Aquatic Vegetation of

Long Lake (ID #49-0015-00)

Morrison County, Minnesota

April 2006, August 2008 and August 2009

Long Lake, August 2009.

Minnesota
DEPARTMENT OF NATURAL RESOURCES

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Summary

Long is a 126 acre, hard-water lake in central Minnesota. Beginning in 2005, aquatic herbicide has been applied to control the growth of the non-native, submerged plant, curly-leaf pondweed *(Potamogeton crispus)*. A vegetation survey was conducted in April 2006 to assess the distribution and abundance of curly-leaf pondweed. The survey was repeated in August 2008 and 2009 to describe the native plant communities.

In all survey years, plants were commonly found within the shore to 15 feet depth zone: 82% of the sites were vegetated in April 2006 compared to 94% in August 2008 and August 2009. In 2009, vegetation was observed in 21 feet, but beyond the 15 feet depth, only 6% of sites contained plants. Frequency values were calculated for the 0 to 15 feet depth zone.

A total of 33 native aquatic plant species were recorded including six emergent, four floating-leaved, four free-floating and 19 submerged plants. In August 2008 and 2009, 94% of the survey sites contained at least one native plant species.

About 33 acres of emergent and floating-leaf plants were mapped. Wild rice (*Zizania palustris*) was the most common emergent species and during the August 2008 and 2009 surveys it was found in more than 40% of the sample sites. Other common emergent and floating-leaf species included hard-stem bulrush (*Schoenoplectus acutus*), white waterlily (*Nymphaea odorata*), yellow waterlily (*Nuphar variegata*), floating-leaf pondweed (*Potamogeton natans*), and watershield (*Brasenia schreberi*).

Coontail (*Ceratophyllum demersum*) was the most frequently observed submerged plant occurring with a frequency of 48% in 2006, 75% in 2008, and 55% in 2009. It was distributed around the entire perimeter of the lake and was the dominant submerged plant at all water depths.

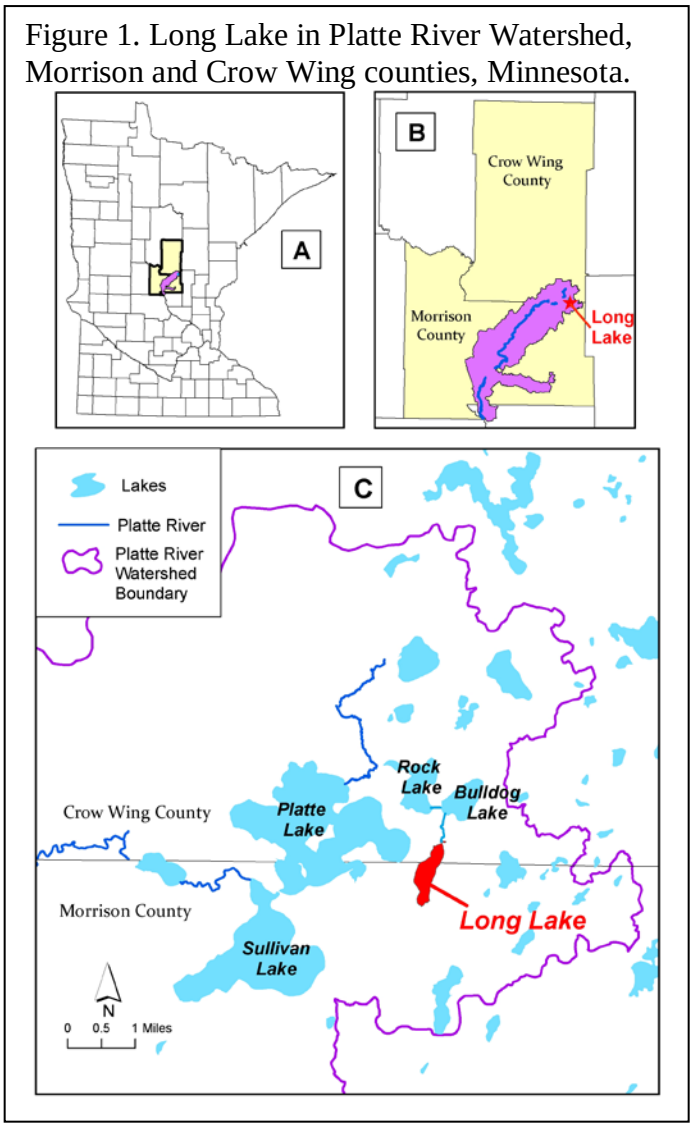
Other native submerged taxa that were common (occurring in at least 20% of the sites) in the August 2008 and/or August 2009 surveys were Canada waterweed (*Elodea canadensis*), greater bladderwort (*Utricularia vulgaris*), northern watermilfoil (*Myriophyllum sibiricum*), wild celery (*Vallisneria americana*) and native pondweeds (*Potamogeton* spp.).

With the exception of native pondweeds, native submerged taxa increased in frequency from April 2006 to August 2008 and August 2009. However, the number of sites containing native pondweeds decreased from 34% in April 2006 to 24% in August 2008 and 21% in August 2009. This was unexpected because native pondweeds typically increase in frequency between Spring and Summer. The species that showed the most dramatic decline was flat-stem pondweed (*Potamogeton zosteriformis*).

