Aquatic Vegetation of
Upper Mission Lake (DOW 18-0242-00)
and Lower Mission Lake (DOW 18-0243-00)
Crow Wing County, Minnesota

May 17, 19, 23, 26 and June 1, 2005

Lower Mission Lake (18-0243-00), May 23, 2005

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Summary

Upper and Lower Mission Lakes are connected basins that differ in factors such as size, depth, water clarity and shoreland development. Water clarity in Upper Mission Lake is higher than Lower Mission and both lakes are described as mesotrophic. Native submerged vegetation is abundant in both lakes and occurs to a depth of 18 feet in Upper Mission and 16 feet in Lower Mission. Plants are most common in depths less than 15 feet in both lakes. Within the zone from shore to a depth of 20 feet, 75 percent of the sites in Upper Mission Lake and 72 percent of the sites in Lower Mission Lake contained vegetation. Native vegetation occurred in 64 percent of the Upper Mission sites compared to 46 percent of the Lower Mission sites. A total of 23 native plant species were recorded. Common native species included muskgrass (*Chara* sp.), coontail (*Ceratophyllum demersum*), flat-stem pondweed (*Potamogeton zosteriformis*), white-stem pondweed (*Potamogeton praelongus*), northern watermilfoil (*Myriophyllum sibiricum*) and star duckweed (*Lemna trisulca*).

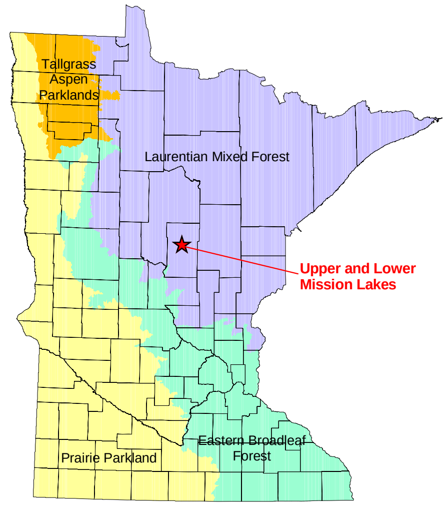
The non-native species, curly-leaf pondweed (*Potamogeton crispus*) occurred in 10 percent of the Upper Mission Lake sites and in 26 percent of the Lower Mission Lake sites, but it was not the most abundant species in either lake. In Upper Mission it dominated in the zone from 11 to 15 feet deep while in Lower Mission it was the most common species in the zone from six to 15 feet deep. In both lakes, curly-leaf was uncommon in depths less than six feet (Fig 11).

Lower Mission Lake (18-0243-00), May 23, 2005

Introduction

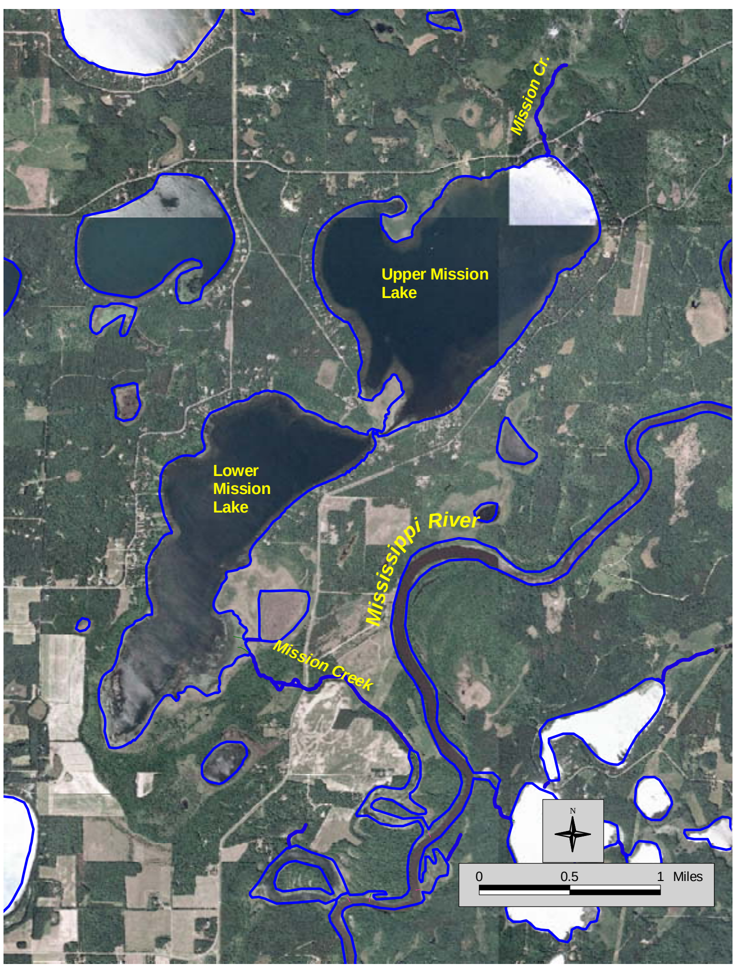
Upper Mission Lake (DOW 18-0242-00) and Lower Mission Lake (DOW 18-0243-00) are located about 14 miles northeast of the city of Brainerd in Crow Wing County, Minnesota. The lakes occur within the ecological region called the Laurentian Mixed Forest Province, the true forested region of the state (Fig. 1).

Figure 1. Upper Mission (18024200) and Lower Mission (18024300) Lakes, Crow Wing Co, MN.



The lakes lay in the north central portion of the Mississippi River – Brainerd Watershed about one mile to the northwest of the Mississippi River. Mission Creek enters Upper Mission Lake and flow continues into Lower Mission Lake and then into the Mississippi River (Fig. 2). Uplands surrounding the lakes include a mix of forest, wetlands, agricultural and residential development (Fig. 2). Both lakes are developed with residential homes. A public access occurs on the north end of Upper Mission Lake and on the west side of Lower Mission Lake(Fig. 3). Access between the two lakes is available through a channel.

