Aquatic Vegetation Surveys of Toad Lake
Becker County, Minnesota
(DOW 03-0107-00)
August 2004
June 2005
May 2006

Report by: Donna Perleberg
MNDNR Ecological Services Division
1601 Minnesota Dr., Brainerd, MN 56401
email: donna.perleberg@dnr.state.mn.us
phone: 218-833-8727

Acknowledgments

Lake sampling
2006: Josh Knopik, Stephanie Loso, Lucas Wandrie, MnDNR Ecological Services, Brainerd
2005: Josh Knopik, Michele Mattson, Cody Peterson, MnDNR Ecological Services, Brainerd.
2004: Nicole Brown and Josh Knopik, MnDNR Ecological Services, Brainerd

Report Review:
Mandy Erickson, MnDNR Fisheries, Detroit Lakes.
Jed Anderson, MnDNR Fisheries, Glenwood
Wendy Crowell, MnDNR Ecological Services, St. Paul

Funding:
Collection of these data was made possible by support from the Heritage Enhancement Fund.

This report should be cited as:

D. Perleberg. 2006. Aquatic Vegetation of Toad Lake, Becker County, Minnesota (DOW 03-0107-00), August 2004, June 2005 and May 2006. Minnesota Dept. of Natural Resources, Ecological Services Division, 1601 Minnesota Drive, Brainerd, MN 56401. 22 pages.

Summary

Toad Lake is a relatively large (1666 acres), clear, hard-water lake located near Detroit Lakes, Minnesota. Vegetation surveys were conducted in August 2004 to assess the native aquatic plant community and in early June 2005 and May 2006 to assess the non-native, curly-leaf pondweed population. These surveys provide estimates of the abundance of common submerged plant species.

A total of 31 native plant species were identified in the lake. Emergent and floating-leaf plants were common in shallow bays along the western shore. Submerged aquatic plants occurred to a maximum depth of 24 feet but were most frequent in water depths less than 15 feet. Common submerged species included muskgrass (*Chara* sp.), coontail (*Ceratophyllum demersum*), northern watermilfoil (*Myriophyllum sibiricum*), flat-stem pondweed (*Potamogeton zosteriformis*) and greater bladderwort (*Utricularia vulgaris*).

The non-native submerged plant, curly-leaf pondweed (*Potamogeton crispus*) has been present in Toad Lake since at least 1959. In August 2004, it occurred in 13 percent of the sample sites, in June 2005, it was found in 10 percent of the sites, and in May 2006 it was present in seven percent of the sample sites. During all surveys, curly-leaf was most frequent in water depths of 10 to 15 feet.

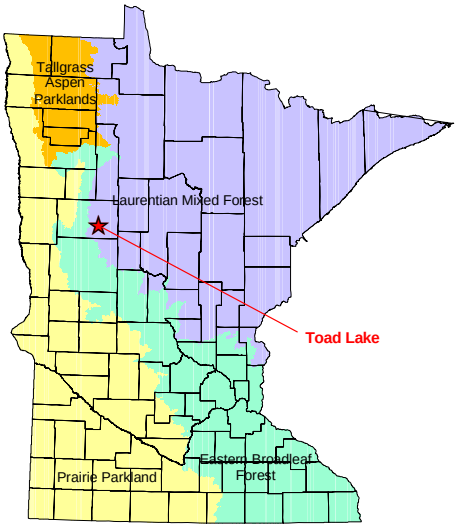
A note to readers:

Text that appears in blue and underlined indicates a hyperlink to a web page. If you are viewing this report on a computer that is connected to the Internet, double-click on the hyperlink text to view additional information.

Introduction

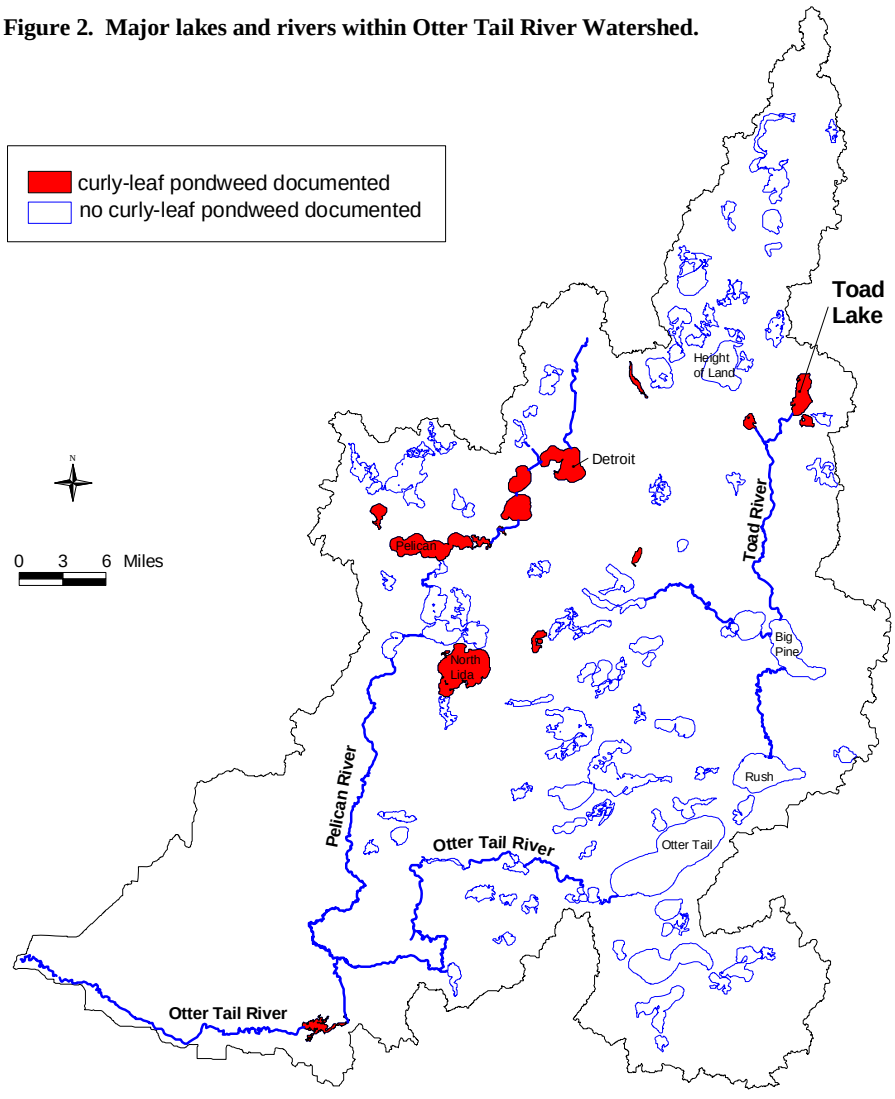
Toad Lake (DOW 03-0107-00) is located about 18 miles east of Detroit Lakes in Becker County, Minnesota. It occurs at the western edge of the Laurentian Mixed Forest Province, the true forested region of Minnesota (Fig. 1).

