of plant types by water depth.

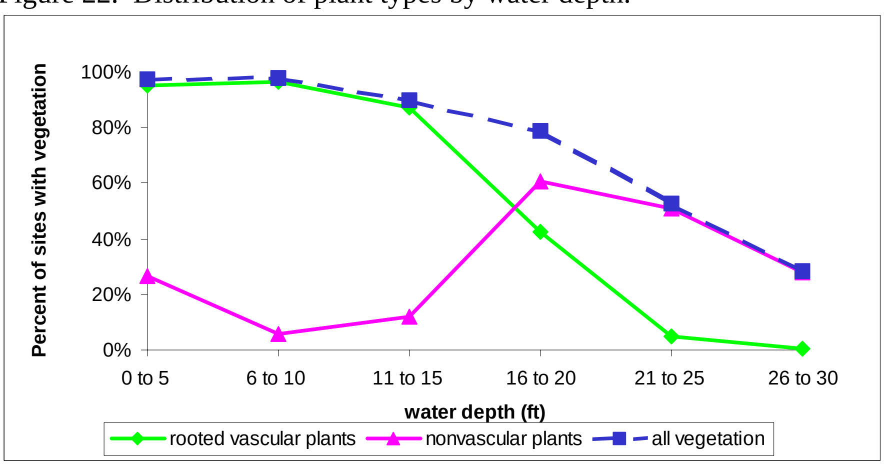
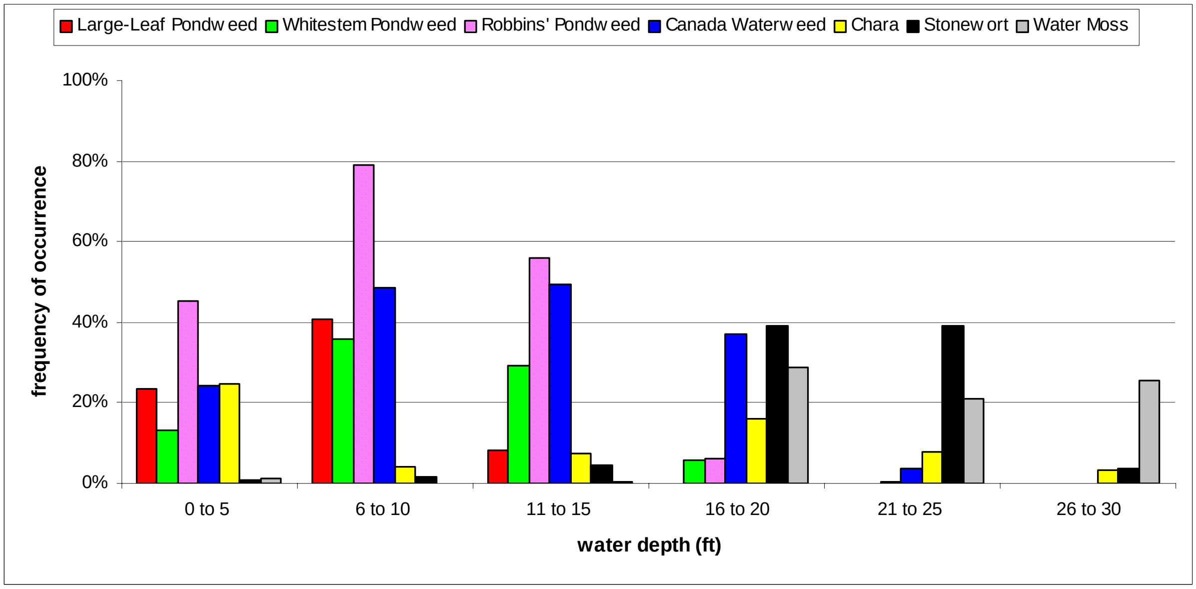


Figure 23. Distribution of common submerged plant species in Long Lake, June 2007.



Pondweeds were the largest group of submerged plants in Long Lake and the most common were Robbin's pondweed (*Potamogeton robbinsii*), white-stem pondweed (*Potamogeton praelongus*) and large-leaf pondweed (*Potamogeton amplifolius*). These rooted, perennial plants with broad leaves are primarily submerged but the latter two species will form floating leaves in shallower water.

Robbin's pondweed was the most abundant pondweed in Long Lake and was found in 36 percent of all sample sites (Table 3). This pondweed has long, narrow leaves that resemble a palm branch (Figure 24). This species may form dense underwater beds that can provide important fish cover.