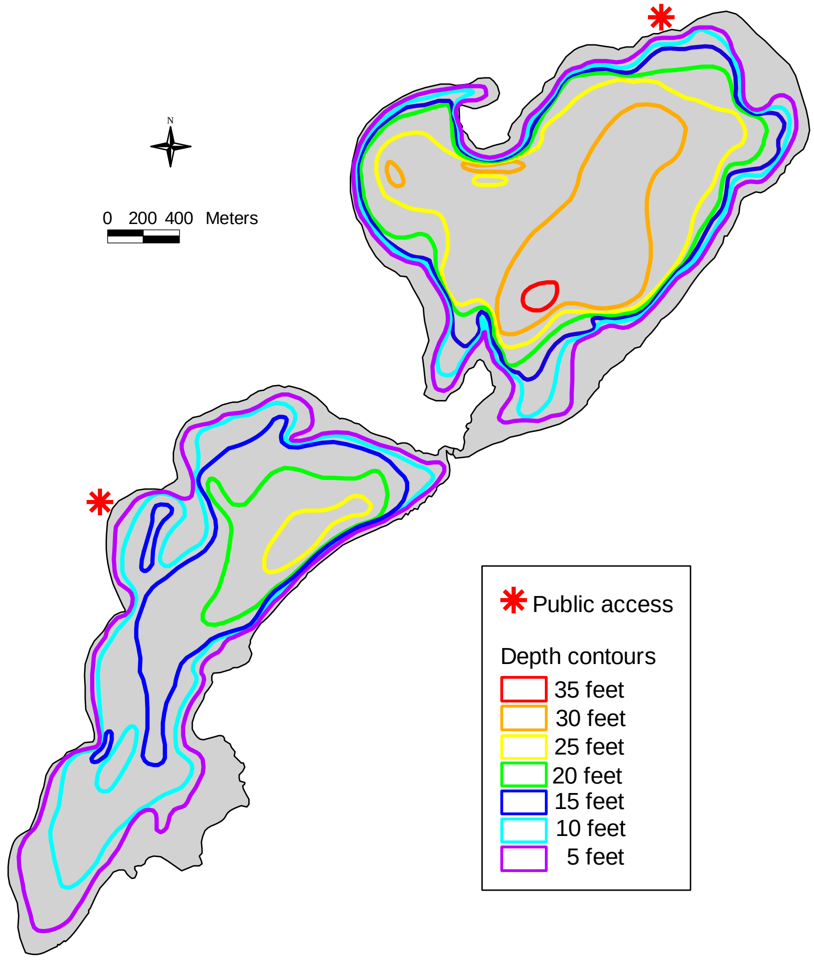
Figure 2. Water flow through Upper and Lower Mission Lakes into the Mississippi River.



Upper and Lower Mission Lakes are connected but act as separate basins. Upper Mission is larger in surface area (817 acres) than and Lower Mission (698 acres). Upper Mission is also deeper with a maximum depth of 36 feet and about 31 percent of the basin is less than 15 feet in depth (Fig. 3). Lower Mission has a maximum depth of 27 feet and about 65 percent, including the entire south half of the lake, is less than 15 feet deep (Fig. 3).

Both lakes are classified as mesotrophic, an intermediate category describing lakes with moderate nutrients, algae and

Figure 3. Depth contours of Upper Mission (18-042-00) and Lower Mission (18-0243-00) Lakes. Source: MnDNR 1969.



water clarity. A 1991 water quality study found that phosphorus levels in these lakes were higher than most other lakes in the region and concluded that the lake are sensitive to nutrient loadings from the watershed (Hodgson and Heiskary 1991). Between 1995 and 2004, water clarity was slightly higher in Upper Mission, with a mean summer Secchi disc reading of 9.8 feet compared to 8.6 feet in Lower Mission (MPCA 2005).

Historical surveys of these lakes describe abundant emergent and submerged aquatic plant communities. Emergent species included bulrush, cattail, wild rice, and giant cane. Floating leaf plants were yellow waterlily and floating-leaf pondweed. Submerged vegetation was described as abundant to a depth of seven or eight feet and well-distributed throughout the lake with a variety of native submerged plants speices present (MnDNR Fisheries Lake Files 1942).

The non-native submerged plant, curly-leaf pondweed (*Potamogeton crispus*) occurs in both Upper and Lower Mission Lakes. Within the Mississippi River – Brainerd Watershed, curly-leaf pondweed has been documented in at least 25% of the lakes that are 100 acres or more in size (Invasive Species Program 2004).

Vegetation Survey Objectives

The purpose of vegetation survey of Upper and Lower Mission Lakes was to describe the current aquatic plant community including:

1) Estimate the maximum depth of rooted vegetation
2) Estimate the percent of the lake occupied by rooted vegetation
3) Record the aquatic plant species that occur in the lake
4) Estimate frequencies of occurrence of individual species
5) Develop distribution maps for the common species