Figure 1. Toad Lake (03-0107-00).



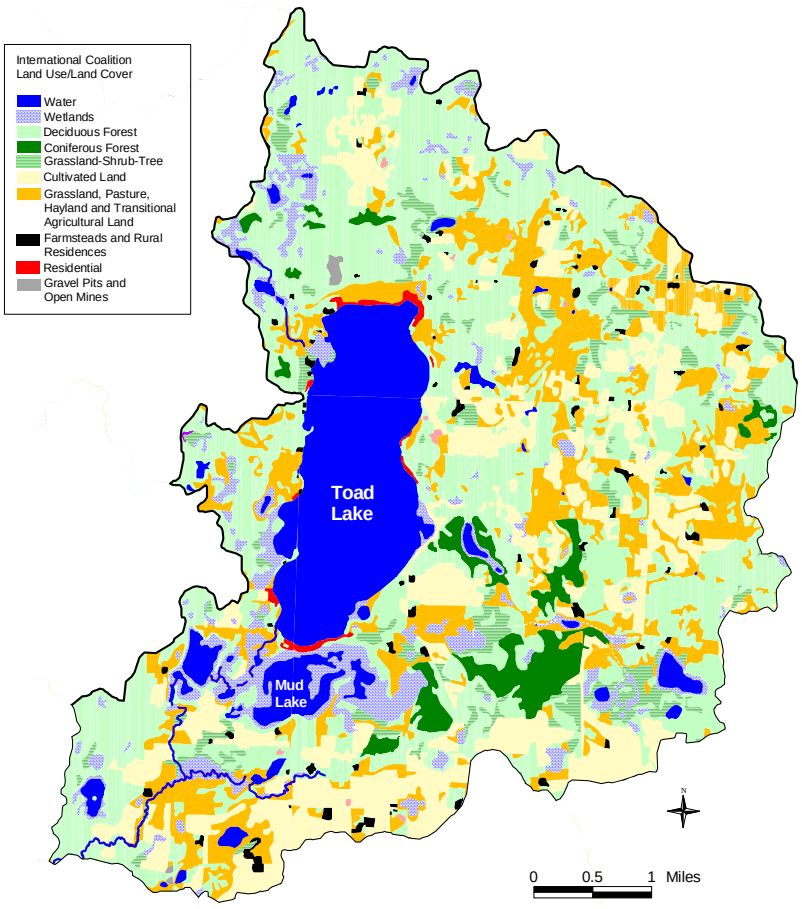
Toad Lake lies in the northeastern edge of the Otter Tail River Watershed. The lake receives inflow from several adjacent wetlands. A small creek drains Toad Lake south into Mud Lake eventually draining southward into the Toad and Otter Tail Rivers (Fig. 2). The watershed itself drains southwesterly to the Red River.

Figure 2. Major lakes and rivers within Otter Tail River Watershed.



This region is characterized by gently rolling topography with loamy coarse (gravelly) and sandy soils from glacial outwash. Pre-settlement vegetation consisted of aspen-birch stands trending to conifers and red and white pine stands. Currently, land cover within the minor watershed is dominated by deciduous forest and agricultural land interspersed with several small lakes and wetlands (Fig. 3).

Figure 3. Land use within the minor watershed that includes Toad Lake (03-0107-00).

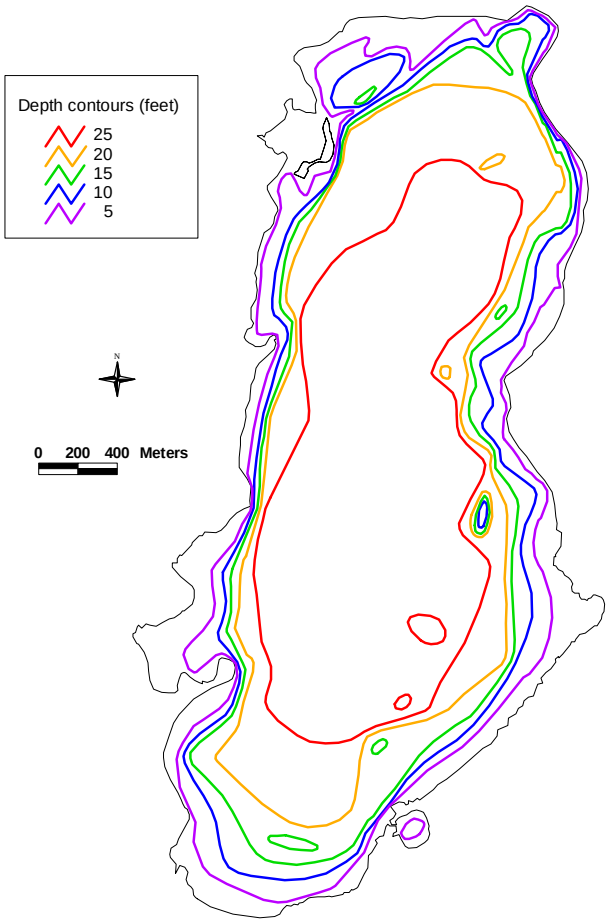


With a surface area of about 1666 acres, Toad Lake is the tenth largest lake in Becker County and among the top 20 large lakes in the Otter Tail River Watershed (Fig 2). It has an elongated basin with a north-south orientation. Maximum water depth is 29 feet, and about 34 percent of the lake is less than 15 feet deep (Fig. 4). Shallow zones include the north and south ends of the lake and several bays along the east and west shores.