The non-native plant, curly-leaf pondweed (*Potamogeton crispus*) was found in all three surveys but the August 2008 and 2009 surveys were conducted after this plant had naturally begun to senesce. Curly-leaf pondweed was present in 23% in 2006, 11% in 2008 and 3% in 2009. It was concentrated at the north and south side of the lake in all three surveys.

Introduction

Figure 1. Long Lake in Platte River Watershed, Morrison and Crow Wing counties, Minnesota.



Long Lake is located about 6 miles west of Mille Lacs Lake, on the border of Morrison and Crow Wing Counties in north central Minnesota (Figure 1a). The lake lies at the north end of the Platte River Watershed (Figure 1b). There are no major inlets to the lake and it outlets north to Bulldog Lake. Flow continues through Rock Lake which outlets to the Platte River (Figure 1c). The Platte River continues through a series of lakes and drains the watershed to the south where it eventually meets the Mississippi River.

Long Lake is relatively small with a surface area of 126 acres. As its name implies, it is elongated in outline with about 14 miles of shoreline. It has a maximum depth of 35 feet and at least half of the lake basin is less than 15 feet in depth (Figure 2). The lake is described as mesotrophic with moderate water clarity. The average summer secchi disk reading for Long Lake in 2008 was nine feet (MPCA, 2009).

Because of its broad shallow zone and relatively clear water, Long Lake supports an abundant aquatic plant community. Previous surveys have recorded 33 different native lake and shoreline plants (DNR Fisheries Files). The non-native plant, curly-leaf pondweed (*Potamogeton crispus*), occurs in Long Lake and in most lakes in the watershed. The non-native plant, Eurasian watermilfoil (*Myriophyllum spicatum*), has not been found in Long Lake but does occur in nearby Mille Lacs Lake.

Objectives

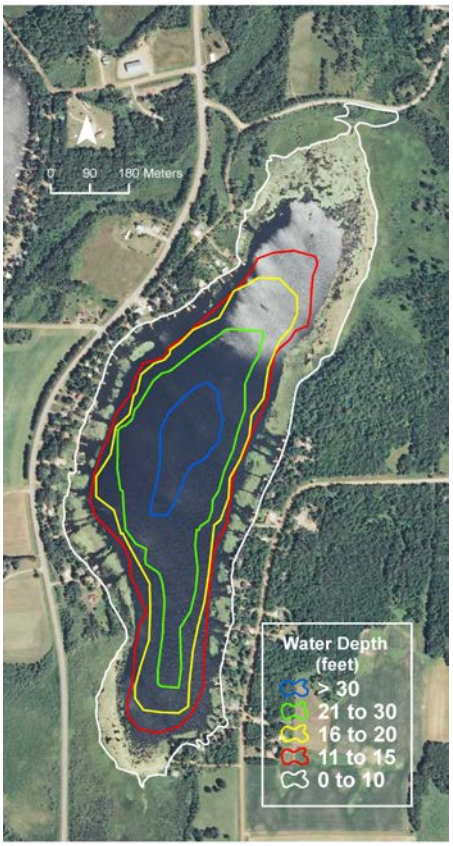
Vegetation surveys were conducted to provide quantitative descriptions of the native and non-native plants in Long Lake. Because the non-native, curly-leaf pondweed, reaches its peak growth in the Spring and native plants are mature in the Summer, surveys were conducted in April and August of various years.

Objectives included:

1. Record the aquatic plant species that occur in the lake
2. Estimate the maximum depth of rooted vegetation
3. Estimate the percent of the lake occupied by rooted vegetation

4. Estimate the abundance of curly-leaf pondweed (2006) and common native species (2008 and 2009)
5. Develop distribution maps for curly-leaf pondweed (2006) and native plants (2008 and 2009).

Figure 2. Depth contours of Long Lake (based on 2009 data).



Methods

Lakewide surveys

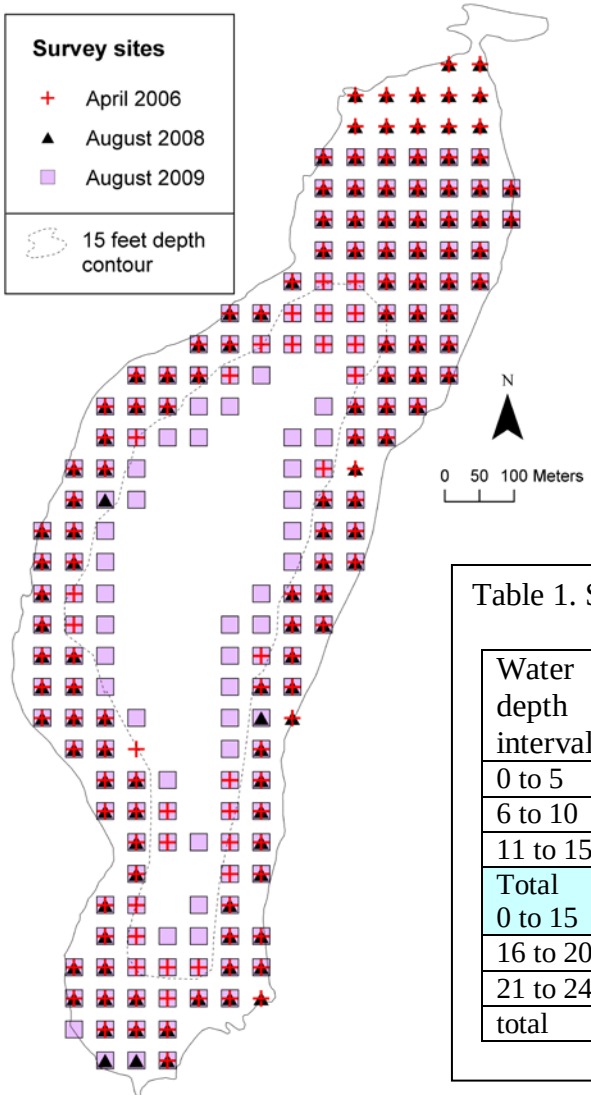
Long Lake was surveyed on April 27, 2006, August 6, 11, 26, 2008 and August 3, 2009. A point-intercept survey method was used and followed the methods described by Madsen (1999). Survey waypoints were created using a Geographic Information System (GIS) computer program and downloaded into a handheld Global Positioning System (GPS) receiver. Survey points were placed across the entire lake and spaced 45 meters (148 feet) apart.