Methods

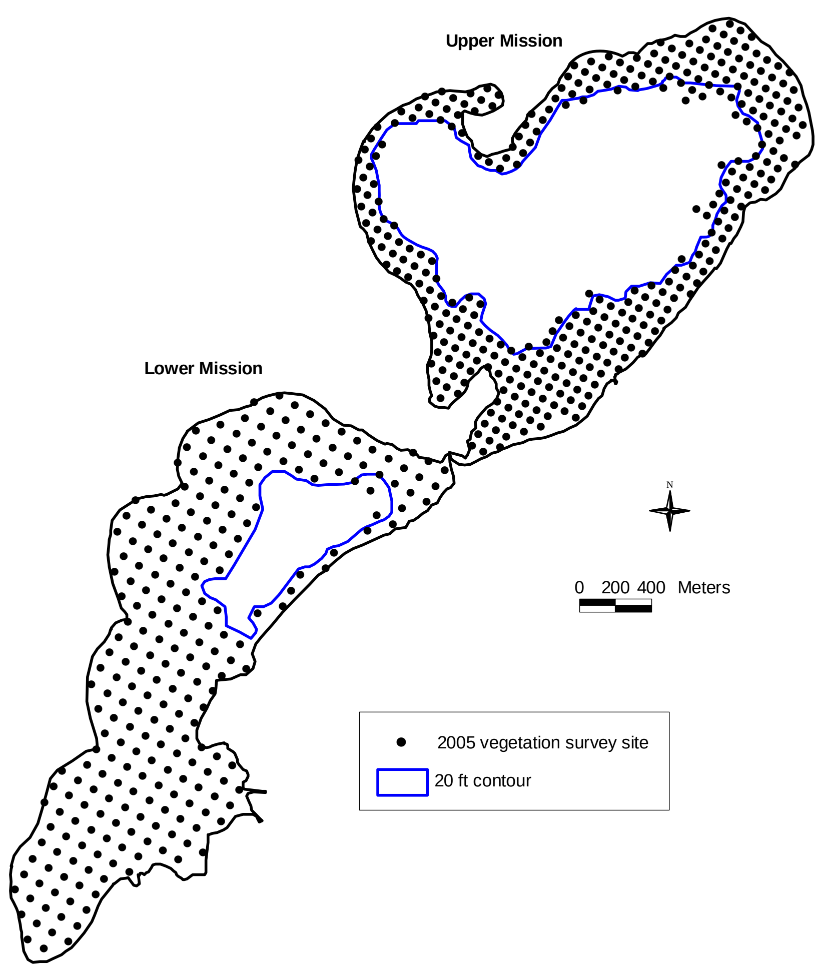
Aquatic Vegetation Survey Methods

A Point-Intercept vegetation survey of Upper Mission Lake was conducted on May 17, 19, 26 and June 1, 2005 and of Lower Mission Lake on May 23, 26 and June 1, 2005. The surveys followed the methods described by Madsen (1999).

Survey waypoints were created and downloaded into a Global Positioning System (GPS) receiver. To establish a minimum of 200 points within the vegetated zone of each lake, sample point spacing was different on each lake. Survey points were spaced 75 meters apart on Upper Mission Lake and 100 meters apart on Lower Mission. In the field, surveyors began sampling to a depth of 25 feet but found no vegetation beyond a depth of 18 feet. All survey points between shore and 20 feet were sampled for a total of 331 sample sites on Upper Mission Lake and 253 sample sites on Lower Mission Lake (Fig 4). Some sampling did occur at depths of 21 to 25 feet, but this zone was not extensively surveyed.

The GPS unit was used to navigate the boat to each sample point. One side of the boat was designated as the sampling area. At each site, water depth was recorded in one foot increments using a measured stick in water depths less than eight feet and an electronic depth finder in water depths greater than eight feet. The surveyors recorded all plant species found within a one meter squared sample site at the pre-designated side of the boat. A double-headed, weighted garden rake, attached to a rope was used to survey vegetation not visible from the surface (Fig. 5).

Figure 4. 2005 vegetation survey points on Upper Mission (18-0242-00) and Lower Mission (18-0243-00) Lakes.



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

Data were entered into a Microsoft Access database and frequency of occurrence was calculated for each species as the number of sites in which a species occurred divided by the total number of sample sites.

Example:
In Upper Mission Lake there were 331 samples sites in the zone from shore to the 20 feet depth. Coontail occurred in 87 of those sites.
Frequency of coontail in the shore to 20 ft zone of Upper Mission Lake = 87/331 (*100) = 26%

Figure 5. Rake used to sample vegetation

Frequency was calculated for the entire area from shore to 20 feet and sampling points were also grouped by water depth and separated into five depth zones for analysis: 0 to 5 feet, and 6 to 10 feet, 11 to 15 feet, 16 to 20 feet.

Results

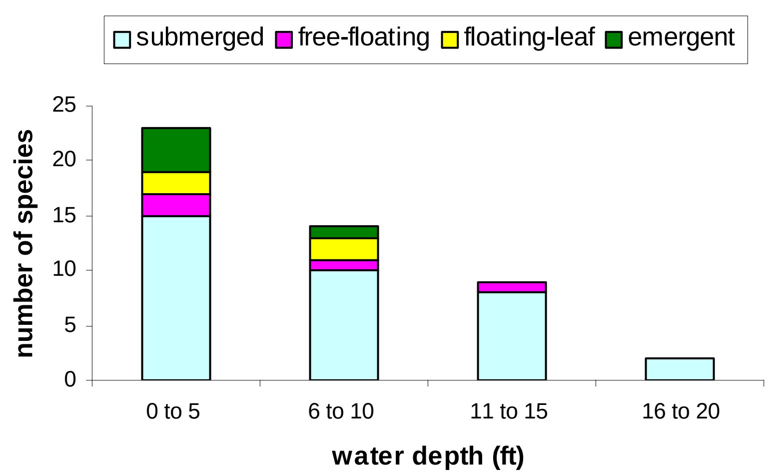
Number of species recorded

A total of 23 native aquatic plant species were recorded in Upper and Lower Mission Lakes including four emergent, two floating-leaved, two free-floating and 15 submerged species (Table 1). Curly-leaf pondweed, (*Potamogeton crispus*), a non-native, submerged aquatic plant species was documented in both lakes.

Occurrence of different plant life forms by water depth

The highest number of plant species was found in the zone from shore to a depth of five feet, where all but one species were found (Fig. 6).