Toad Lake is classified as eutrophic (nutrient-rich) lake with moderate clarity as measured by a mean summer Secchi depth reading of 9.7 feet between 1988 and 2004 (MPCA 2005). In early summer, clarity can be high with Secchi depth measurements over 24 feet. High phosphorus levels contribute to algal blooms that decrease water clarity throughout the summer. Secchi depths of three to four feet are common in late summer (DNR Fisheries Lake Files). Shoal

substrates are primarily sand and gravel with some muddy areas, especially at the south end of the lake (DNR Fisheries Lake Files).

Figure 4. Depth contour map of Toad Lake (03-0107-00). Source: MnDNR 1956.



Previous vegetation surveys of Toad Lake have been conducted in 1959, 1972, 2001 (MnDNR Fisheries Lake Files) and 2003 (Myhre 2003). In 1959, bulrush was reported as common along nearly the entire shoreline and other common native aquatic plant species were wild rice (*Zizania aquatica*), cattail (*Typha* sp.), various sedges (*Carex* spp.), yellow waterlilies (*Nuphar variegata*), floating-leaf pondweed (*Potamogeton natans*), Canada waterweed (*Elodea canadensis*), flat-stem pondweed (*Potamogeton zosteriformis*), sago pondweed (*Stuckenia pectinata*) and large-leaf pondweed (*Potamogeton amplifolius*). Submerged plants were found to a depth of 20 feet.

In 2005, a rare submerged plant species, largesheath pondweed (*Stuckenia vaginata*) was confirmed in Toad Lake (Myhre 2003). This species is listed as Special Concern in Minnesota.

Curly-leaf pondweed *(Potamogeton crispus)*, a non-native invasive species, has been present in Toad Lake since at least 1959 (MnDNR Lake Files) and it has been documented in at least 14 other lakes within the Ottertail River Watershed (Fig. 2). It is likely present in additional lakes but not verified. During an August 2001 survey of Toad Lake, DNR Fisheries staff recorded the presence of curly-leaf pondweed at numerous locations around the shoreline (MnDNR Lake Files).

Objectives

These vegetation surveys describe the aquatic plant communities of Toad Lake and include:

1) Estimation of the maximum depth of rooted vegetation
2) Estimation of the percent of the lake occupied by rooted vegetation
3) Record of the aquatic plant species that occur in the lake
4) Estimation of the abundance of common species
5) Distribution maps for the common species

The August 2004 survey assessed the native plant community and the survey was repeated in June 2005 and May 2006 to estimate the abundance and distribution of curly-leaf pondweed, a non-native species that typically reaches its peak growth in late spring and dies back in early summer.

Methods

Vegetation of Toad Lake was surveyed on August 17, 23, 24 and 25, 2004, June 2, 6 and 9, 2005 and May 18, 19, 22, 23, 2006. The 2005 and 2006 survey dates were scheduled so that vegetation could be surveyed within one week of planned herbicide applications on the lake.

A point-intercept survey method was used following the methodology described by Madsen (1999).

A Geographic Information System (GIS) was used to generate sample points across the lake surface in a 100 meter by 100 meter grid, resulting in a total of 693 potential survey points. In the field, surveyors decided not to sample in depths greater than 25 feet since vegetation was consistently not found beyond the 24-foot depth. In August 2004, dense emergent and floating-leaf vegetation growth prevented surveyors from accessing some shallow water sites. Many of these sites were accessible during the June 2005 and/or the May 2006 survey and therefore, spring surveys included additional sites that were not sampled in August 2004. In addition, in any given survey year, a site may

Figure 5. Vegetation sample sites for Toad Lake (03-0107-00) 2004-06.