White-stem pondweed (Figure 25) and large-leaf pondweed (Figure 26) occurred in 16 and 15 percent of the sites, respectively. These broad-leaved plants are often referred to as "cabbage" by anglers and provide food for waterfowl and habitat for insects and fish.

These pondweeds were found around the entire perimeter of Long Lake, often co-occurred at sites, (Figure 27) and were most frequent in depths of 15 feet and less (Figure 23).

Figure 27. Common pondweeds in Long Lake, 2007

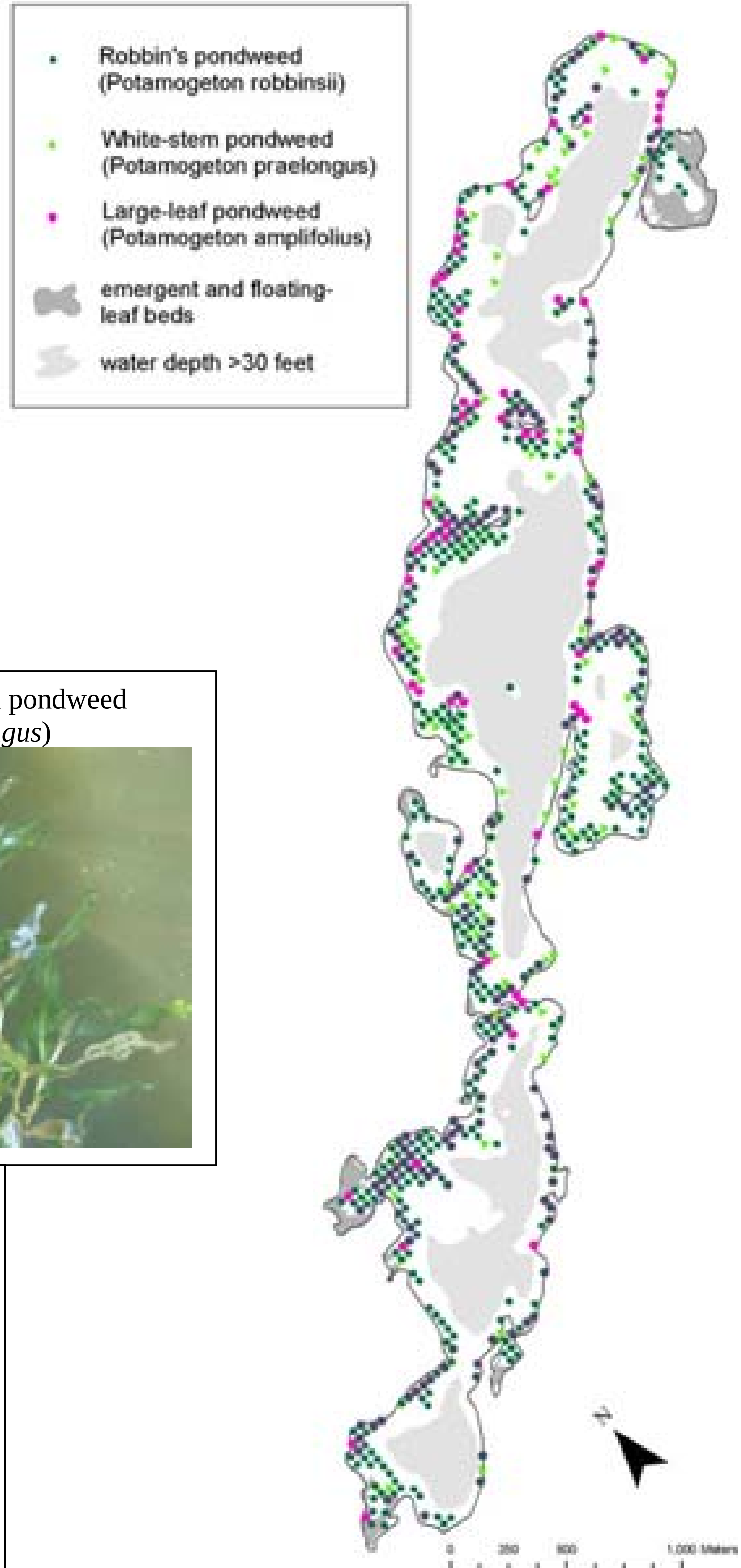
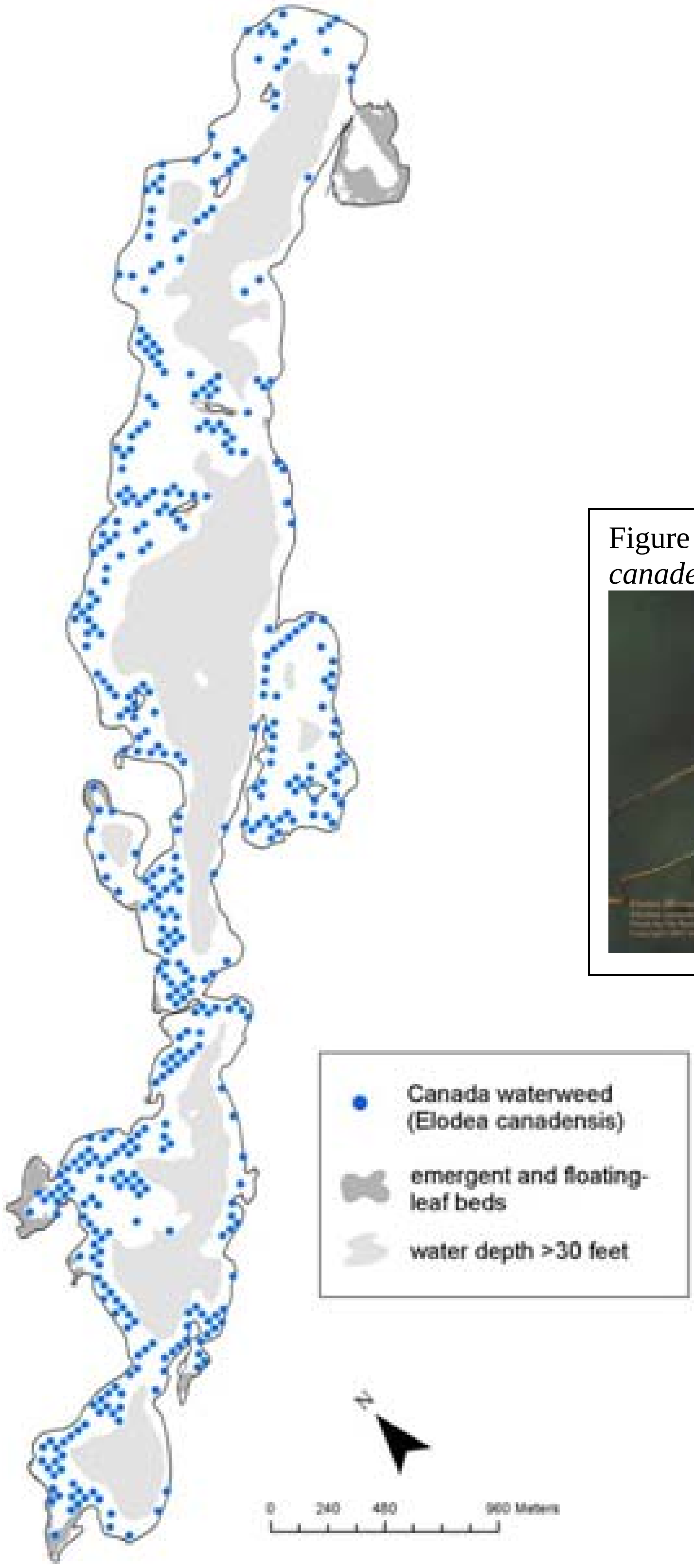