Figure 6. Number and types of species found at each depth zone.
U. Mission (18024200) and L. Mission (18024300). May-June, 2005



Emergent and floating-leaved species were restricted to depths of six feet and less and free-floating species were found to a depth of 13 feet. Within the depth zone from shore to five feet, at least one floating-leaf or emergent species was present in 13 percent of the Upper Mission sites and in 33 percent of the Lower Mission sites. This survey was conducted before most

Table 1. Aquatic Plants of Upper Mission (18-0242-00) and Lower Mission (18-0243-00) Lakes (Crow Wing County). May 17, 19, 26, and June 1, 2005

Frequency calculated for zone from shore to 20 feet depth
Frequency = percent of sites in which species occurred

Life Form	Common Name	Scientific Name	U.pper Mission 331 samples Frequency	Lower Mission 253 samples
SUBMERGED-ANCHORED These plants grow primarily under the water surface. Upper leaves may float near the surface and flowers may extend above the surface. Plants are often rooted or anchored to the lake bottom.	Coontail	*Ceratophyllum demersum (v)*	26	30
	Muskgrass	*Chara sp.*	38	9
	Canada waterweed	*Elodea canadensis*	14	31
	Curly-leaf pondweed	*Potamogeton crispus (v)*	10	26
	Flat-stem pondweed	*Potamogeton zosteriformis (v)*	15	10
	Northern watermilfoil	*Myriophyllum sibiricum*	9	15
	Whitestem pondweed	*Potamogeton praelongus*	9	5
	Narrowleaf pondweed	*Potamogeton sp.*	2	5
	White water buttercup	*Ranunculus longirostris*	4	3
	Water stargrass	*Zosterella dubia*	1	3
	Greater bladderwort	*Utricularia vulgaris*	<1	2
	Illinois pondweed	*Potamogeton illinoensis*	1	---
	Stonewort	*Nitella sp.*	2	1
	Large-leaf pondweed	*Potamogeton amplifolius*	<1	---
	Clasping-leaf pondweed	*Potamogeton richardsonii (v)*	---	<1
	Sago pondweed	*Stuckenia pectinata (v)*	present	----
FREE-FLOATING These plants float on the water and drift with water currents.	Star duckweed	*Lemna trisulca*	4	27
	Water moss	*Not identified to species*	---	<1
FLOATING These plants are rooted in the lake bottom and have leaves that float on the water surface. Many have colorful flowers that extend above the water	Yellow waterlily	*Nuphar variegata*	2	4
	White waterlily	*Nymphaea odorata(v)*	--	5
EMERGENT These plants extend well above the water surface and are usually found in shallow water, near shore.	Wild Rice	*Zizania palustris (v)*	4	7
	Hardstem bulrush	*Scirpus acutus*	2	3
	Needlerush	*Eleocharis acicularis.*	1	1
	Giant Cane	*Phragmites australis*	--	<1

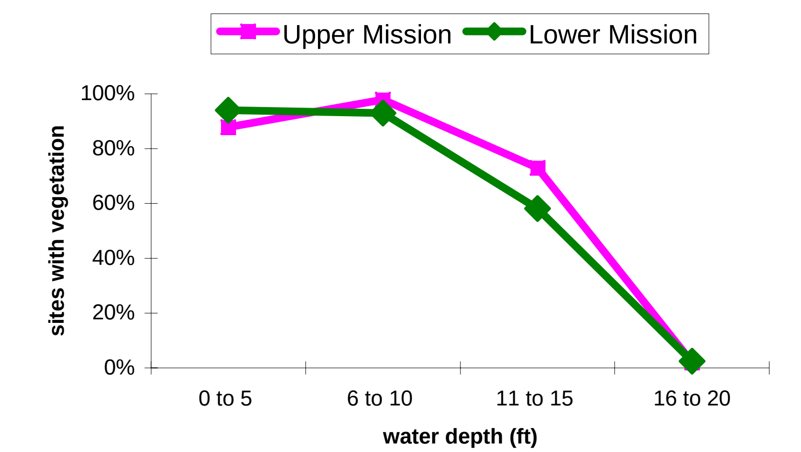
Present = species occurred in lake but not found within sample sites
V = voucher specimen collected
Highlite = non-native species

Figure 7. Early growth of floating-leaf and emergent vegetation in Lower Mission Lake (18-0243-00) May 23, 2005.

emergent and floating- leaf species reached maturity and frequency values from the spring 2005 survey likely underestimate the actual abundance of these species. Bulrush (*Scirpus acutus*), wild rice (*Zizania aquatica*), Yellow waterlily (*Nuphar variegata*) and White waterlily (*Nymphaea odorata*) were the most common species present but were not yet fully emerged (Fig. 7).

Submerged vegetation was found to a maximum depth of 18 feet in Upper Mission Lake and 16 feet in Lower Mission but in both lakes, vegetation was sparse beyond the 15 feet depth. Within the zone from shore to 20 feet, 75 percent of the Upper Mission Lake sites and 72 percent of the Lower Mission Lake sites contained vegetation. Vegetation was most abundant in the zone from shore to a depth of ten feet where 90 percent of the Upper Mission Lake sites and 94 percent of the Lower Mission Lake sites contained vegetation (Fig. 8). In depths greater than 15 feet, only two percent of the Upper Mission Lake sites and three percent of the Lower Mission Lake sites contained vegetation (Fig. 8) and only two species, curly-leaf pondweed and flat-stem pondweed, were found in depths greater than 15 feet.