Within the 0 to 15 feet depth zone, surveyors sampled all sites that were accessible by motorboat. During the August surveys there was abundant waterlily growth in the northern shallows. To avoid damage to these plant beds, surveyors kayaked to shallow sites in 2008. In 2009, these sites were not surveyed but surveyors added sites in the 21 to 24 feet depth zone. Surveyors sampled 160 sites in 2006, 135 in 2008 and 182 sites in 2009 (Figure 3, Table 1). There were 116 sites in the 0-15 feet depth zone that were sampled in all three years and only those sites were used in frequency calculations.

The surveys were conducted by boat (and kayak in 2008) and a 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 seven feet and an electronic depth finder in depths greater than seven feet. Surveyors recorded all plant taxa 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 (Figure 4) was used to survey vegetation not visible from the surface. Plant identification and nomenclature followed MnTaxa (2009).

Data were entered into a Microsoft Access database and frequency of occurrence was calculated for each taxon as the number of sites in which taxa occurred divided by the total number of sample sites (see example). For the 116 sites that were sampled in all three years, frequency was calculated for the entire area from shore to 15 feet and sampling points were also grouped by water depth and separated into three depth zones for analysis (Table 1). For several sites where recorded water depth was different between survey years, the 2008 and 2009 water depth data were used.

Figure 3. Vegetation survey sites, Long Lake, 2006, 2008 and 2009.



Emergent and floating-leaf plant bed delineation

Field surveys to map emergent vegetation were conducted in September 2008 and focused on bulrush mapping. Bulrush plants are difficult to observe on aerial photographs and therefore, surveyors motored around the perimeter of each bed and mapped the locations using a handheld Global Positioning System (GPS) receiver. Field data were uploaded to a computer and a Geographic Information System (GIS) software program was used to estimate acreage. 2008 true color aerial photographs (Farm Service Administration) were used to delineate other major beds of floating and emergent vegetation.

Table 1. Sampling effort by water depth.

Water depth interval	2006	2008	2009
	( ) = sites surveyed in all years		
0 to 5	61	60	90
6 to 10	47	53	16
11 to 15	25	22	25
Total 0 to 15	133 *(116)*	135 *(116)*	131 *(116)*
16 to 20	27	0	39
21 to 24	0	0	12
total	160	135	182

Results

Number of plant species recorded

A total of 33 aquatic plant taxa (types) were recorded in Long Lake including five emergent, four floating-leaved, four free-floating and 20 submerged taxa (Table 2). Submerged plants included large algae and mosses, divided-leaf plants and grass-leaf plants. One non-native plant, curly-leaf pondweed, was found in all three survey years. Some native plants were found during the August 2008 and 2009 survey. Fewer plant taxa were located during the April 2006 and likely had not yet germinated until water temperatures increased later in the summer of that year. The mean number of plant taxa found at each sample site was two in 2006, five in 2008 and four in 2009 (Table 2).

Figure 4. Sampling rake.

Table 2. Frequency of aquatic plants in Long Lake, April 2006 and August 2008 and 2009.

(Frequency is the percent of 116 sample sites in which a plant taxon occurred within the 0 to 15 ft water depth.)

Life Form	Common Name	Scientific Name	Frequency (%)		
			April 2006	August 2008	August 2009
Algae and Mosses	Muskgrass	*Chara* sp.	7	14	27
	Water moss	*Not identified to genus*	---	3	8
	Stonewort	*Nitella* sp.	2	---	1
SUBMERGED Dicots (Divided leaves)	Coontail	*Ceratophyllum demersum*	48	75	55
	Bladderwort	*Utricularia vulgaris*	6	35	23
	Northern water milfoil	*Myriophyllum sibiricum*	16	14	24
	White-water buttercup	*Ranunculus aquatilis*	---	7	17
	Water marigold	*Megaladonta beckii*	---	9	2
SUBMERGED Monocots (Entire leaves, grass-like leaves)	Canada waterweed	*Elodea canadensis*	12	39	25
	Wild celery	*Vallisneria americana*	---	21	22
	Curly-leaf pondweed	*Potamogeton crispus(NON)*	23	11	3
	Flat-stem pondweed	*Potamogeton zosteriformis*	22	---	2
	White-stem pondweed	*Potamogeton praelongus*	16	14	9
	Large-leaf pondweed	*Potamogeton amplifolius/illinoensis**	3	11	8
	Variable pondweed	*Potamogeton gramineus*	---	1	2
	Narrow-leaf pondweed	*Potamogeton* sp.	1	---	1
	Sago pondweed	*Stuckenia pectinata*	1	1	---
	Bushy pondweed	*Najas flexilis*	---	13	9
	Water star-grass	*Zosterella dubia*	7	15	15
FREE-FLOATING	Star duckweed	*Lemna trisulca*	16	17	17
	Lesser duckweed	*Lemna minor*	---	---	3
	Greater duckweed	*Spirodela polyhriza*	---	20	2
	Watermeal	*Wolffia* sp.	---	14	---
FLOATING	White waterlily	*Nymphaea odorata*	P	22	30
	Yellow waterlily	*Nuphar variegata*	P	29	32
	Watershield	*Brasenia schreberi*	---	4	6
	Floating-leaf pondweed	*Potamogeton natans*	---	---	1
EMERGENT	Wild rice	*Zizania palustris*	16	43	47
	Hard-stem bulrush	*Schoenoplectus acutus*	3	5	4
	Spikerush	*Eleocharis* sp.	---	3	3
	Arrowhead	*Sagittaria* sp.	---	3	1
	Cattail	*Typha* sp.	---	2	2
Mean number of plant taxa found in each sample site			2.0	4.5	4.0