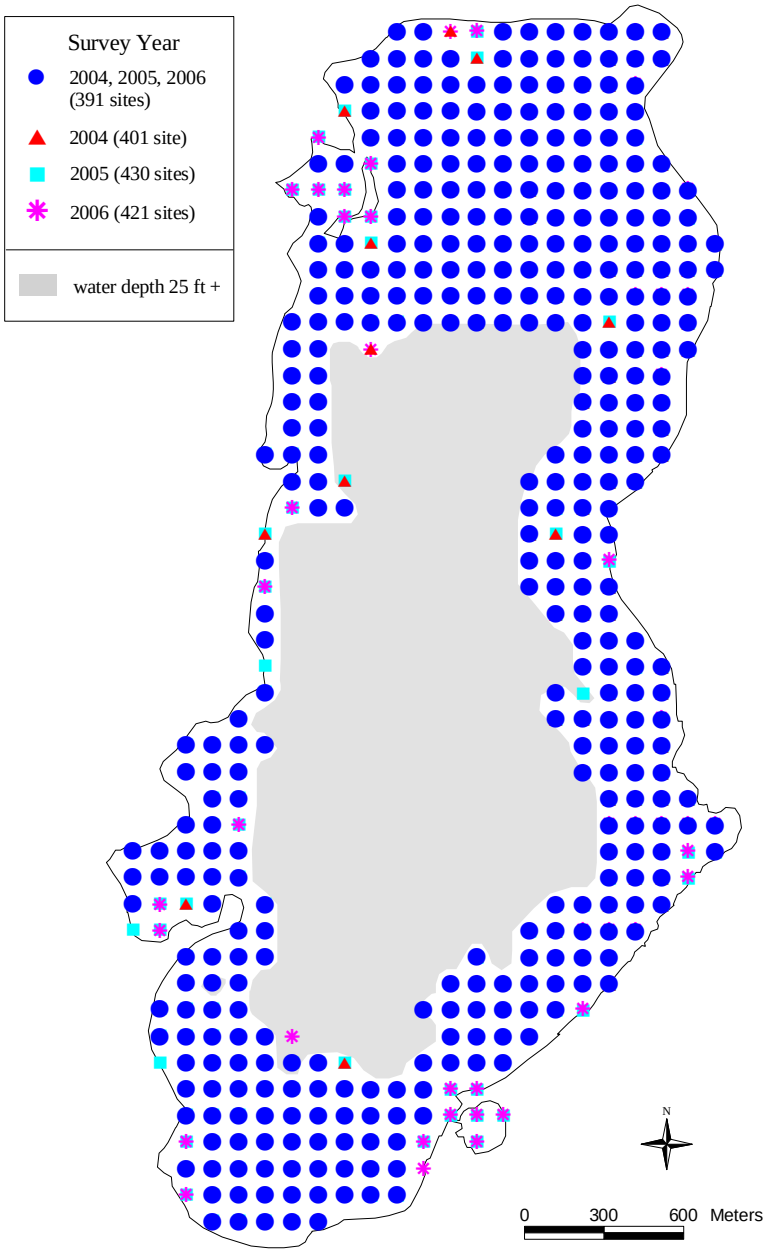


Figure 6. Rake used to sample vegetation.

have been inaccessible due to boating or swimming activities. For data analysis, the 391 survey points within the shore to 25 feet depth, and sampled during all three years (Fig. 5) were used to calculate frequency values. Sites that were sampled only in only one or two years are shown in plant distribution maps for those respective years.

After the survey points were generated in the GIS, they were uploaded into a Global Positioning System (GPS) receiver unit, which was used to navigate the boat to each sample point. Water depths at each site were recorded in 1-foot increments using an electronic depth finder. In water depths less than 8 feet, a measuring stick was used instead. 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 (Fig. 6) was used to survey vegetation not visible from the surface.

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

Data were entered into a Microsoft Access database and transferred to a Microsoft Excel spreadsheet for further analysis. Frequency of occurrence was calculated for each species as the number of sites in which a species occurred divided by the total number of sample sites. Frequency was calculated for the entire surveyed area (0 to 25 feet).

Example:
There were 391 sample sites that were surveyed in all years.
In August 2004, muskgrass (*Chara* sp.) occurred in 134 of those sample sites
Frequency of muskgrass in 2004 = (134/391) x 100 = 34 percent.

Sampling points were also grouped by water depth and separated into five depth zones for analysis: 0 to 5 feet, and 6 to 10 feet, 11 to 15 feet, 16 to 20 feet and 21 to 25 feet.

Results / Discussion

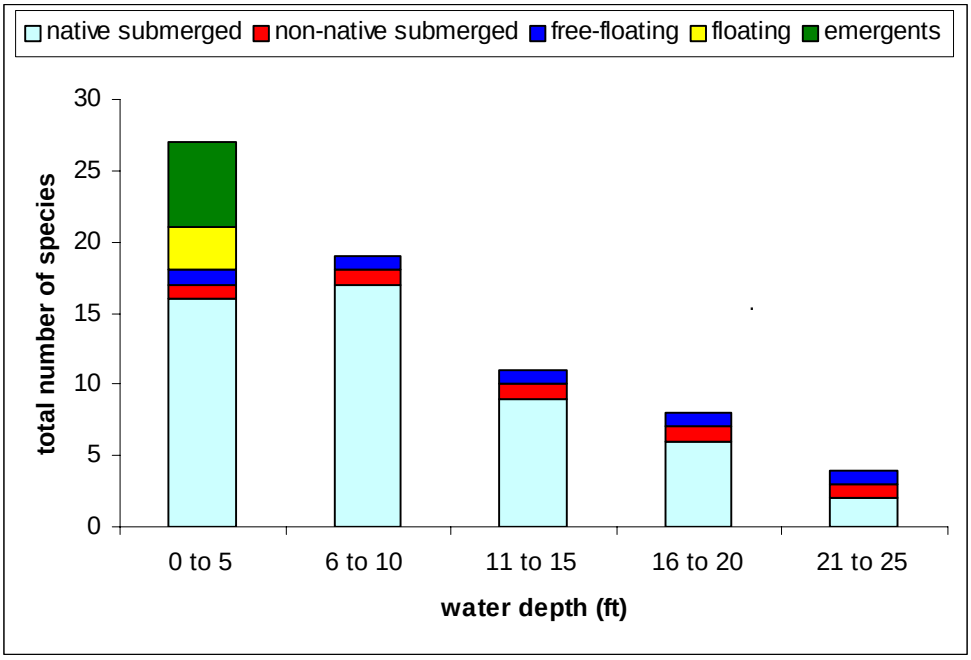
The data from the August 2004 survey cannot be directly compared to the June 2005 or May 2006 survey data because native plant species reach peak biomass in late summer and the non-native, curly-leaf pondweed reaches peak biomass in mid to late spring. Lower frequency values for native species during the June 2005 and May 2006 surveys are expected and do not necessarily indicate that these native species have actually decreased in abundance in the lake. Similarly, curly-leaf pondweed naturally senesces by mid-summer and a low frequency value for this species in August may not be predictive of its potential growth in the following spring. In order to compare changes in native species abundance, a survey should be repeated in late

summer. To estimate changes in curly-leaf pondweed abundance, the June 2005 and May 2006 survey data are compared.