Figure 8. Frequency of vegetation vs. water depth, U. Mission (18024200) and L. Mission (18024300). May-June, 2005



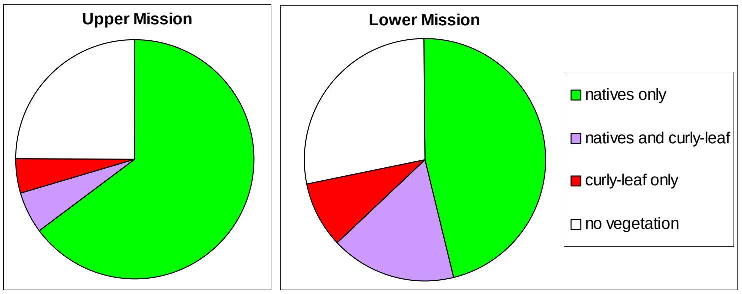
Distribution and abundance of native and non-native species

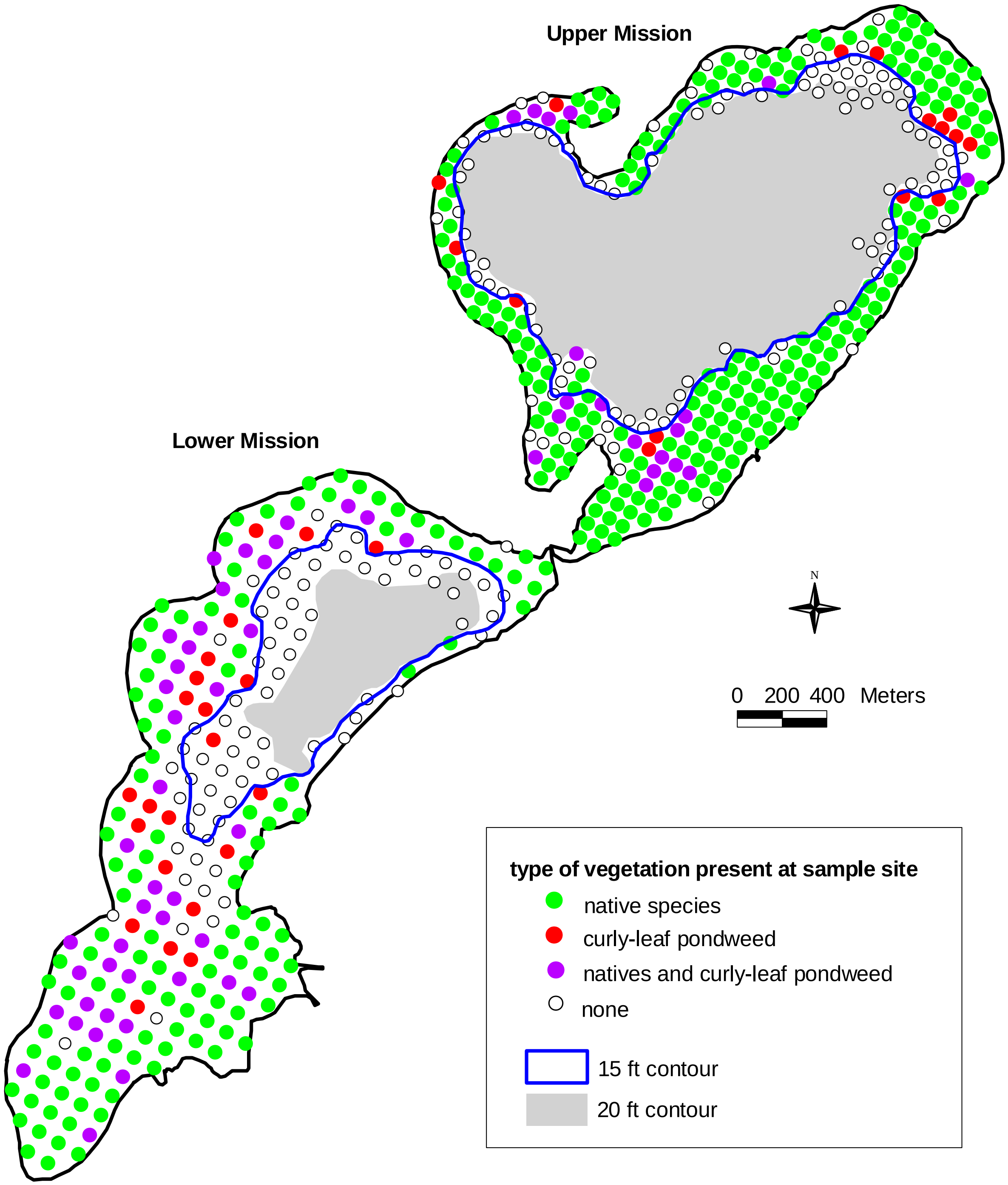
Native species were more abundant in both lakes than the non-native species, curly-leaf pondweed. In the zone from shore to the 20 feet depth, 70 percent of the Upper Mission Lake sites and 63 percent of the Lower Mission Lake sites contained native vegetation (Fig. 9). Upper Mission Lake had a higher percentage of sites (64 percent) where only natives occurred, compared to 46 percent in Lower Mission Lake (Fig. 9).

Common submerged and free-floating species

The most frequently occurring native species in these lakes included coontail (*Ceratophyllum demersum*), muskgrass (*Chara* sp.), Canada waterweed (*Elodea canadensis*), flat-stem pondweed

Figure 9. Types of vegetation found in Upper Mission (18024200) and Lower Mission (18024300) Lakes, May-June 2005





(*Potamogeton zosteriformis*), whitestem pondweed (*Potamogeton praelongus*), northern watermilfoil (*Myriophyllum sibiricum*) and star duckweed (*Lemna trisulca*). The non-native species, curly-leaf pondweed (*Potamogeton crispus*) was common in both lakes, but not the dominant species. Distributions and frequencies of these common species differed between the two lakes.

Muskgrass (*Chara* sp.) was the most frequent species in Upper Mission Lake, where it was found in 38 percent of the sample sites (Table 1). It dominated the shallow zone in that lake to a depth of five feet (Fig. 10). Muskgrass was a minor component of the Lower Mission Lake community, where it occurred in nine percent of the sample sites (Table 1). Muskgrass is a submerged, macroscopic algae that is common in many hardwater Minnesota lakes. It is named for its characteristic musky odor. Because this species does not form true stems, it is a low-growing plant, often found entirely beneath the water surface where it may form low “carpets” on the lake bottom. Muskgrass is adapted to variety of substrates and is often the first species to invade open areas of lake bottom where it can act as a sediment stabilizer. In Upper Mission Lake, muskgrass was found along the broad shallow areas of the east, west and north shore but in Lower Mission its distribution was patchy (Fig. 11).