"---" means not found in that year.

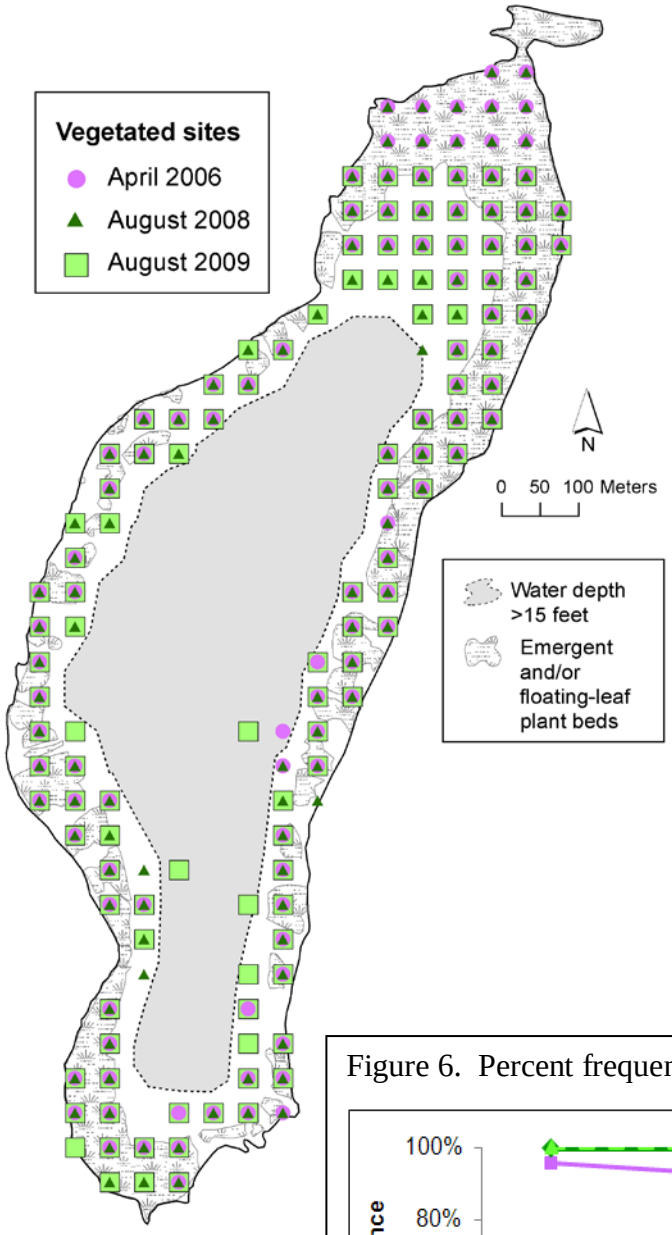
P = Present in lake but not found in survey sites NON – non-native species

**Potamogeton amplifolius* and *Potamogeton illinoensis* were both identified in the lake but were combined for data analysis because it can be difficult to distinguish these species in the field.

Example:

Within the 0-15 feet depth zone, 116 sample sites were surveyed in 2006, 2008 and 2009.
In 2006, Coontail (*Ceratophyllum demersum*) occurred in 56 sites.
2006 frequency of coontail in 0-15 feet zone = (56/116)*100 = 48%

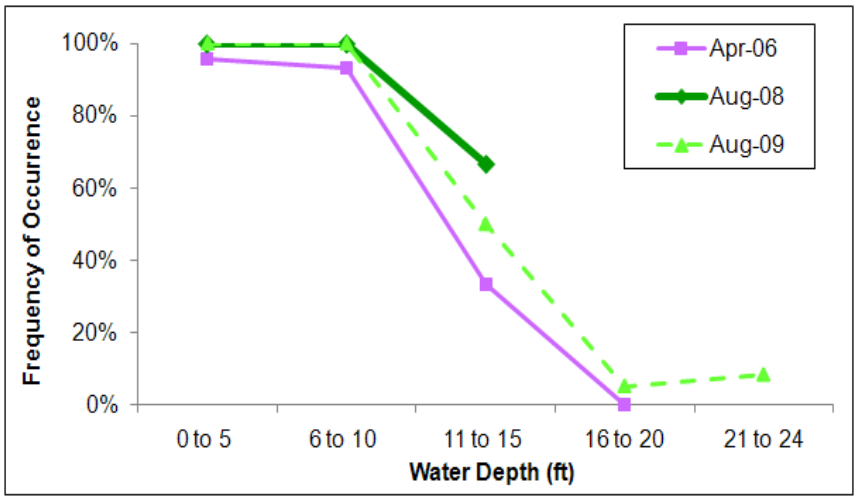
Figure 5. Distribution of aquatic plants in Long Lake, 2006, 2008 and 2009.



