Aquatic vegetation of Cross Lake

June and July, 2010

ID# 18-0312-00

Crow Wing County, Minnesota

Cross Lake 2010.

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This report should be cited as:
Simon, S. and D. Perleberg. 2010. Aquatic vegetation of Cross Lake (ID# 18-0312-00), Crow Wing County, Minnesota, 2010. Minnesota Department of Natural Resources, Ecological and Water Resources Division, 1601 Minnesota Drive, Brainerd, MN 56401. 22 pp.

Summary

Cross Lake is the 6th largest lake in Crow Wing County and part of the Whitefish chain of lakes. In 2010, surveyors conducted a lakewide assessment of Cross Lake's vegetation that included mapping major emergent and floating-leaf plant beds and sampling aquatic plant distribution and diversity at 968 sites.

The aquatic plant communities of Cross Lake include a diversity of native plants, with 35 species (types) recorded, including 7 emergent, 4 floating-leaved, one free-floating and 23 submerged species. Nineteen of these species were identified for the first time in the lake in 2010.

Within the 0-25 feet depth zone of Cross Lake, 83% of sites contained plants. Plants were most frequent in depths of 15 feet and the broadest zones of plants were found in shallow areas, such as the southern portion of the lake.

Emergent and floating-leaf plants restricted to water depths less than 6 feet and within that shallow zone, they occurred in 2% of the sample sites. . About 16 acres of emergent and floating-leaf plants were delineated and these beds occurred in the shallow waters of the eastern bays. Species included bulrush (*Schoenoplectus* sp.) cattail (*Typha* sp.), White waterlily (*Nymphaea odorata*) watershield (*Brasenia schreberi*) and floating smartweed (*Persicaria amphibia*).

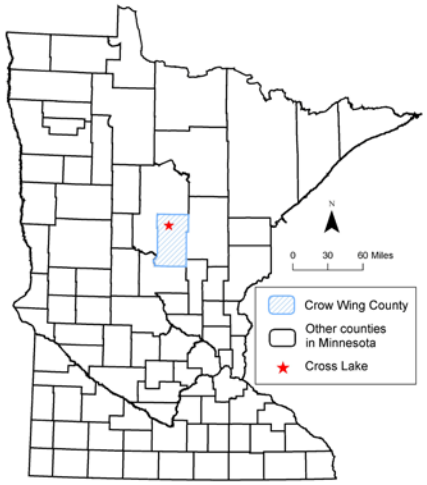
Submerged plants were commonly found to a depth of 20 feet and a few scattered plants occurred to 21 feet. The macroalgae, muskgrass (*Chara* sp.) was the most common submerged plant and occurred in 32% of the sites. It dominated the 0 to 5 feet depth zone where it was found in 68% of the sites. Submerged rooted plants were found in 73% of the sites and were most frequent in the 6 to 15 feet depth zone, where they occurred in 88% of the sites. Commonly occurring submerged rooted species (those found in at least 20% of the sites) were coontail (*Ceratophyllum demersum*), northern watermilfoil (*Myriophyllum sibiricum*), southern naiad (*Najas guadalupensis*), and white-stem pondweed (*Potamogeton praelongus*).

The non-native submerged plant, curly-leaf pondweed (*Potamogeton crispus*), was present in the lake, but was found at only 6 sites (1% of all sites). This plant has been present in the Whitefish chain since at least the early 1940's and remains a minor component of the plant community.

Introduction

Cross Lake is located by the city of Cross Lake in Crow Wing County, north central Minnesota (Figure 1). The lake is named Cross Lake, because the Pine River flows from west to east across Cross Lake (Upham 2001). It is a popular lake for fishing, boating and other water recreation activities.

Figure 1. Cross Lake, Crow Wing County, Minnesota.



Lake Characteristics

Cross Lake is one of the eastern-most waterbodies in the Whitefish Chain of Lakes. This chain of 14 waterbodies was connected in 1886 when the Pine River Dam was completed and raised water levels making channels between the set of lakes. Most of the lakes are connected by the Pine River as it flows east through the chain (Figure 2).

Figure 2. Cross Lake within the Whitefish Chain of lakes.