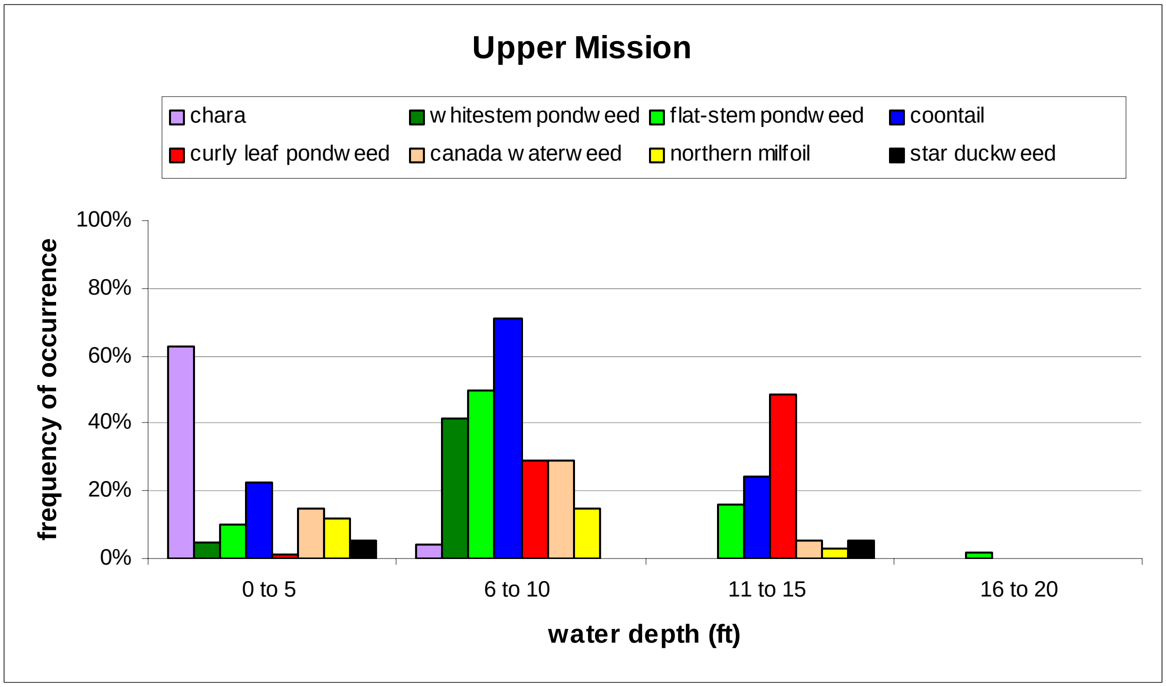
Coontail (*Ceratophyllum demersum*) was common in both lakes, occurring with a frequency of 26 percent in Upper Mission and 31 percent in Lower Mission (Table 1). Coontail is the most common submerged flowering plant in the state. This perennial grows entirely submerged and is adapted to a broad range of lake conditions, including turbid water. It is often found growing in deeper water than other native species because it is more tolerant of low light conditions. In Upper Mission, coontail dominated the zone from six to 10 feet and in Lower Mission it was among the most common species in both the shore to five feet and six to 10 feet zones (Fig. 10). Coontail was concentrated at the north and south ends of Upper Mission Lake and it was more evenly distributed in Lower Mission (Fig. 11).

Canada waterweed (*Elodea canadenis*) was twice as abundant in Lower Mission Lake (31 percent frequency) than in Upper Mission (14 percent). This submerged perennial prefers soft substrates and is tolerant of turbidity. In both lakes, it reached its maximum abundance in the depth zone of six to 10 feet, but in Lower Mission it was also common in shallower depths (Fig. 10). It occurred in numerous locations and often co-occurred with coontail (Fig. 11).

Flat-stem pondweed (*Potamogeton zosteriformis*) and white-stem pondweed (*Potamogeton praelongus*) were both more frequent in Upper Mission Lake than in Lower Mission (Table 1). Both pondweeds occur as submerged plants and are perennial. These species are closely related and neither is tolerant of turbidity. Flat-stem had a frequency of 15 percent in Upper Mission and 10 percent in Lower Mission. White-stem occurred with a frequency of nine percent in Upper Mission and five percent in Lower Mission. In Upper Mission, both pondweeds occurred in at least 40 percent of the sites in the six to ten feet depth, which was more than twice their abundance in Lower Mission Lake at that depth zone (Fig. 10 and Fig. 11).

Northern watermilfoil (*Myriophyllum sibiricum*) had a higher occurrence in Lower Mission Lake (15 percent frequency) than in Upper Mission (nine percent frequency) (Table 1) and in both lakes it was most often found in depths less than 11 feet (Fig. 10). This perennial submerged

Figure 10. Frequency of common aquatic plant species vs. water depth.
U. Mission (18-0242-00) and L. Mission (18-0243-00) Lakes, May-June 2005