Distribution of aquatic plants

Aquatic plants occurred around the entire perimeter of Long Lake in each survey year (Figure 5). Vegetation was found to a depth of 15 feet in April 2006 and August 2008. Sampling was extended to 24 feet in August 2009 and surveyors found scattered plants to a depth of 21. Plants were commonly found in the 0 to 15 feet depth zone where plant frequency was 82% in 2006 and 94% in 2008 and in 2009. The lower occurrence of plants in 2006 was likely due to the cold water temperatures during the April survey (i.e. Most plants had not yet reached maturity).

Figure 6. Percent frequency of vegetation by water depth interval.



Emergent and floating-leaf plants

Emergent and floating-leaf aquatic plants offer food, cover and nesting material for waterfowl, marsh birds and muskrats, and provide shelter and shade for insects, young fish, and amphibians. The root systems of emergent and floating-leaf plants protect shorelines against erosion by buffering the wave action and by holding soil in place.

Figure 7. Emergent (EV) and floating-leaf (FL) plants in Long Lake 2008.

About 33 acres (25%) of Long Lake contained emergent and floating-leaf plant beds. These plants occupied the shallow waters to a depth of about 5 feet. Extensive beds were present on the north and south ends of the lake but other beds had been bisected by boat channels running perpendicular to the shoreline (Figure 7). The majority of the beds (31 acres) were dominated by wild rice and other plants included hard-stem bulrush, spikerush and waterlilies (Figure 7).

Wild rice (*Zizania palustris*) (Figure 8) is an annual, emergent plant that germinates each year from seed that fell to the lake bottom in the previous fall. It prefers soft substrates (Lee 1986, Nichols 1999) and generally requires moving water for growth (MnDNR 2008b). The plant begins growth underwater and then forms a floating-leaf stage before becoming fully emergent. Wild rice is susceptible to disturbance because it is weakly rooted to the lake bottom. In addition to its ecological value as habitat and food for wildlife, wild rice has important cultural and economic values in Minnesota (MnDNR 2008b). This valuable plant is increasingly threatened by factors such as lakeshore development and increased water recreational use (MnDNR 2008b).

Figure 8. Wild rice

Wild rice was the most common emergent plant in Long Lake and was found in at least 40% of the sites during the August 2008 and 2009 surveys (Table 2). It was the dominant plant in shallow (0 to 5 feet) water, where it occurred with a frequency of at least 60% in 2008 and 2009.

Hard-stem bulrush (*Schoenoplectus acutus*) (Figure 9) is an emergent, perennial plant that occurs in lakes and wetlands throughout Minnesota (Ownbey and Morley 1991). Bulrush stems are round in cross section and

lack showy leaves. Clusters of small flowers form near the tips of long, narrow stalks. This emergent may occur from shore to water depths of about six feet and its stems may extend several feet above the water surface. Spikerush (*Eleocharis* sp.) (Figure 10) is similar to bulrush but shorter. Bulrush and spikerush stands are particularly susceptible to destruction by excess herbivory and direct removal by humans. The western shore contained the largest bulrush and spikerush beds and in total, about three acres of bulrush and spikerush were mapped (Figure 9). Bulrush occurred with a frequency of 3% to 5% in each survey (Table 2).

Figure 9. Hard-stem bulrush

Figure 10. Spikerush

Floating-leaf plants were found in nearly half of all sample sites during the August 2008 and 2009 surveys (Table 2). Floating-leaf plants included yellow waterlily (*Nuphar variegata*), white waterlily (*Nymphaea odorata*), floating-leaf pondweed (*Potamogeton natans*), and watershield (*Brasenia schreberi*). Waterlily beds were located on the west shore and covered about one acre but these floating-leaf plants also occurred mixed within stands that were described as "mixed wild rice beds" (Figure 11). Waterlily beds often also contained submerged plants.

Figure 11. Waterlilies in Long Lake.

Submerged plants

In all survey years, native submerged plants were abundant in Long Lake, occurring with a frequency of 78% in April 2006, 94% in August 2008 and 88% in August 2009. It was expected that plant occurrence would be higher during the August surveys because many natives do not reach maximum growth until mid to late summer.