Types of aquatic plants found

A total of 31 native aquatic plant species were recorded during the 2004, 2005 and 2006 surveys of Toad Lake (Table 1). The native plant community included six emergent, three floating-leaved, two free-floating and 20 submerged species. More species of each of these plant types were found in August 2004 than in June 2005 or May 2006, most likely because plants had not yet reached maturity in early June and late May. In all years, the highest number of native species occurred in the shore to five feet depth, where all plant types were found (Fig. 7). Emergent and floating-leaf species were restricted to this shallow depth zone while submerged and free-floating species were found at all depth zones sampled (Fig. 7).

Figure 7. Aquatic plants types found at each depth zone in Toad Lake (03-0107-00) August 2004.



The rare submerged species, largesheath pondweed (*Stuckenia vaginata*), was first collected in Toad Lake in 2003 (Myhre 2003) but the specimen identification was not verified until 2005. Largesheath pondweed is currently classified as a species of Special Concern in Minnesota and is known to occur in only a few Minnesota lakes. Largesheath pondweed can be difficult to distinguish from two other submerged species in Toad Lake: thread-leaf pondweed (*Stuckenia filiformis*) and sago pondweed (*Stuckenia pectinata*). Largesheath pondweed was not found during the 2004, 2005 or 2006 vegetation surveys but is likely still present in Toad Lake. The fact that it was not found during these latest surveys may indicate that it is uncommon in the lake or it may have been found but misidentified as one of the look-a-likes mentioned above.

One non-native submerged species, curly-leaf pondweed (*Potamogeton crispus*) was found in Toad Lake during all surveys.

Table 1. Aquatic Plants of Toad Lake, (03-0107-00) Becker Co. 2004-2006.

Frequency calculated for depth zone from shore to 25 feet depth
Frequency = percent of sites in which species occurred
391 sample sites

Life Forms	Common Name	Scientific Name	Aug 2004	June 2005	May 2006
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 rooted or anchored to the lake bottom.	Muskgrass	*Chara sp.*	34	30	25
	Coontail	*Ceratophyllum demersum*	29	19	19
	Native milfoil	*Myriophyllum sibiricum*	16	9	5
	Curly-leaf pondweed	*Potamogeton crispus*	13	10	7
	Flat-stem pondweed	*Potamogeton zosteriformis*	11	1	<1
	Greater bladderwort	*Utricularia vulgaris*	9	6	2
	Sago pondweed	*Stuckenia pectinata*	3	0	0
	White-stem pondweed	*Potamogeton praelongus*	2	3	1
	Narrow-leaf pondweed	*Potamogeton freisii**	3	1	1
	Illinois pondweed	*Potamogeton illinoensis*	1	0	0
	Robbin's pondweed	*Potamogeton robbinsii*	0	<1	2
	Clasping-leaf pondweed	*Potamogeton richardsonii*	0	<1	<1
	Thread-leaf pondweed	*Stuckenia filiformis*	x	<1	0
	Canada waterweed	*Elodea canadensis*	3	2	4
	Bushy pondweed	*Najas flexilis*	3	0	1
	Water marigold	*Megaladonta beckii*	2	1	1
	Stonewort	*Nitella sp.*	2	1	0
	Lesser Bladderwort	*Utricularia minor*	1	0	1
	Marestail	*Hippuris vulgaris*	0	<1	0
	Water stargrass	*Zosterella dubia*	<1	1	0
	White water buttercup	*Ranunculus sp.*	0	<1	0
FREE-FLOATING	Star duckweed	*Lemna trisulca*	7	4	7
	Not identified to genus	*watermoss*	0	4	0
FLOATING	Yellow waterlily	*Nuphar variegata*	4	1	2
	White waterlily	*Nymphaea odorata*	3	1	1
	Floating leaf pondweed	*Potamogeton natans*	1	0	0
EMERGENT	Hardstem Bulrush	*Scirpus acutus*	6	4	3
	Arrowhead	*Sagittaria sp*	<1	0	0
	Wild Rice	*Zizania palustris*	1	<1	0
	Cattail	*Typha sp*	<1	<1	0
	Spikerush	*Eleocharis sp.*	<1	<1	0
	Needlerush	*Eleocharis acicularis*	<1	0	0

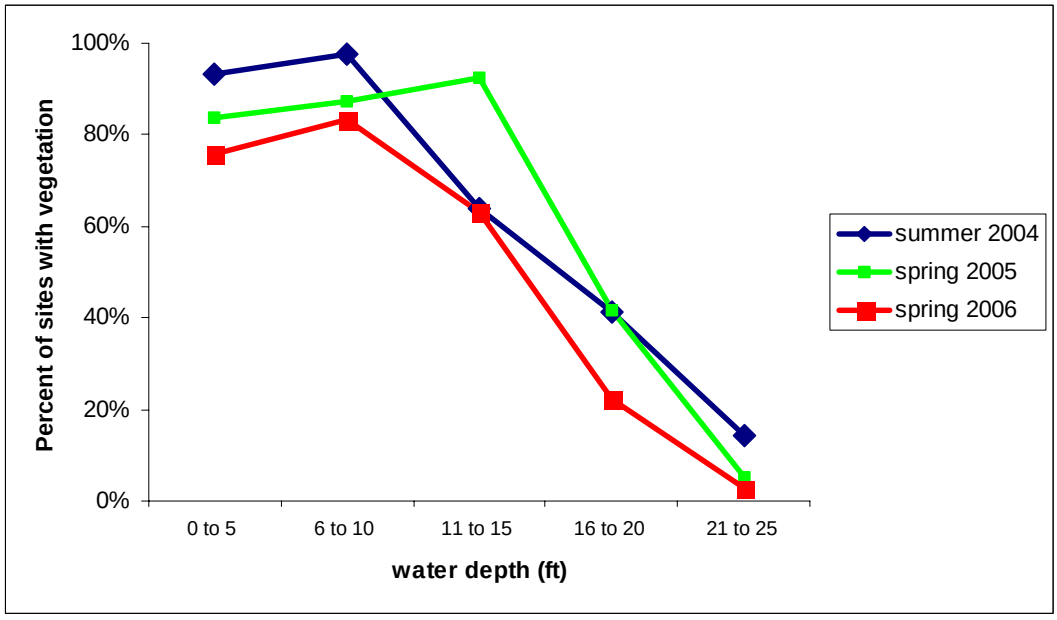
**Potamogeton freisii* was verified as present in the lake but several similar plants could only be identified to genus (*Potamogeton* sp.). All "narrow-leaf pondweeds" were grouped together for analysis.