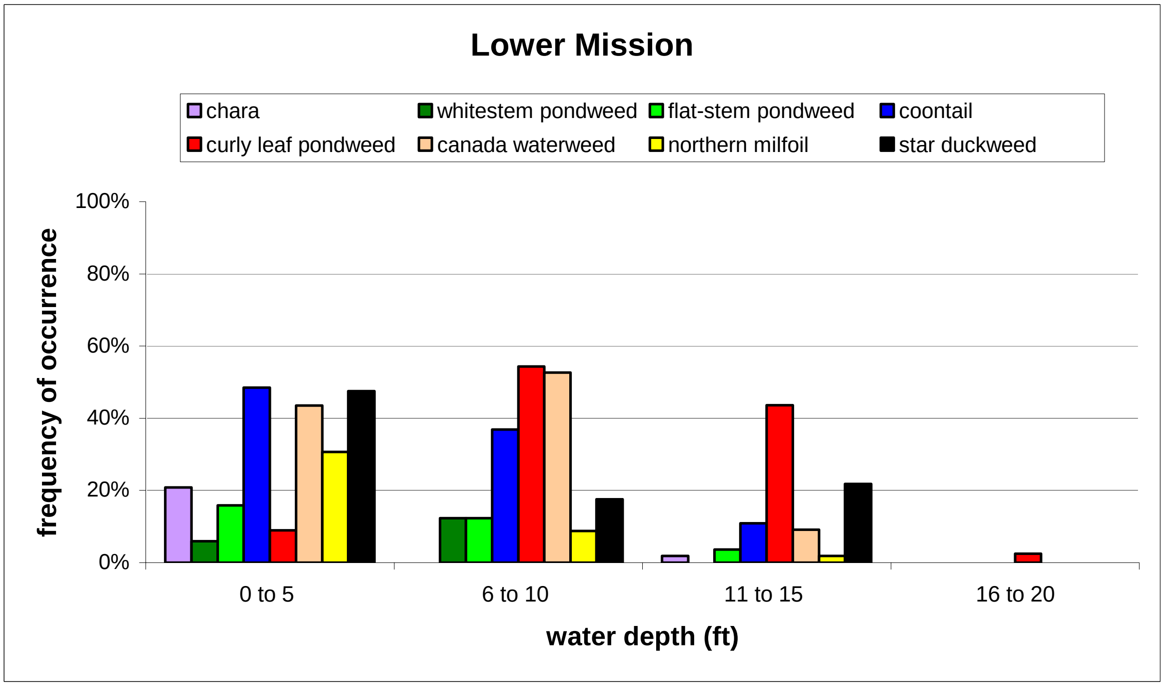
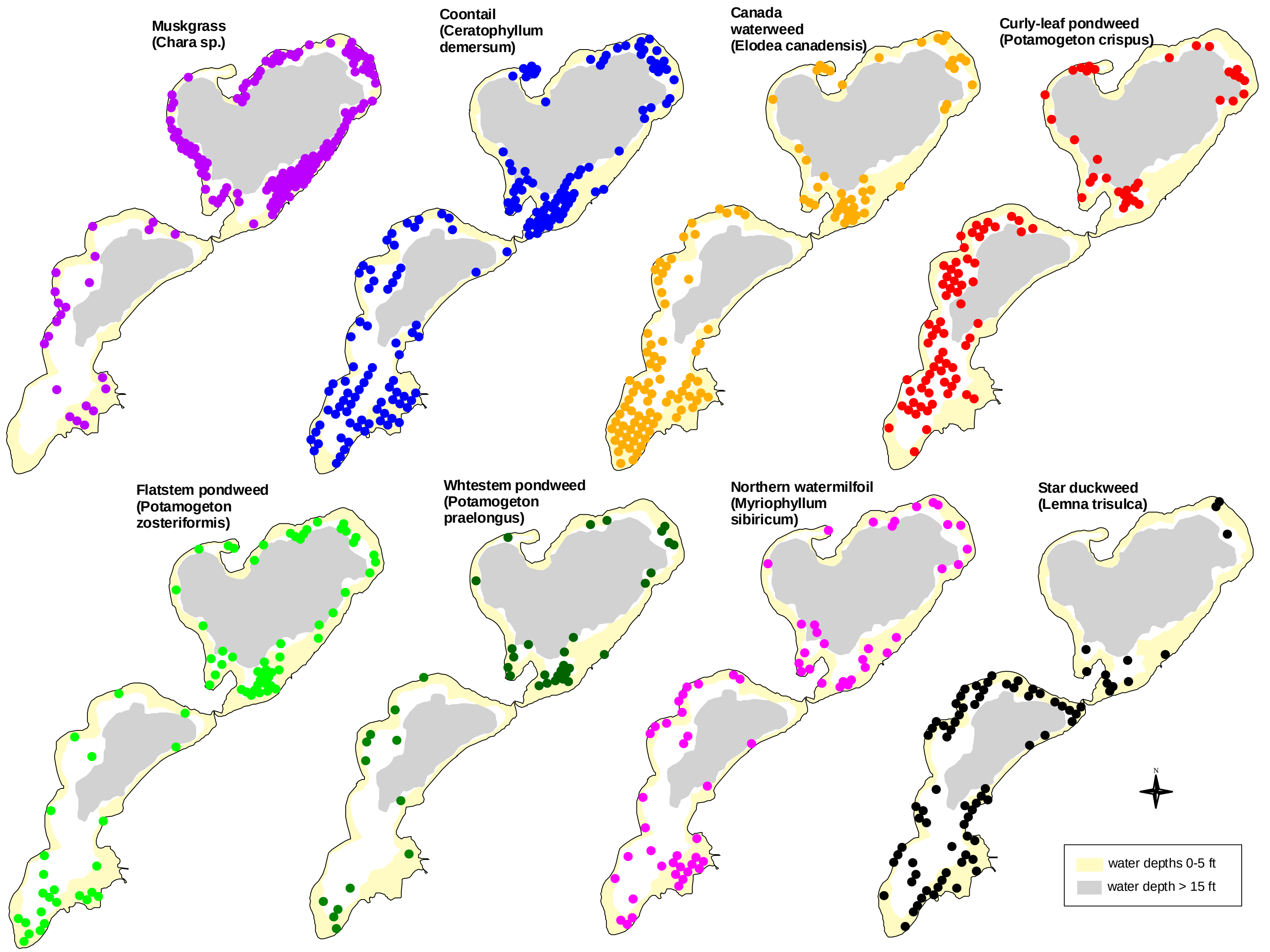


Figure 11. Distribution of common plant species in Upper Mission (18-0242-00) and Lower Mission (18-0243-00) Lakes, May-June, 2005



species prefers soft substrates and is not tolerant of turbidity. Its distribution was widespread in both lakes and it was often found co-occuring with other native species including coontail, flat-stem pondweed and Canada waterweed (Fig. 11).