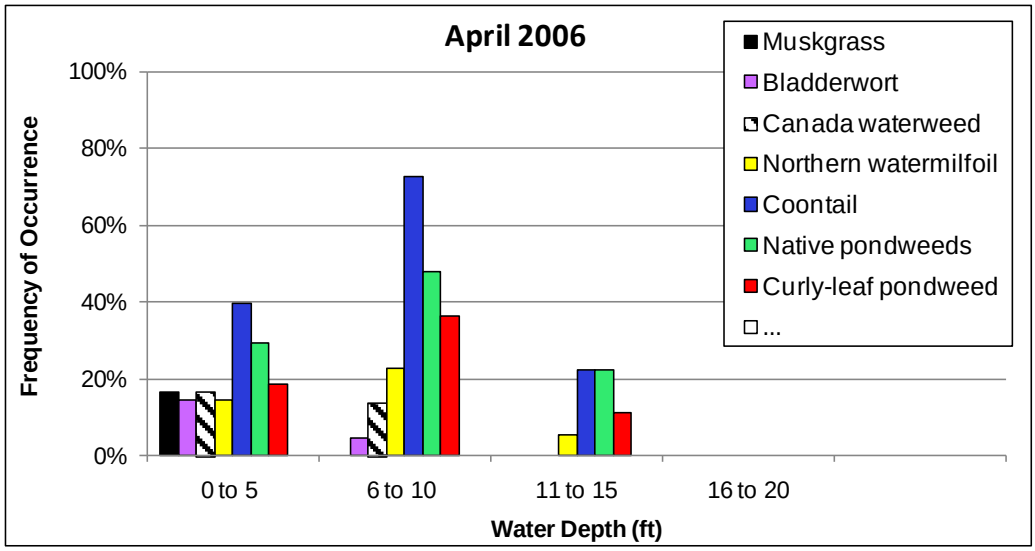
Submerged plant taxa were described as "common" in Long Lake if they were present in at least 20% of the sample sites during one of the surveys. The April 2006 survey assessed the curly-leaf pondweed population and the August 2008 and 2009 surveys assessed native submerged plants.

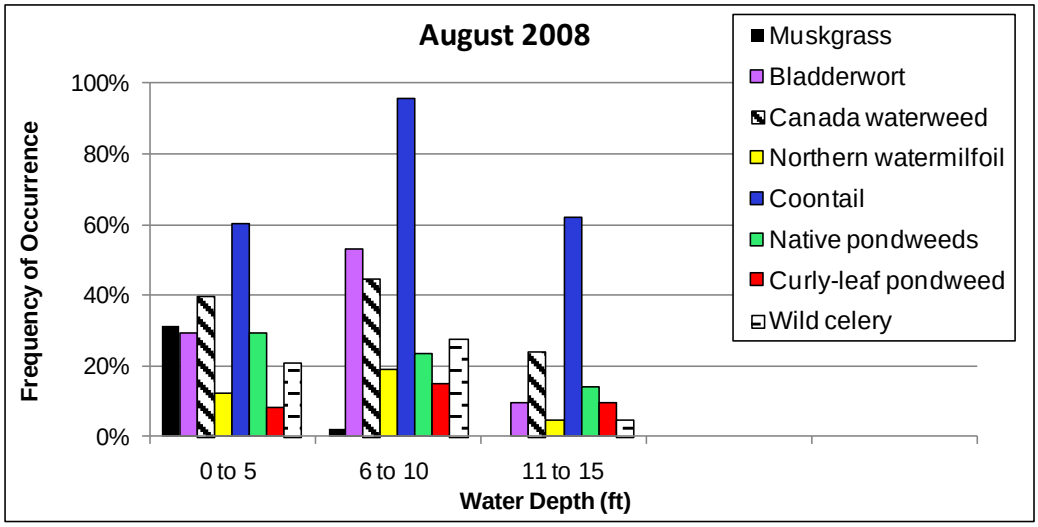
Native submerged plants

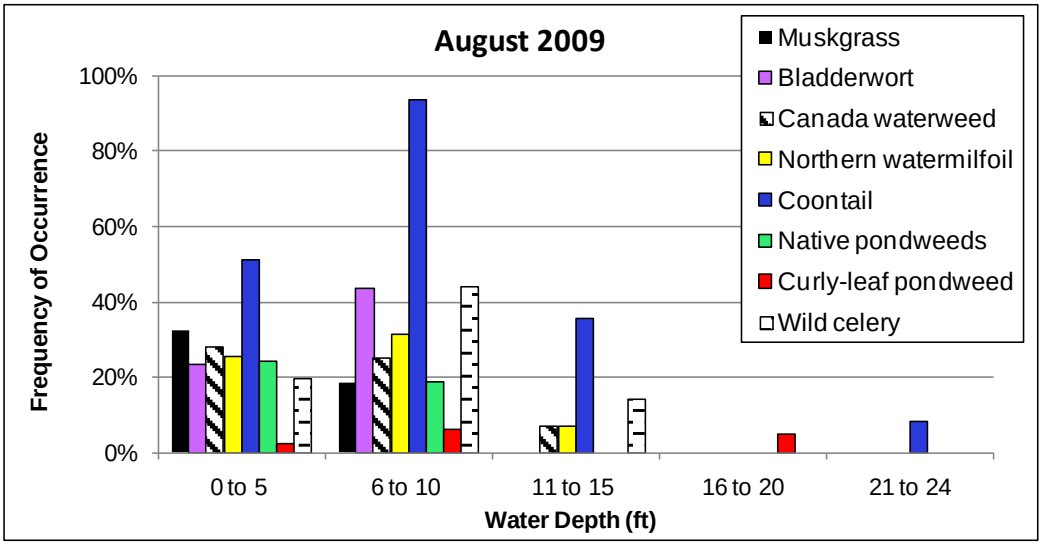
Coontail (Figure 12) was the most common native submerged species, occurring with a frequency of 48% in 2006, 75% in 2008 and 55% in 2009 (Table 2). In all three years, coontail was found in all sample depths and was the dominant native plant from 0 to 15 feet (Figure 13). It was most frequent in the 6 to 10 feet depth zone and during the August 2009 survey, it was the only submerged plant located in the 21 to 24 feet depth zone.

Figure 12. Coontail

Figure 13. Frequency of common submerged plants by water depth interval.