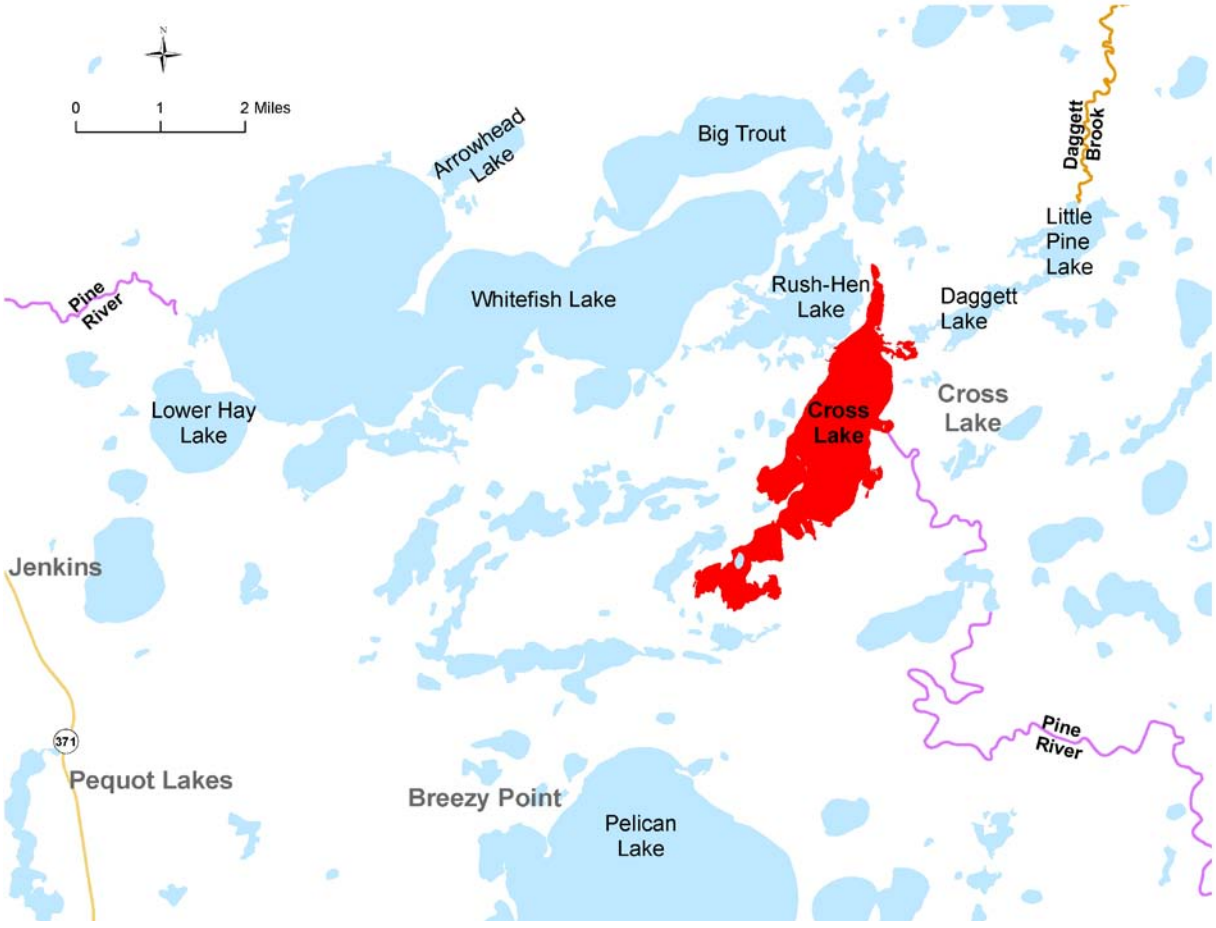
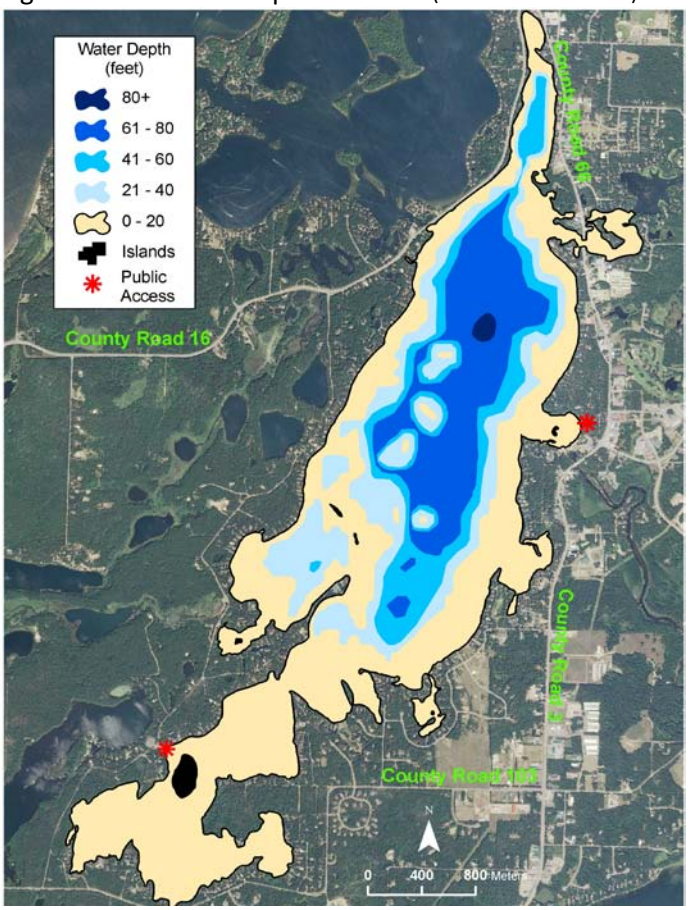


Figure 3. Cross Lake depth contours (Based on 2010 data).



With a surface area of 1,812 acres, Cross Lake is the 6th largest lake in the county and the 2nd largest in the Whitefish chain. It has 21 miles of shoreline and stretches about 5 miles long, from north to south, with an average width of about 1 mile. The lake consists of a large central basin that has an elongated oval outline and numerous smaller bays (Figure 3).

Cross Lake has a maximum depth of 84 feet but half of the lake, including the southern third, is shallow (15 feet or less in depth). Four islands, ranging in size from 136 to 925 acres, are present in the lake.

Cross Lake is characterized as a mesotrophic (moderate nutrients), hard water lake, with relatively clear water. The Secchi disc transparency measures the depth to which a person can see into the lake and provides a rough estimate of the light penetration into the water column. Water clarity can fluctuate annually and depends on the amount of particles in the water. In 2009, mean summer (June through September) water clarity, as measured by Secchi disc readings, was 12 feet in Cross Lake (MPCA 2010). 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. Based on Secchi disk measurements alone, aquatic plants have the potential to reach depths of 18 feet in this lake.

The majority of Cross Lake shoreline is privately owned and developed as residential homes. Access is available at the MnDNR public access on the southwest side of the lake, Army Corps public access on the east side of the lake, and several private resorts.

Historic aquatic plant community

Previous lakewide, aquatic plant surveys of Cross Lake were conducted in 1942, 1950, and 1990 (MnDNR Lake files). These surveys recorded a total of 17 aquatic plant species: 4 emergent, 2 floating-leaf and 11 submerged species (Appendix 1). Submerged plants were found to a depth of 18 feet and included muskgrass (*Chara* sp.), 8 different native pondweeds (*Potamogeton* spp.), northern watermilfoil (*Myriophyllum sibiricum*), coontail (*Ceratophyllum demersum*), bushy pondweed (*Najas flexilis*), and Canada waterweed (*Elodea canadensis*). Several wetland

emergent plants were also recorded during the 1990 survey (Appendix 1). The non-native submerged plant, curly-leaf pondweed (*Potamogeton crispus*), was not recorded during formal surveys but has been present in the Whitefish Chain since at least the 1940's.

Objectives

The purpose of this vegetation survey was to provide a quantitative description of the 2010 plant population of Cross 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 floating-leaf and emergent vegetation beds

Beds of bulrush and other emergents occur in near-shore areas of Cross Lake. Waterlilies and cattails were mapped using 2008 Farm Service Administrative (FSA) true color aerial photographs. Field surveys were conducted in September 2010 to map bulrush, which is difficult to identify from aerial photos, and to verify photo-interpretation of other plant beds. Surveyors mapped bulrush beds in the field by motoring around the perimeter of each bed and recording their track with a handheld Global Positioning System (GPS) unit. Field data were uploaded to a computer and a Geographic Information System (GIS) software program was used to estimate acreage.