"0" indicates plant species may have been present in the lake but was not found during the survey.
"x" indicates plant species was observed in lake but did not occur within any sample sites.

Percent of vegetated sites and plant frequency by water depth

Approximately 60 percent of Toad Lake basin is less than 25 feet and can potentially support aquatic vegetation. Within that area, 65 percent of the sample sites contained vegetation during the August 2004 survey compared to 58 percent during the June 2005 survey and 48 percent in May 2006. Plants were found to a depth of 24 feet in August 2004, to 22 feet in June 2005 and to 25 feet in May 2006. However, these deep site occurrences of plants were rare and were typically species that are not strongly rooted to the lake bottom but rather drift with the current. In general, rooted plants were found to a maximum depth of 20 feet in all years and vegetation was most common in water depths of 10 feet and less (Fig. 8), where plant occurrence was 95 percent in August 2004, 86 percent in June 2005 and 81 percent in May 2006.

Figure 8. Frequency of native species vs. water depth. Toad Lake (03-0107-00) Becker Co., 2004-2006.



Vegetated areas occurred around the entire lakeshore and extended lakeward as much as 500 meters in areas such as the northwest shore and shallow areas at the south end of the lake (Fig. 9). The narrowest band of vegetation occurred along the west shore, where water depths increased sharply (Fig. 9). Emergent and floating leaf species were dense in the shallow bays along the western shore.

Native vs. non-native species

Native plant species dominated Toad Lake and during all surveys at least 80 percent of all vegetated areas contained only native plant species (Fig. 9). Sites containing the non-native species, curly-leaf pondweed, were scattered around the entire lake (Fig. 9) but were primarily found in depths of 11 to 20 feet of water (Fig. 10).

Figure 9. Distribution of native aquatic plants and curly-leaf pondweed in Toad Lake, Becker Co (03-0107-00) 2004-2006.