Coontail grows entirely submerged and its roots are only loosely anchored to the lake bottom. It is adapted to a broad range of lake conditions and is tolerant of higher turbidity and can grow in muck substrates. Coontail is perennial and can over winter as a green plant under the ice and then begins new growth early in the spring, spreading primarily by stem fragmentation. The finely divided leaves of this plant provide a home for insects valuable as fish food.

Canada waterweed (Figure 14) is a perennial submerged species that is widespread throughout Minnesota. It is adapted to a variety of conditions and is tolerant of low light and prefers soft substrates. Canada waterweed can overwinter as an evergreen plant and spreads primarily by fragments. It occurred in 39% of the August 2008 surveys and 25% of the August 2009 surveys (Table 2). Canada waterweed was one of the few submerged plants that were frequently found in depths greater than 10 feet (Figure 13).

Figure 14. Canada waterweed

Greater bladderwort (Figure 15) grows entirely submerged except during bloom when it's small, showy yellow flower extends above the water. Bladderwort often floats freely in the water column and is tolerant of turbid water. It reproduces by fragments and winter buds that can float to new areas of the lake. Bladderwort is an insectivorous plant and uses its small "bladders" to trap invertebrates. Bladderwort was found in 35% of the sites in 2008 and 23% in 2009 (Table 2). Like most submerged plants, it was most often found in depths of 10 feet and less (Figure 13).

Figure 15. Flowers of greater bladderwort

Northern watermilfoil (Figure 16) is a native, submerged plant. It is a rooted perennial with finely dissected leaves (Figure 16). Particularly in depths less than ten feet, this plant may reach the water surface and its flower stalk will extend above the water surface. It spreads primarily by stem fragments and over-winters by hardy rootstalks and winter buds. Northern watermilfoil is not tolerant of turbidity and grows best in clear water lakes. For information on how to distinguish the native northern watermilfoil from the non-native, Eurasian watermilfoil, click here: identification. Northern watermilfoil occurred in 14% of the August 2008 sites and 24% of the August 2009 sites (Table 2). It was found to a maximum depth of 12 feet and was most frequent in the 6 to 10 feet depth zone (Figure 13).

Figure 16. Northern watermilfoil

Wild celery is a rooted, perennial submerged plant with long, grass-like leaves (Figure 17). Beds of wild celery provide food and shelter for fish and all parts of the plant are consumed by waterfowl, shorebirds and muskrats (Borman et al. 2001). Wild celery occurred in at least 20%

of the August survey sites in 2008 and 2009 (Table 2) and was most common in depths less than 10 feet (Figure 14).

Figure 17. Wild celery

Muskgrass (Figure 18) is a macroscopic, or large, algae and is common in many hard water Minnesota lakes. It has a brittle texture and a characteristic "musky" odor. Because muskgrass 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 a variety of substrates and is often the first taxa to colonize open areas of lake bottom where it can act as a sediment stabilizer. Beds of muskgrass can provide important fish spawning and nesting habitat. Muskgrass most often occurred in the 0 to 5 feet depth (Figure 13) and occurred with a frequency of 14% in August 2008 and 27% in August 2009 (Table 2).

Figure 18. Muskgrass.

Pondweeds (*Potamogeton* spp. and *Stuckenia*) have opposite, entire leaves and form cigar-shaped flowers that emerge above the water surface. Many pondweed species over-winter as hardy rhizomes while other species produce tubers, specialized winter buds, or remain "evergreen" under the ice. Seeds and tubers of pondweeds are an important source of waterfowl food (Fassett 1957). The foliage of pondweeds is food for a variety of marsh birds, shore birds and wildlife and provides shelter, shade and spawning sites for a range of fish species (Borman et al. 2001). Pondweeds inhabit a wide range of aquatic sites and species vary in their water chemistry and substrate preferences and tolerance to turbidity. There are over 35 species of pondweeds in Minnesota and they vary in leaf shapes and sizes. Eight native pondweed species were located in Long Lake.

As a group, native pondweeds remained relatively stable in their frequency between August surveys. In August 2008, 24% of all sites contained at least one native pondweed, compared to 21% in August 2009. However, more sites (34%) contained native pondweeds in the April 2006 survey. This was unexpected because native pondweeds typically increase in frequency between Spring and Summer.

Figure 19. Flat- stem pondweed

Flat-stem pondweed (Figure 19) is anchored to the lake bottom by underground rhizomes and over-winters by winter buds. It is named for its flattened, grass-like leaves. Depending on water clarity and depth, these plants may reach the water surface and may produce flowers that extend above the water. Flat-stem pondweed occurred in 22% of the April 2006 sites. It was expected that this plant would increase in occurrence during August surveys but it was not found

in August 2008 and occurred in only 2% of the August 2009 sites.

White-stem pondweed (Figure 20) occurred with a frequency of 16% in April 2006, 14% in August 2008 and 9% in August 2009 (Table 2). This plant is often found in deeper water than other native pondweeds and in Long Lake it was most frequent in the 11 to 15 feet depth zone.

Figure 20. White-stem pondweed.

Other native submerged taxa occurred in less than 20% of sample sites but are still an important component of the plant community. The variety of submerged plant types present in Long Lake provides a diversity of habitat for fish and other aquatic life.