Lakewide vegetation survey

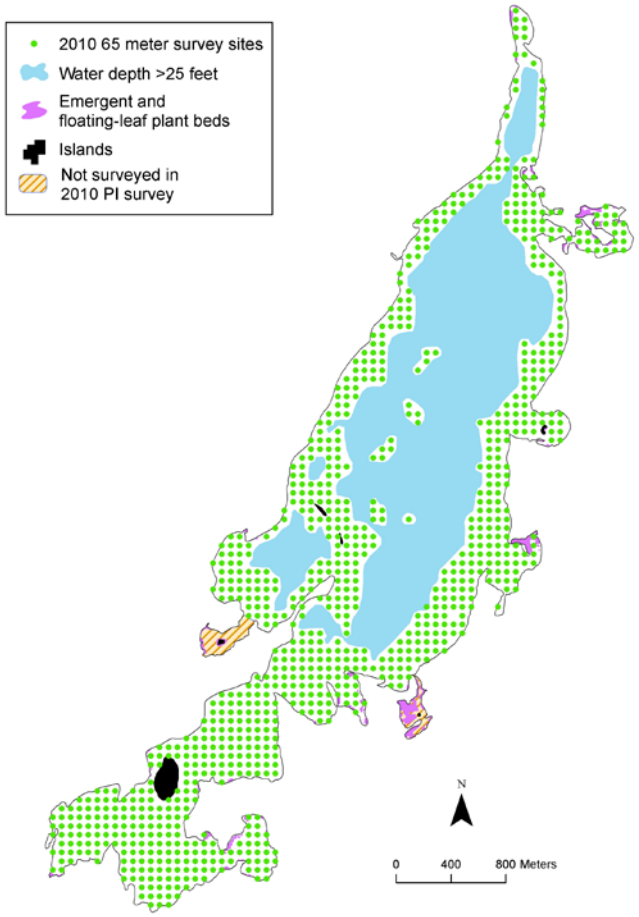
A lakewide vegetation survey was conducted using a point-intercept survey method (Madsen 1999, MnDNR 2009). Survey waypoints were created using a GIS computer program and downloaded into a handheld GPS unit. Survey points were placed across the entire lake and spaced 65 meters (213 feet) apart. In the field, surveyors sampled sites where water depth was less than 26 feet. To minimize damage to vegetation, surveyors did not survey sites if they occurred in dense beds of emergent or floating-leaf plants. A total of 968 sites were surveyed in Cross Lake (Figure 4, Table 1).

Cross Lake was surveyed on June 17, 21, 22, 28, and July 13, 20, 29, 2010. The survey was conducted by boat 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 7 feet and an electronic depth finder in deeper water.

Table 1. Survey effort by depth interval.

Water depth (feet)	Number of sample sites
0 to 5	214
6 to 10	287
11 to 15	349
16 to 20	71
21 to 25	47
Total	968

Figure 4. 2010 vegetation survey sites on Cross Lake.



Substrate sampling

At each sample site where water depths were 7 feet and less, surveyors described the bottom substrate using standard substrate classes (Table 2). If more than one substrate type was found, surveyors recorded the most common type. Surveyors attempted to record a substrate description at the shore side of each row of points. If a sample site occurred near shore but in water depth greater than 7 feet, surveyors collected depth and vegetation data and then motored into shallower water and recorded the substrate type adjacent to the actual survey point.

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

Plant sampling

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 water surface (Figure 5). Any additional plant species found outside of sample sites were recorded as "present" in the lake but these data were not used in frequency calculations. Points were not placed in two small bays on the south end of the lake (Figure 4) but surveyors searched these areas for additional species. Plant identification followed Crow and Hellquist (2000) and Flora of North America (1993+) and nomenclature followed MnTaxa (2010). Voucher specimens were collected for some species and are stored at the MnDNR in Brainerd or at the University of Minnesota herbarium.

Data were entered into a Microsoft Access database and frequency of occurrence was calculated for each species as the number of sites in which the species occurred divided by the total number of sample sites. Frequency was calculated for the entire area from shore to 25 feet and sampling points were also grouped by water depth and separated into 5 depth zones for analysis (Table 1).

Example:
In Cross Lake there were 968 samples sites in the 0-25 feet depth zone. Muskgrass occurred in 310 sites. Frequency of Muskgrass in 0 to 25 feet zone = (310/ 968)*100 = 32%

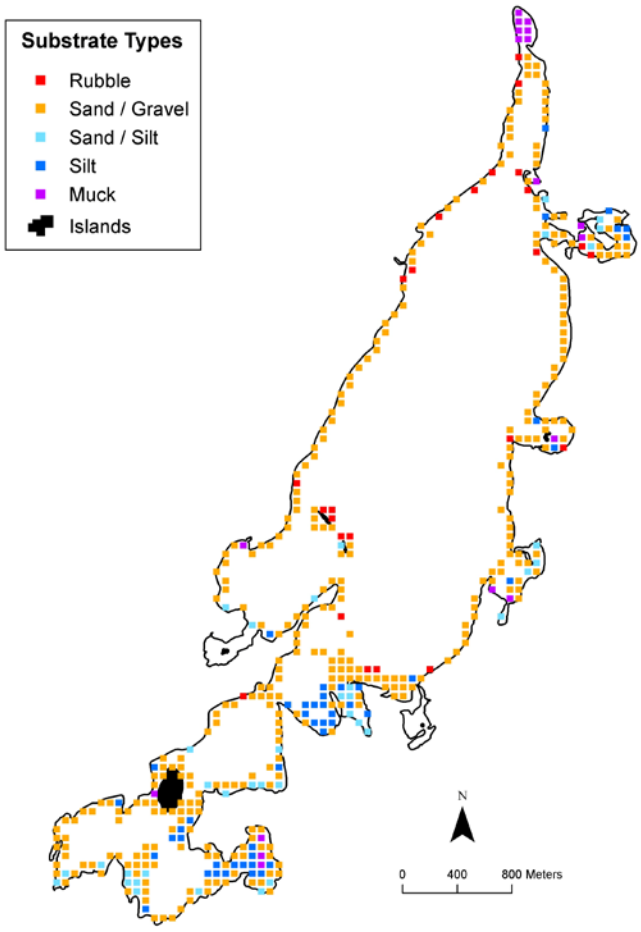
Figure 5. Sample rake.

Results and Discussion

Shoal Substrates

The shoal substrates of Cross Lake were primarily hard substrates of sand, gravel, and rubble (Figure 6). Softer substrates of silt and muck were found in shallow, protected bays (Figure 6).

Figure 6. Shoal substrates of Cross Lake, 2010.



Types of plants recorded

A total of 35 native aquatic plant species (types) were recorded in Cross Lake including 7 emergent, 4 floating-leaved, 1 free-floating and 23 submerged plants (Table 3). Nineteen of these species were recorded for the first time in Cross Lake (Appendix 1).

Submerged plants included macroalgae, an aquatic moss, and a diversity of rooted plants that can be grouped by leaf shape and size: dissected, small, narrow, broad and grass-leaved plants.

Three non-native plants were documented: the submerged plant, curly-leaf pondweed (*Potamogeton crispus*), and the emergent wetland plants, purple loosestrife (*Lythrum salicaria*) and reed canary grass (*Phalaris arundinaceae)*.