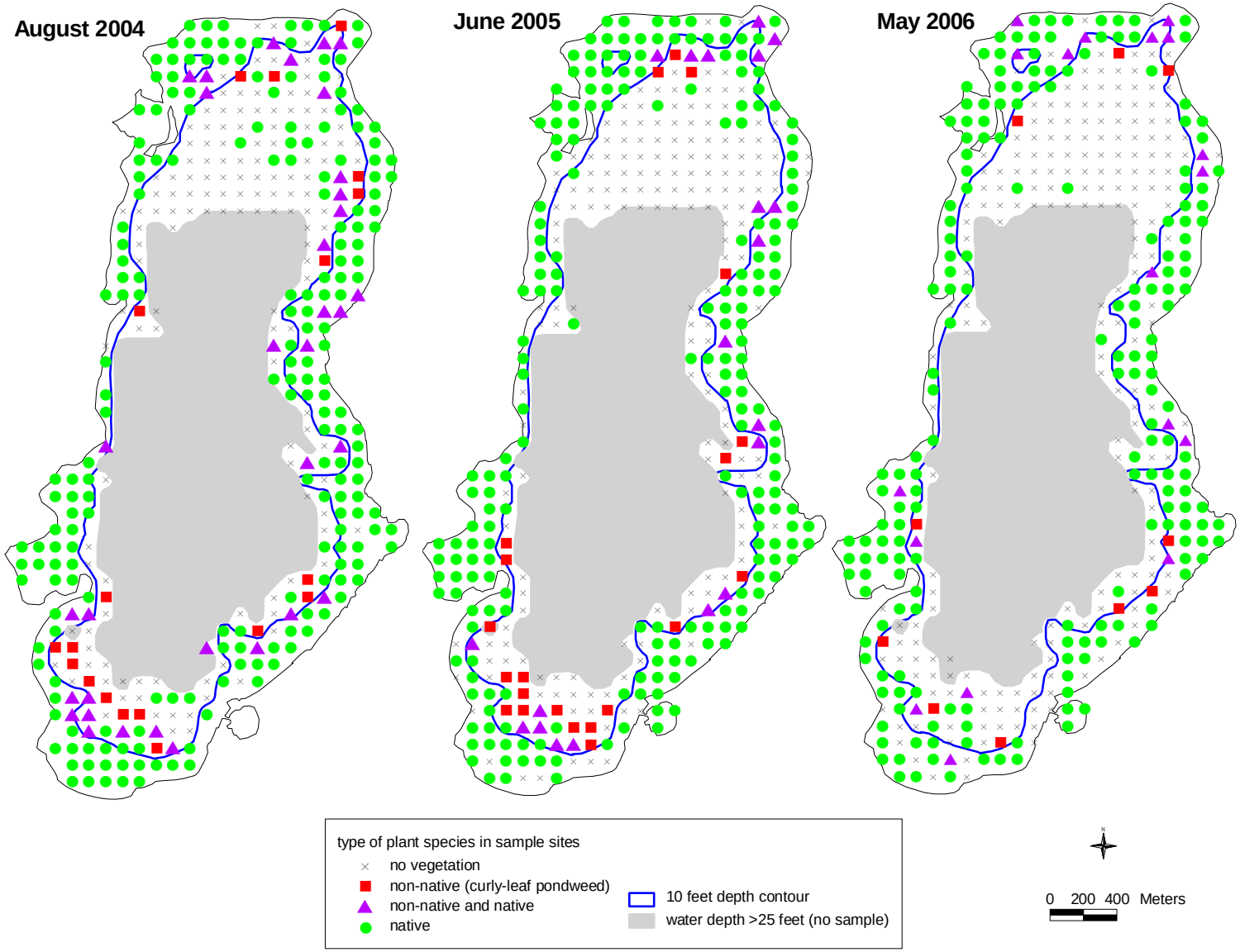
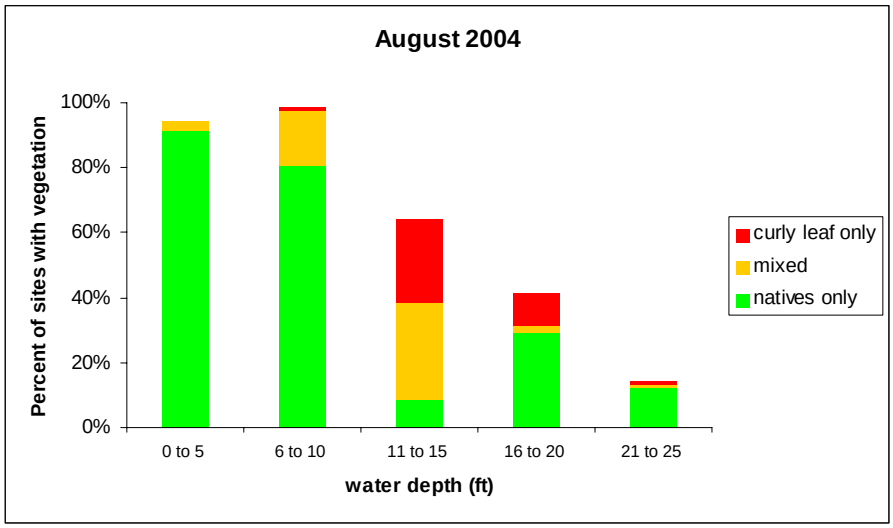
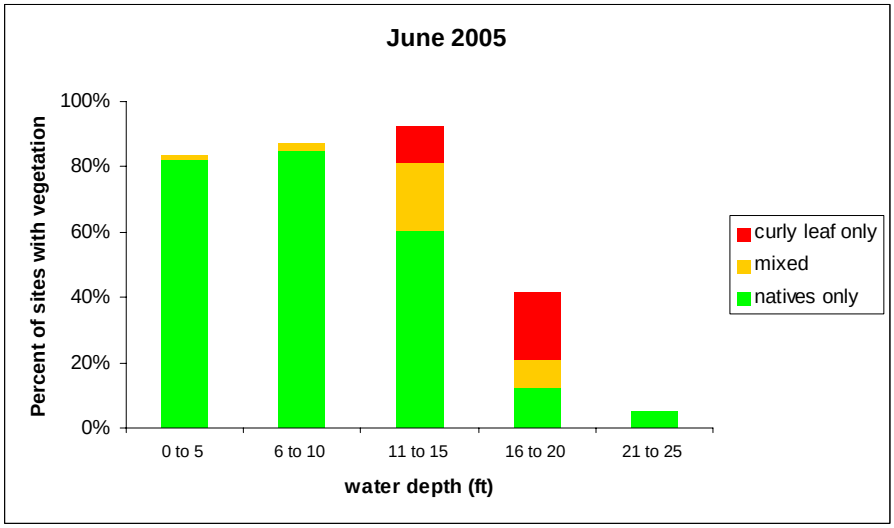
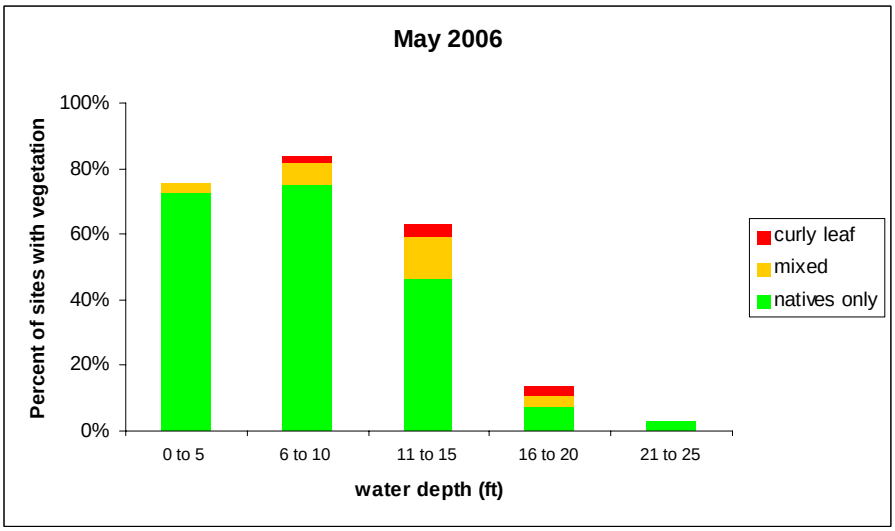


Figure 10. Frequency of all vegetation vs. water depth. Toad Lake (03-0107-00) Becker Co., 2004-2006.







Natives species

The most common emergent species was hardstem bulrush (*Scirpus acutus*). A band of mixed vegetation, dominated by bulrush and muskgrass *(Chara sp.)*, occurred along the southeast shore, extending about 350 feet from shore and covering approximately 65 acres. All other emergent and floating-leaf species were present in less than five percent of the sample sites, but were common within the shallow depths in which they occurred (Fig. 11).

Figure 11. Bed of waterlilies in Toad Lake (03-0107-00) Becker Co., May 22, 2006.