Curly-leaf pondweed

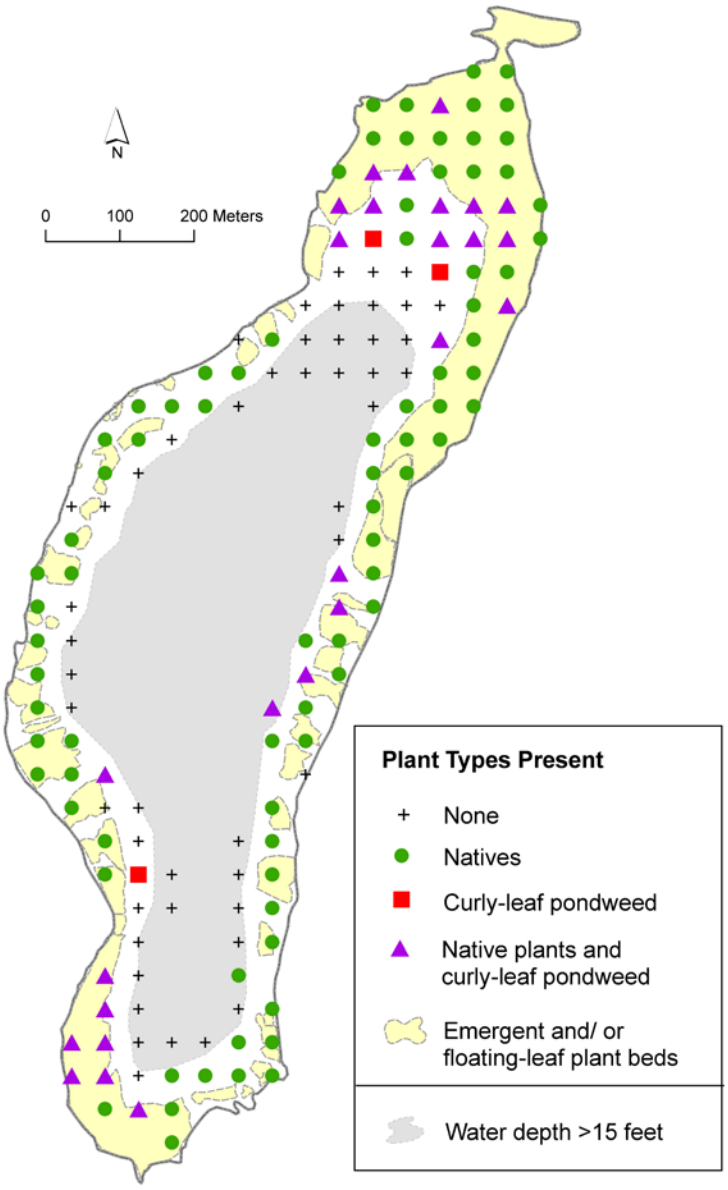
Curly-leaf pondweed (Figure 21). This non-native, submerged plant is closely related to native pondweeds but it is not native to Minnesota. Curly-leaf pondweed has been present in Minnesota since at least 1910 (Moyle and Hotchkiss 1945) and is now found in at least 700 Minnesota lakes (MnDNR Invasive Species Program 2008). Like many native submerged plants, it is perennial but has a unique life cycle that may provide a competitive advantage over native species. Curly-leaf pondweed is actually dormant during late summer and begins new growth in early fall. 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 21. Curly-leaf pondweed

The foliage of curly-leaf pondweed does provide some fish and wildlife habitat, but it may create problems in some lakes. During its peak growth in spring, curly-leaf may reach the water surface at certain depths and create dense mats. These dense growths may compete with native vegetation and can also cause problems for recreational lake users.

In April 2006, curly-leaf pondweed occurred with a frequency of 23% (Table 2). It was found in depths of 3 to 12 feet but did not dominate at any depth (Figure 13). It was found scattered around the entire lake with concentrations in the north and south ends (Figure 22). At most of the sites where curly-leaf was found, it co-occurred with native plants. The 2008 and 2009 surveys were conducted in August, after curly-leaf pondweed naturally dies back. It was present in 11% of the sites in 2008 and 3% in 2009 (Table 2). In 2009, it was found at two sites in water depths greater than 15 feet (Figures 13).

Figure 22. Native plants vs. Curly-leaf Pondweed in Long Lake, April, 2006.



Monitoring changes in aquatic plant community

The types and amounts of aquatic vegetation that occur within a lake are influenced by a variety of factors including water clarity and water chemistry. 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.

Data from the April 2006 Long Lake survey can also be compared to future Spring surveys to assess changes in the frequency and distribution of curly-leaf pondweed. The August 2008 and August 2009 surveys can be used to monitor annual changes in the native species composition.

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

- Change in water clarity
  If water clarity in Long Lake increases, submerged vegetation may be more common at depths greater than 15 feet.

- Snow and ice 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, and/or a reduced ice-over period, 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 aquatic plants are perennial and regrow in similar locations each year. However, a few species such as wild rice (*Zizania palustris*) and bushy pondweed (*Najas flexilis*) are annuals and are dependent on the previous year's seed set for regeneration.

- Aquatic plant management activities
  Humans can impact aquatic plant communities directly by destroying vegetation with herbicide or by mechanical means. The results of these control activities can be difficult to predict and should be conducted with caution to reduce potential negative impacts to non-target species. Motorboat activity in vegetated areas can be particularly harmful for species such as 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. For information on the laws pertaining to aquatic plant management: MnDNR APM Program.

The abundant and diverse aquatic plant communities found in Long Lake provide critical fish and wildlife habitat and other lake benefits. (Click here for more information on: value of aquatic plants).

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