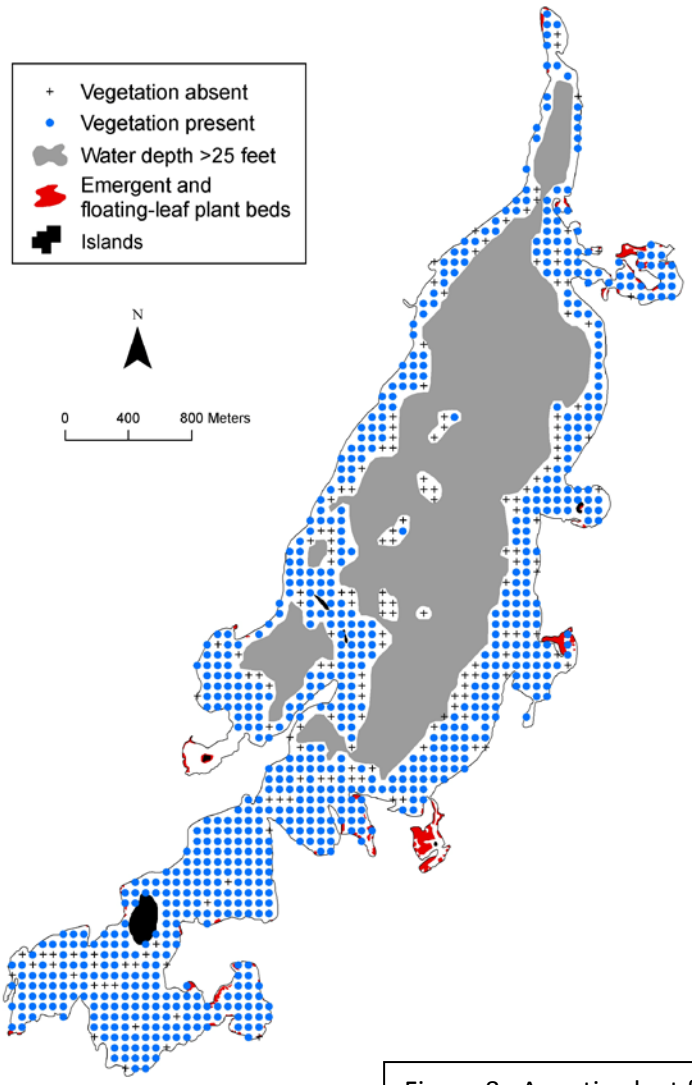
The 2010 survey did not include an inventory of all shoreland plants but surveyors did record the presence of several emergent wetland plants (Appendix 1).

Table 3. Frequency of aquatic plants in Cross Lake, June and July 2010.
[Frequency is the percent of sample sites in which a plant species occurred within the 0 to 25 ft water depth].

Life Form		**Common Name**	**Scientific Name**	**Frequency (%)** 968 sites
SUBMERGED non-rooted	Macroalgae	Muskgrass	*Chara* sp.	32
		Stonewort	*Nitella* sp.	<1
	Moss	Watermoss	*Not identifies to genus*	<1
SUBMERGED rooted, flowering plants	Dissected-leaf rooted plants	Northern watermilfoil	*Myriophyllum sibiricum*	27
		Coontail	*Ceratophyllum demersum*	25
		Water marigold	*Bidens beckii*	3
		White-water buttercup	*Ranunculus aquatilis*	2
		Greater bladderwort	*Utricularia vulgaris*	1
	Small-leaf rooted plants	Southern naiad	*Najas guadalupensis*	29
		Canada waterweed	*Elodea canadensis*	8
		Bushy pondweed	*Najas flexilis*	2
	Narrow-leaf pondweeds	Narrow-leaf pondweed group[a]	*Potamogeton friesii*	17
			Potamogeton pusillus	
		Sago pondweed	*Stuckenia pectinata*	2
	Broad-leaf pondweeds	White-stem pondweed	*Potamogeton praelongus*	20
		Illinois pondweed	*Potamogeton illinoensis*	4
		Variable pondweed	*Potamogeton gramineus*	3
		Clasping-leaf pondweed	*Potamogeton richardsonii*	2
		Large-leaf pondweed	*Potamogeton amplifolius*	1
		Curly-leaf pondweed (I)	*Potamogeton crispus*	1
	Grass-leaf rooted plants	Flat-stem pondweed	*Potamogeton zosteriformis*	19
		Wild celery	*Vallisneria americana*	13
		Robbins pondweed	*Potamogeton robbinsii*	6
		Water star-grass	*Heteranthera dubia*	2
Free-floating		Star duckweed**	*Lemna trisulca*	1
FLOATING-LEAVED		White waterlily	*Nymphaea odorata*	<1
		Watershield	*Brasenia schreberi*	<1
		Floating smartweed	*Persicaria amphibia*	*Present
		Floating-leaf pondweed	*Potamogeton natans*	*Present
EMERGENT (includes only in-lake emergents and not wetland plants)		Needlegrass	*Eleocharis acicularis*	1
		Bulrush	*Schoenoplectus* sp.	<1
		Broad-leaf cattail	*Typha latifolia*	<1
		Giant burreed	*Sparganium eurycarpum*	*Present
		Arum-leaved arrowhead	*Sagittaria cuneata*	*Present
		Broad-leaf arrowhead	*Sagittaria latifolia*	*Present
		Narrow-leaf cattail	*Typha* sp.[b]	*Present

*Present = Occurred infrequently throughout the lake I = introduced species
**Star duckweed = is a free-floating plant that often accumulates on the lake bottom
[a] Species in this genus were grouped together for analysis because field identification to the species level was difficult. At least two species of narrow-leaf pondweeds were identified in the lake: Fries pondweed (*Potamogeton friesii*) and small pondweed (*Potamogeton pusillus*). Additional narrow-leaf pondweed species (*Potamogeton* spp.) may have also been present.
[b] narrow leaf cattail was identified in the survey but it is not known whether this included *Typha angustifolia* and/or *Typha* x *glauca*.