Figure 24. Robbin's pondweed (*Potamogeton robbinsii*)

Figure 25. White-stem pondweed (*Potamogeton praelongus*)

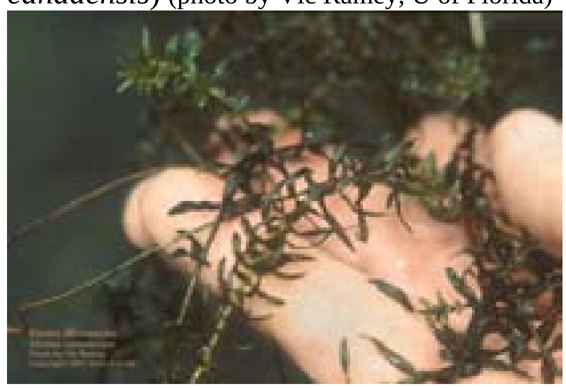
Figure 26. Large-leaf (*Potamogeton amplifolius*)

Figure 29. Canada waterweed Long Lake, 2007



Canada waterweed (*Elodea canadensis*) (Figure 28) 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.

Figure 28. Canada waterweed (*Elodea canadensis*) (photo by Vic Ramey, U of Florida)

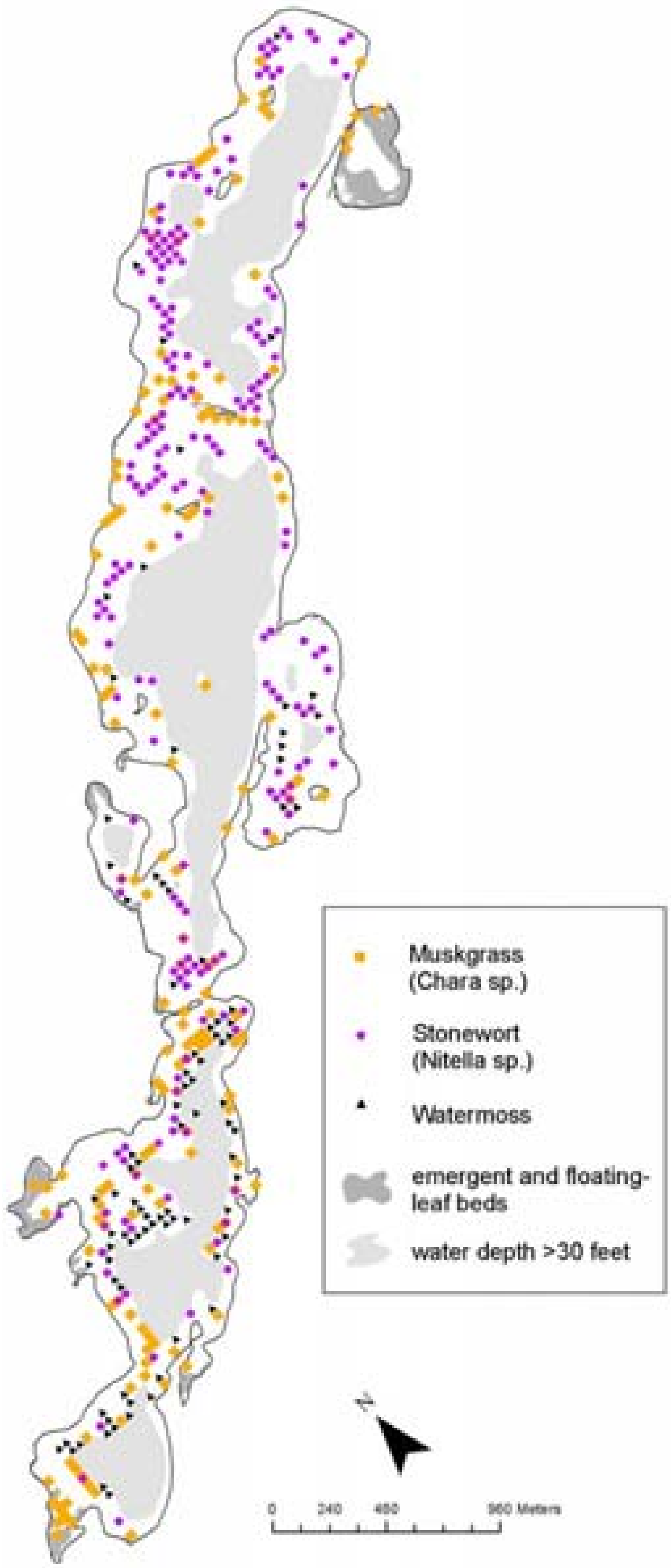


In Long Lake, it occurred from shore to a depth of 22 feet (Figure 29). It was found in 29 percent of all sample sites (Table 3) and was most common in the six to 15 feet depth zone where occurred in 49 percent of the sites (Figure 23).

Submerged plants – algae and mosses

Algae and aquatic mosses resemble flowering plants but they do not form true stems, leave or flowers. These plants are adapted to grow in deeper water than rooted plants and they play important roles in the lake

Figure 30. Large Algae and Watermoss. Long Lake, 2007



ecosystem. Large algae and mosses remove nutrients directly from the water column. Beds of these plants can support a large invertebrate population and provide a deep-water shelter for fish populations. In Long Lake, two large algae and an aquatic moss were common around the lake (Figure 30).