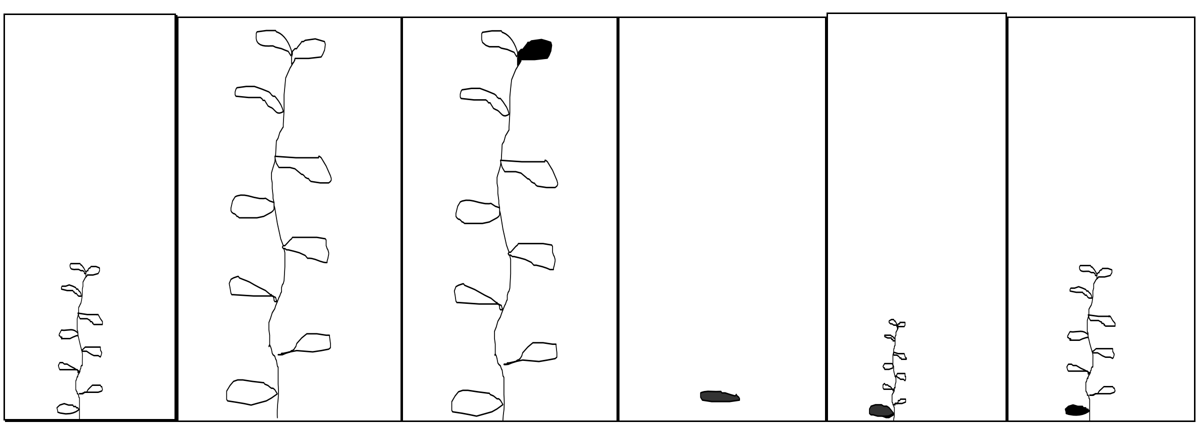
Star duckweed (*Lemna trisulca*) was not an important part of the Upper Mission Lake plant community but occurred in 27 percent of the Lower Mission sites (Table 1). This free-floating species can drift with water currents and is often found submerged but not anchored to the lake bottom. Star duckweed was common in shallow water as well as depths greater than ten feet in Lower Mission (Fig. 10). It was well distributed throughout Lower Mission Lake but was infrequent in Upper Mission (Fig. 11).

All other native species were present in less than eight percent of the sample sites (Table 1)

Curly-leaf pondweed (*Potamogeton crispus*) was not the most abundant species in either Upper or Lower Mission, but it was among the top five most frequent species in each lake (Table 1). It was found in 10 percent of the Upper Mission Lake sites and in 26 percent of the Lower Mission Lake sites (Table 1). In Upper Mission it dominated in the zone from 11 to 15 feet deep while in Lower Mission it was the most common species in the zone from six to 15 feet deep (Fig. 10). In both lakes, curly-leaf was uncommon in depths less than six feet (Fig 11).

Curly-leaf pondweed 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 at least 700 Minnesota lakes (Invasive Species Program 2005). Like many native 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 (Fig. 12). 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

Figure 12. Life cycle of Curly-leaf pondweed (*Potamogeton crispus*).



Winter	**Spring**	**Late Spring**	**Summer**	**Fall**	**Winter**
Plants continue Growing Under ice	Plants reach maximum growth	Plants die back and form turions	Turions remain dormant	Turions germinate	New plants sprout from turions

structures called "turions" which are hardened stem tips that break off and fall to the substrate (Fig. 13). Turions remain dormant through the summer and germinate into new plants in early fall (Catling and Dobson, 1985). During its peak growth in spring, curly-leaf may reach the water surface at certain depths and create dense mats.

In Upper and Lower Mission Lakes, curly-leaf had not yet formed surface mats at the time of the spring 2005 survey.

Figure 13. Turions forming at tips of curly-leaf plants in Lower Mission Lake (18-0243-00), May 23, 2005

Discussion

The native plant communities of Upper and Lower Mission Lakes include a diversity of native species that are also common in many other central Minnesota lakes. Native vegetation provides critical habitat for fish and invertebrates, buffers the shorelines from wave action, and stabilizes sediments and utilizes nutrients that would otherwise be available for algae. (Click here for more information on: value of aquatic plants).

Higher mid-summer water clarity in Upper Mission Lake allows plants to grow to a greater depth than in Lower Mission. Some species that are intolerant of turbidity were more common in Upper Mission than in Lower Mission. Curly-leaf pondweed, a non-native species that is tolerant of turbidity, grew more abundantly in Lower Mission Lake.

Curly-leaf pondweed is probably not a recent invader in Upper and Lower Mission Lakes. It has been present in Minnesota for at least 100 years and common in central Minnesota lakes for at least the past 20 years. Although curly-leaf pondweed has invaded both lakes, it does not dominate in either basin. Factors that may contribute to the lack of dominance by curly-leaf may include: 1) the presence and abundance of a number of native submerged species that can adequately compete with curly-leaf, and 2) the moderately high water clarity. Lower clarity in Lower Mission may contribute to the higher abundance of curly-leaf because the species is better adapted to low light levels than are many native species. For more information on management of curly-leaf pondweed see page 51 in this report: MnDNR Invasive Species Annual Report

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 2005 vegetation survey can also be used to monitor annual changes in the native and non-native plant 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 Upper and Lower Mission Lakes 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 submerged plants are perennial and regrow in similar locations each year. However, a few species such as wild rice (*Zizania aquatica*) and bushy pondweed (*Najas flexilis*) are annuals and are dependant on the previous years seed set for regeneration.
- Aquatic plant management activities
  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: MnDNR APM Program. 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. Herbicide and mechanical control of aquatic plants can directly impact the aquatic plant community. Monitoring these control activities can help insure that non-target species are not negatively impacted.

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