Figure 7. Distribution of aquatic plants, Cross Lake 2010

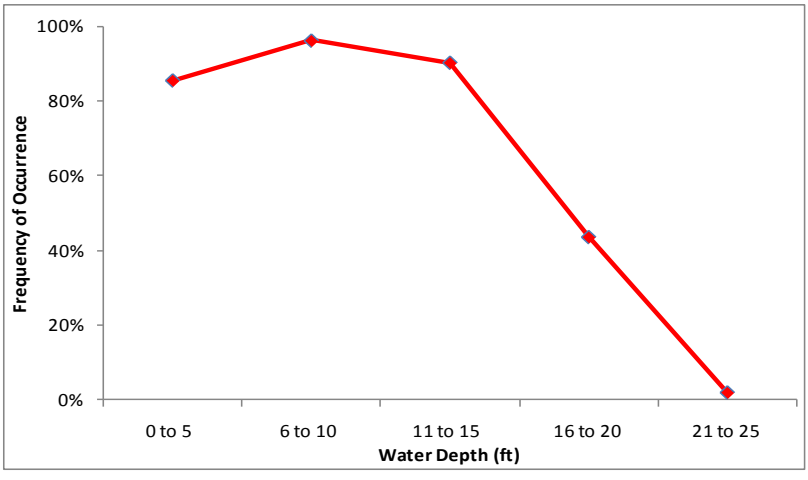


Distribution of aquatic plants

Plants were distributed around the entire perimeter of the lake, but were more frequent in the shallow southern bay (Figure 7). On the north shores, where the depth contours are close together, only a narrow band of vegetation occurred.

Plants were found to a depth of 21 feet in Cross Lake and in the 0-25 feet depth zone, 83% of the survey sites contained vegetation. Vegetation was most common in the 0 to 15 feet depth zone, where 91% of sites contained plants (Figure 8). In water depths of 21 to 25 feet, only 2% of sites contained plants.

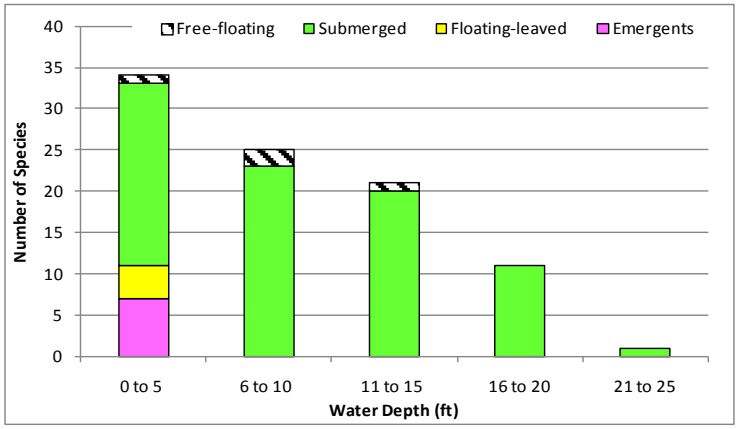
Figure 8. Aquatic plant frequency vs. water depth.



Plant community richness

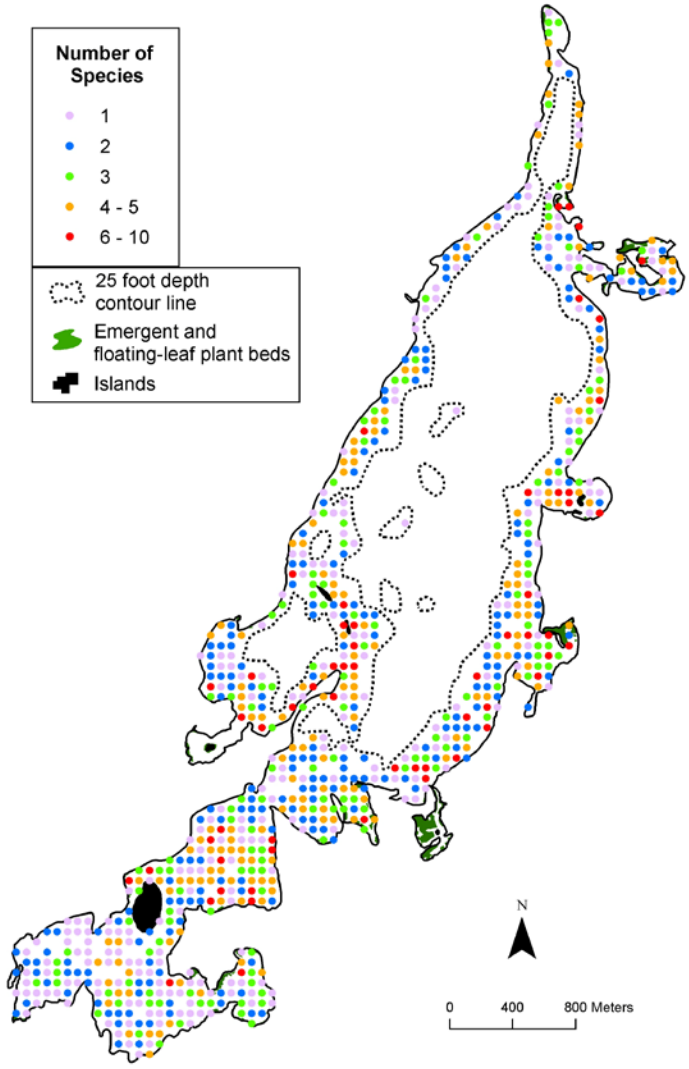
The highest number of plant species was found in shallow water, from shore to a depth of 5 feet (Figure 9). Emergent plants were restricted to water depths of 5 feet and less and floating-leaved plants were most common to a depth of 5 feet. Submerged rooted plants were found to a maximum depth of 21 feet but only one species (coontail) occurred in depths greater than 20 feet.

Figure 9. Number of plant species vs. water depth. Cross Lake, 2010.



The number of plant species found at each one square meter sample site ranged from 0 to 10 with a mean of 2 species per site (Figure 10). Most vegetated sites (55%) contained only 1 or 2 species. Sites with the highest plant richness (5 or more species per site) were often in water depths of 7 to 12 feet.

Figure 10. Number of species per site, Cross Lake 2010.