Stonewort (*Nitella* sp.) is a large algae with fine, bright green strands that resemble hair when pulled from the water (Figure 31). In Long Lake it occurred in 13 percent of the sample sites (Table 3). It is often found in deeper water than rooted plants and in Long Lake it occurred to a depth of 29 feet. It was most common in 16 to 25 feet of water (Figure 23) where it occurred in 39 percent of the sample sites.

Figure 31. Stonewort (*Nitella* sp.)

Muskgrass (*Chara* sp.) (Figure 32) 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. 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.

In Long Lake, muskgrass occurred in 11 percent of all survey sites (Table 3) and was found around the entire lake (Figure 30). Muskgrass occurred to a maximum depth of 29 feet but was most common in depths less than six feet where it occurred in 25 percent of the sites (Figure 23).

Figure 32. Bed of Muskgrass (*Chara* sp.)

Unique Plants

In addition to the commonly occurring plants in Long Lake, there were several unique plants located during the survey. These species are not widespread in Minnesota but are usually associated with low alkalinity lakes of northern Minnesota. Although they were found infrequently during the survey, their presence is indicative relatively undisturbed native plant beds in Long Lake.

Figure 33. Vasey's pondweed (*Potamogeton vaseyi*)

Vasey's pondweed (*Potamogeton vaseyi*) (Figure 33) is a submerged plant that forms small floating leaves in quite waters. This is a species of Special Concern in Minnesota because of its rarity in the state.

Quillwort (*Isoetes* sp.) (Figure 34) is a submerged plant that is associated with low alkalinity, clear lakes of northern Minnesota. It is specially adapted to live in very low carbon environments (Bolton and Adams 1986). This is not a flowering plant but reproduces and spreads by megaspores that are produced late in the summer.

Figure 34. Quillwort (*Isoetes* sp.)
Photo: C. Taylor USDA-NRCS PLANTS Database

Water bulrush (*Scirpus subterminalis*) (Figure 35) is a submerged, perennial plant with fine, grass-like leaves that may form mats and float near the water surface. In mid to late summer its leaf tips and flower stalk may emerge above the water surface. This species once had a patchy distribution throughout North America but may now be extirpated from Illinois (Flora of North America 2007) and its conservation status is listed as critically impaired in several other states (NatureServe 2007). It is infrequently found in Wisconsin (Nichols 1999) and Minnesota (Ownbey and Morley 1991) lakes.

Figure 35. Water bulrush

Photo by: D.W. Taylor. Copyright 1996.

Other unique plants found in Long Lake include floating-leaf burreed (*Sparganium* sp.), leafless watermilfoil (*Myriophyllum tenellum*) and several species of bladderwort (*Utricularia spp.*).

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, depth, substrate type and wave activity. The water clarity of Long Lake is sufficiently high to allow rooted aquatic plant growth to at least the 20 feet depth and large algae and moss to about 30 feet. The lake supports abundant and diverse native aquatic plant communities that in turn, provide critical fish and wildlife habitat and other lake benefits. (Click here for more information on: value of aquatic plants).

The high number of plant taxa found in Long Lake is a reflection of the excellent water clarity. Many of the plants found require clear water and are not found in lakes with higher turbidity. Another reason for the high diversity of plant types is that Long Lake has a variety of sediment types and a mix of protected bays and open water sites. Plant taxa with different habitat requirements can exist within this system.

A review of past vegetation surveys indicates that, over the past 50 years, the general aquatic plant community has not likely changed greatly in Long Lake. In all survey years, a relatively high number of native plants have been recorded and rooted plants remain well distributed throughout the shallow zone. Data collected in 2007 can be used to monitor finer-scale changes that may occur, such as an increase in a particular taxa or a change in the depths at which individual taxa 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 Long 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 submerged species have not been documented in Long 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.

- Natural fluctuation in plant species abundance
  Many submerged plants are perennial and regrow in similar locations each year. However, a few species such as bushy pondweed (*Najas* spp.) and wild rice (*Zizania palustris*) are annuals and are dependant on the previous years seed set for regeneration. Bushy pondweed was not commonly found during the 2007 survey and may not have fully germinated until later in the summer. The 1996 vegetation survey was conducted in late July and bushy pondweed was one of the most abundant submerged species located.
- 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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