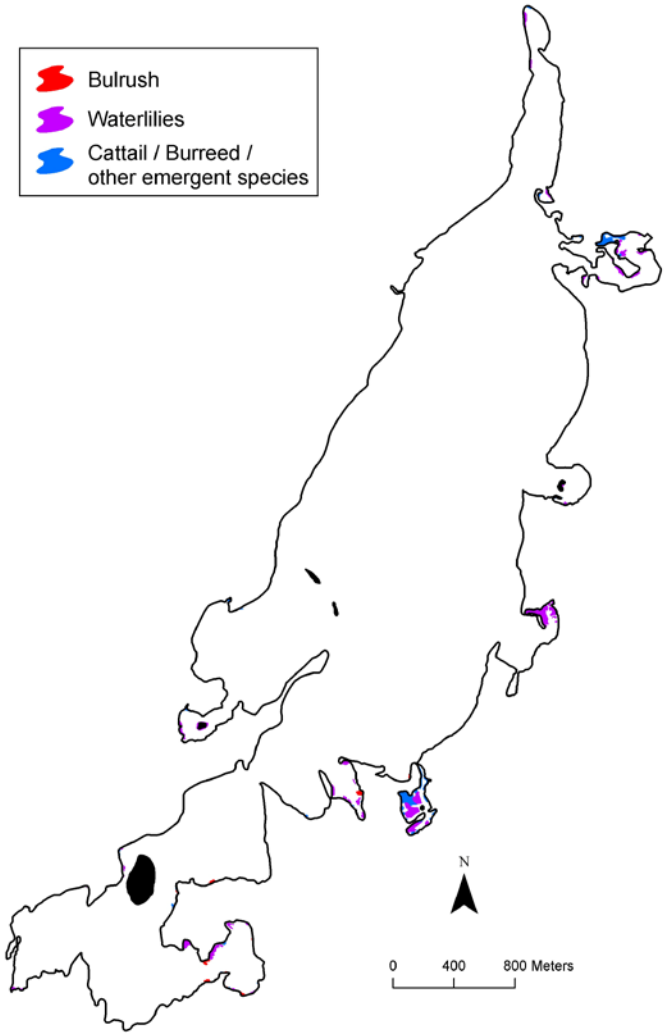


Emergent and Floating-leaf Plant Beds

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.

Approximately 16 acres of emergent and floating-leaf plant beds were mapped in Cross Lake. Emergent and floating-leaf plants were restricted to the 0-5 feet depth zone and within that area, 7% of the Cross Lake sites contained at least one emergent or floating-leaf plant. Plant beds were classified by the dominant species (Figure 11).

Figure 11. Emergent & floating-leaf plant beds, Cross Lake 2010.



Emergent plants included plants with broad grass-like leaves such as cattails (*Typha* sp.) and burreed (*Sparganium*). These emergent plants often occur in wet transitional zones between land and water (Figure 12). In Cross Lake, areas of mixed cattail-burreed stands were found in shallow areas of some of the protected bays and occupied about 4 acres.

Figure 12. Cattails and other emergents along Cross Lake shoreline.

Other emergent plants such as bulrush (*Schoenoplectus* sp.) may extend further into the lake than some of the wetland emergent plants. Bulrush (Figure 13) is an emergent, perennial plant that is rooted in the lake bottom with narrow stems that may extend several feet above the water. In addition to providing valuable fish and wildlife habitat, the extensive root network of these plants help to stabilize sandy shorelines. In shallow water, they may spread by underground rhizomes but these plants are particularly susceptible to destruction by direct cutting by humans, motorboat activity and excess herbivory. Restoration of bulrush beds can

be very difficult, making established beds particularly unique and valuable. In Cross Lake, a few narrow beds of bulrush were mapped and covered an area of about 1.5 acres (Figure 11).

Figure 13. Bulrush

Waterlily beds covered about 11 acres in Cross Lake and primarily occurred along the eastern shores (Figure 11). These beds included white waterlily (*Nymphaea odorata*; Figure 14), watershield (*Brasenia schreberi*; Figure 15), floating smartweed (*Persicaria amphibia*; Figure 16) and floating-leaf pondweed (*Potamogeton natans*) and often contained scattered bulrush and submerged plants.

Figure 14. White waterlily

Figure 15. Watershield

Figure 16. Floating smartweed

Common submerged plants

Submerged plants that occurred in at least 20% of the sample sites were muskgrass, coontail, northern watermilfoil, southern naiad and white-stem pondweed (Table 3). These species occurred with a lakewide distribution (Figure 17) and were each found at all water depths from shore to 20 feet (Figure 18).

Figure 17. Distribution of commonly occurring submerged plants in Cross Lake, 2010.

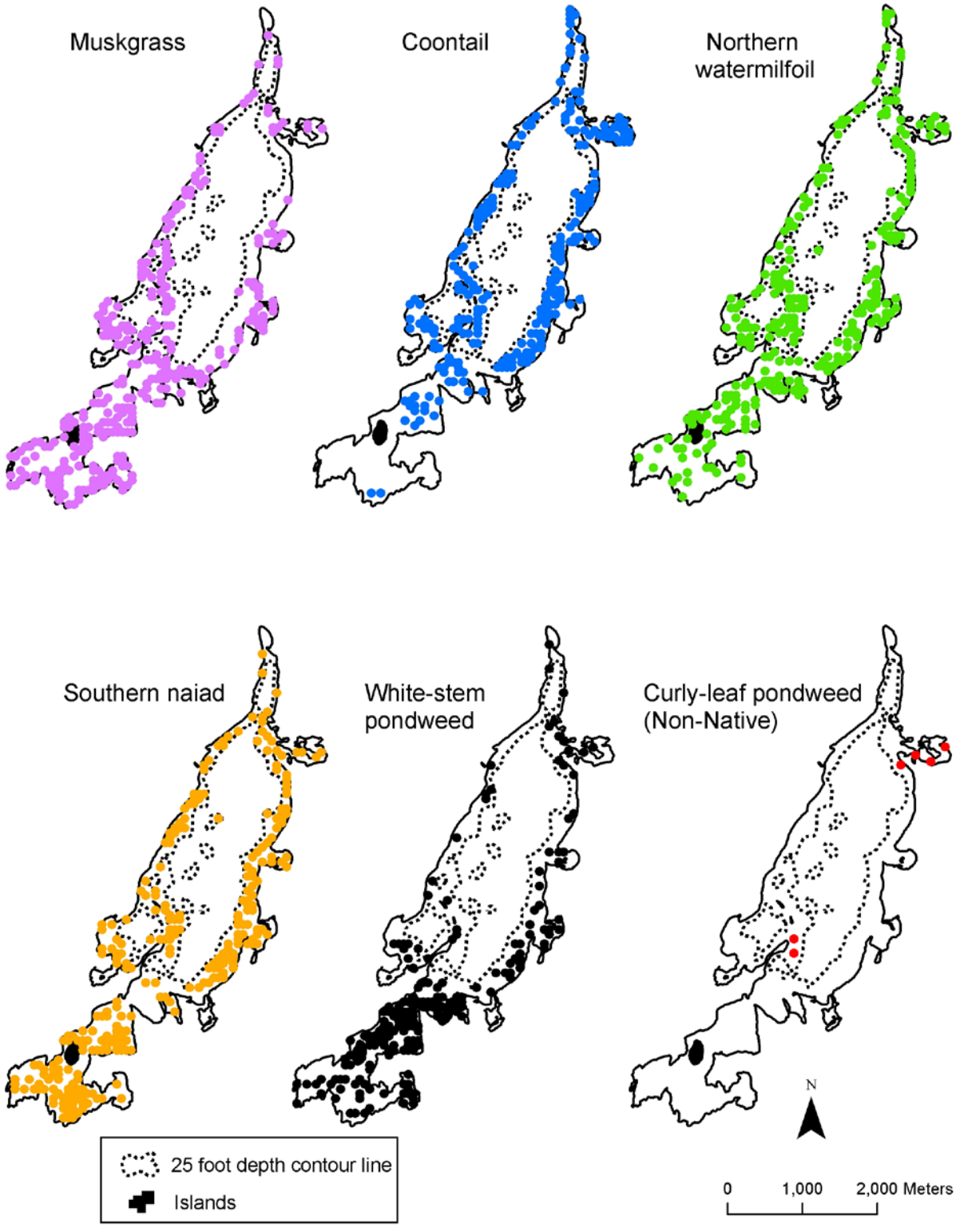
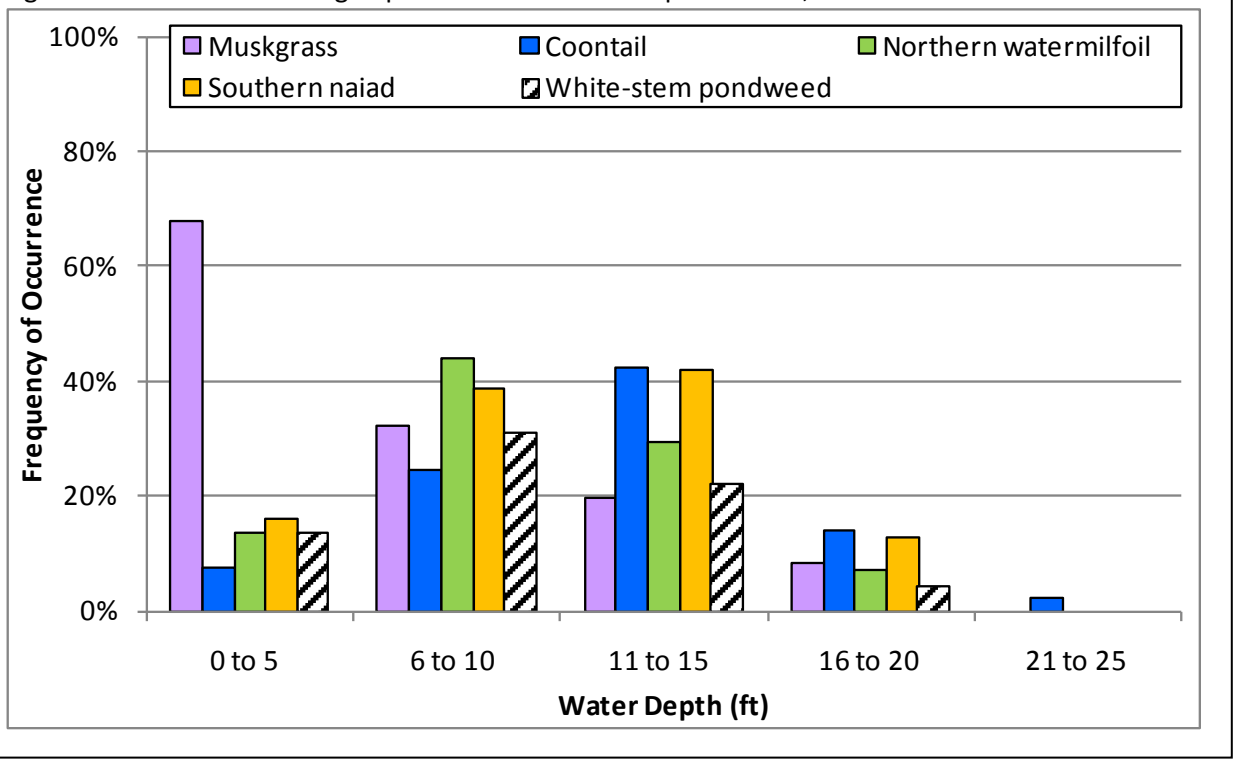


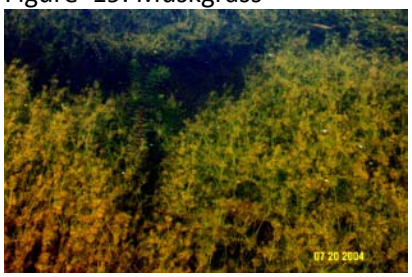
Figure 18. Common submerged plants at each water depth interval, Cross Lake 2010.



Submerged native macroalgae

Algae are primitive forms of plants that do not form true roots, flowers or vascular tissue. They range in size from single cell to giant seaweed. Freshwater algae that live in Minnesota lakes include tiny, free-floating planktonic algae, filamentous algae, and macroalgae. Macroalgae often resemble rooted plants and provide similar habitat and water quality benefits and were therefore included in this survey.

Figure 19. Muskgrass



Muskgrass (*Chara* sp.; Figure 19) is a freshwater macroalgae 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 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 fish spawning and nesting habitat.

In Cross Lake, muskgrass was the most frequently occurring plant with a frequency of 32% (Table 3). It occurred in depths from 1 to 17 feet and was the dominant plant in the 0 to 5 feet depth zone where it was found in 68% of the sites (Figure 18).

Submerged native rooted plants

As a group, rooted submerged plants occurred in 73% of the Cross Lake sample sites and often co-occurred with muskgrass (Figure 17)

Figure 20. Coontail

Coontail (*Ceratophyllum demersum*; Figure 20) 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.

Coontail was found in 25% of the sample sites in Cross Lake and was common at most vegetated areas except the southern bay (Figure 17). It was found from 1 to 21 feet and was the only species found in depths greater than 20 feet. Coontail was most common in the 11 to 15 feet depth zone where it occurred in 42% of the sites (Table 3; Figure 18).

Figure 21. Northern watermilfoil

Photo by John Maunder

Northern watermilfoil (*Myriophyllum sibiricum*; Figure 21) is a native, submerged plant. It is a rooted perennial with finely dissected leaves. Particularly in depths less than 10 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.

Figure 22. Southern naiad. Photo: Kerry Dressler ©1996 Univ. of Florida Center for Aquatic Plants

Northern watermilfoil occurred throughout the littoral zone of Cross Lake and was found in 27% of the sites (Table 3; Figure 18). It was most frequent in depths of 6 to 15 feet, where it occurred in 36% of the sites.

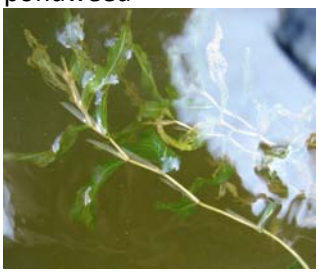
Southern naiad (*Najas guadalupensis*; Figure 22) has not been reported in many Minnesota lakes but it is native to the state. It closely resembles a related submerged species, bushy pondweed (*Najas flexilis*) and it can be difficult to distinguish the two species. Bushy pondweed is an annual plant that regrows each year from seed. Southern naiad can grow from seed and as a perennial plant. Both species grows low in the water column and produce seeds and foliage that provide important duck food and good fish cover.

Both plants occurred in Cross Lake but southern naiad was more frequent, occurring in 29% of the sample sites compared to 2% occurrence of bushy pondweed (Table 3). Southern naiad was frequently found throughout the littoral zone (Figure 17). It was most common in the 10 to 15 feet depth zone where it was found in 40% of the sites (Figure 18).

There are over 20 native species of pondweed (*Potamogeton*) in Minnesota and nine were found in Cross Lake. 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).

White-stem pondweed (*Potamogeton praelongus*; Figure 24) was the most common pondweed (*Potamogeton*) present in Cross Lake. This is broadleaf plant that is sometimes called "cabbage" by anglers. This species is not tolerant of turbidity (Nichols, 1999) and is often one of the first species to decline if water clarity declines. White-stem pondweed was found in 20% of the Cross Lake sites (Table 3; Figure 18) and was most common in depths less than 15 feet. White-stem pondweed was most frequent in the southern half of Cross Lake (Figure 17).

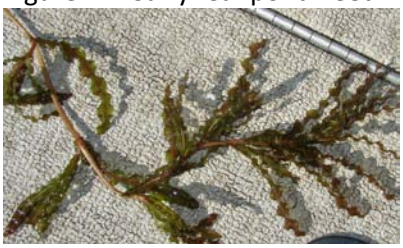
Figure 23. White-stem pondweed



Non-native submerged plant

Curly-leaf pondweed (*Potamogeton crispus*; Figure 24) is a non-native, submerged plant that has been present in Minnesota since at least 1910 (Moyle and Hotchkiss 1945) and is now found in more than 750 Minnesota lakes (Invasive Species Program, 2010). This plant has been present in the Whitefish chain since at least the early 1940's (DNR Fisheries lake files). It is not known when it first entered Cross Lake because most previous vegetation surveys have been conducted in July and August, after this plant has naturally died back.

Figure 24. Curly-leaf pondweed



Like many submerged plants, it is perennial but it 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).

Curly-leaf pondweed is closely related to the native pondweeds and its foliage does provide fish and wildlife habitat. 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.

Curly-leaf pondweed was found in 1% of the Cross Lake survey sites and remains a minor component of the plant community (Table 3). It was found at sites in the channel between Cross Lake and Daggett Lake (Figure 17).

Change in aquatic plant communities

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. 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 collected in 2010 can be used to monitor finer-scale changes that may occur, such as an increase in a particular species or a change in the depths at which individual species occur. 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 Cross Lake increases, submerged vegetation may be more common at depths greater than 20 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.

- 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 Cross 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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Appendix 1. Historical aquatic and wetland plants of Cross Lake

Submerged plants

Common Name	Scientific Name	1942	1950	1990	2010
Water marigold	*Bidens beckii*				X
Coontail	*Ceratophyllum demersum*	X	X	X	X
Muskgrass	*Chara* sp.		X	X	X
Canada waterweed	*Elodea canadensis*	X	X	X	X
Water star-grass	*Heteranthera dubia*				X
Northern watermilfoil	*Myriophyllum sibiricum*	X		X	X
Bushy pondweed	*Najas flexilis*			X	X
Southern naiad	*Najas guadalupensis*				X
Stonewort	*Nitella* sp.				X
Large-leaf pondweed	*Potamogeton amplifolius*			X	X
Curly-leaf pondweed (I)	*Potamogeton crispus*				X
Fries' pondweed	*Potamogeton friesii*				X
Variable pondweed	*Potamogeton gramineus*		X		X
Illinois pondweed	*Potamogeton illinoensis*				X
White-stem pondweed	*Potamogeton praelongus*				X
Small pondweed	*Potamogeton pusillus*				X
Clasping leaf pondweed	*Potamogeton richardsonii*			X	X
Robbin's pondweed	*Potamogeton robbinsii*			X	X
Flat-stem pondweed	*Potamogeton zosteriformis*	X		X	X
White water buttercup	*Ranunculus aquatilis*				X
Sago pondweed	*Stuckenia pectinata*				X
Greater bladderwort	*Utricularia vulgaris*				X
Wild celery	*Vallisneria americana*			X	X
Watermoss	*Not identified to genus*				X
	Total	4	4	10	24
	Max depth (feet)	n/a	n/a	18	21

Floating-leaved plants

Common Name	Scientific Name	1942	1950	1990	2010
Floating leaf pondweed	*Potamogeton natans*	X			X
White waterlily	*Nymphaea odorata*			X	X
Watershield	*Brasenia schreberi*				X
Floating smartweed	*Persicaria amphibia*				X
	Total	1	0	1	4

Free-floating plants

Common Name	Scientific Name	1942	1950	1990	2010
Star duckweed	*Lemna trisulca*				X
	Total	0	0	0	1

Emergent plants

Common Name	Scientific Name	1942	1950	1990	2010
Needlerush	*Eleocharis acicularis*			X	X
Giant cane	*Phragmites australis*			X	
Arum-leaved arrowhead	*Sagittaria cuneata*			X	X
Broad-leaf arrowhead	*Sagittaria latifolia*				X
Bulrush	*Schoenoplectus* sp.				X
Giant burreed	*Sparganium eurycarpum*				X
Broad-leaved cattail	*Typha latifolia*			X	X
Narrow-leaved cattail	*Typha* sp[a]				X
	Total	0	0	4	7

Wetland emergent plants

Common Name	Scientific Name	1942	1950	1990	2010
Swamp milkweed	*Asclepias incarnata*			X	
Blue flag iris	*Iris versicolor*			X	X
Purple loosestrife (I)	*Lythrum salicaria*				X
Reed canary grasss (I)	*Phalaris arundinaceae*				X
Smartweed	*Polygonum ramosissimum*			X	
	Total	0	0	3	3

I = introduced

[a] narrow leaf cattail was identified in the survey but it is not known whether this included *Typha angustifolia* and/or *Typha* x *glauca*.

Sources:

1942 (September 20): Robert Sharp, DNR Fisheries Survey

1950 (June, 13-15): Thomas Bonde, DNR Fisheries Survey

1990 (July, 23-27): Wayne Mueller, DNR Fisheries Survey

2010 (June, July): Simon, Perleberg, Van Dyne, Whichello, Point Intercept survey, MnDNR Division of Ecological and Water Resources