The most frequently located native submerged species during the 2004, 2005 and 2006 vegetation surveys of Toad Lake were muskgrass *(Chara sp.)*, coontail (*Ceratophyllum demersum*), northern watermilfoil *(Myriophyllum sibiricum)*, flat-stem pondweed *(Potamogeton zosteriformis*) and greater bladderwort (*Utricularia vulgaris*). All other native submerged species were found in less than nine percent of the sample sites.

Figure 12. Bed of muskgrass (*Chara* sp.)

Muskgrass (*Chara* sp.) (Fig. 12) was the most frequently found species in Toad Lake, occurring in 34 percent of the sites in August 2004, 30 percent in June 2005, and 25 percent in May 2006 (Table 1). It occurred to a depth of 18 feet and was most frequent in depths from shore to 10 feet (Figs. 13-14). Muskgrass is a native, macroscopic algae that is common in many hardwater Minnesota lakes. This algae resembles a large moss but has a brittle texture due to mineral deposits on it leaf-like surfaces. It is named for its characteristic musky odor. Because this species does not form true stems, it is often the first species to occur in open areas of lake bottom where it can act as a sediment stabilizer. Muskgrass 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 provides beneficial cover for fish, as well as the aquatic insects that bluegills, smallmouth and largemouth bass feed upon.

Coontail (*Ceratophyllum demersum*) (Fig. 15) was the second-most frequent species in Toad Lake and occurred in 29 percent of the August 2004 sites and in 19 percent of the June 2005 and May 2006 sites (Table 1). Coontail was the only submerged species found beyond the 20 feet water depth and was most frequent between depths of six and 15 feet (Figs. 13-14). Coontail is the most common submerged flowering plant in Minnesota lakes. It grows entirely submerged and is adapted to a broad range of lake conditions, including turbid water. Coontail is a perennial and can overwinter as a green plant under the ice and then begins new growth early in

Figure 13. Frequency of native and non-native aquatic plants vs. water depth in Toad Lake (03-0107-00), August 2004, June 2005 and May 2006.

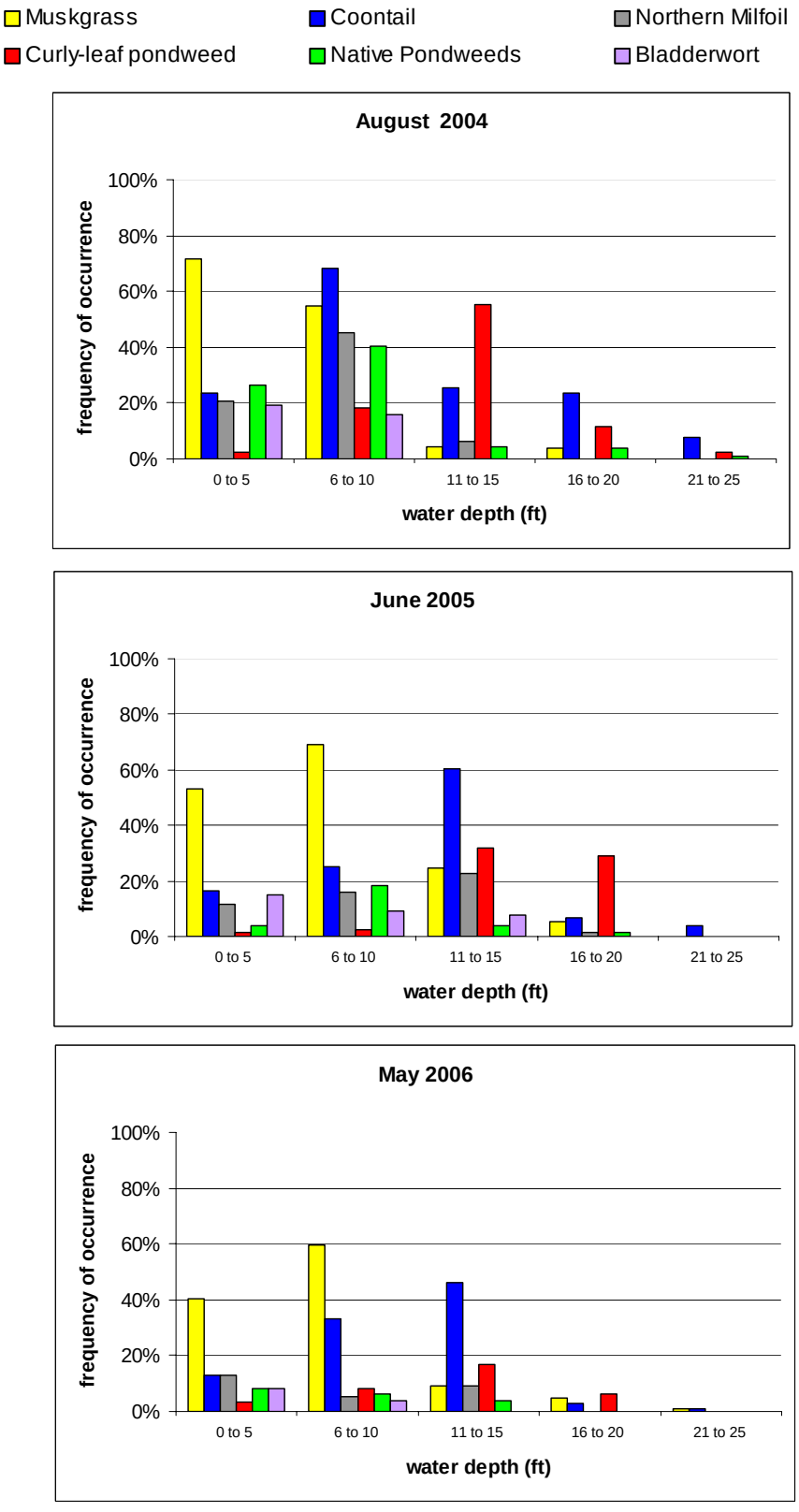
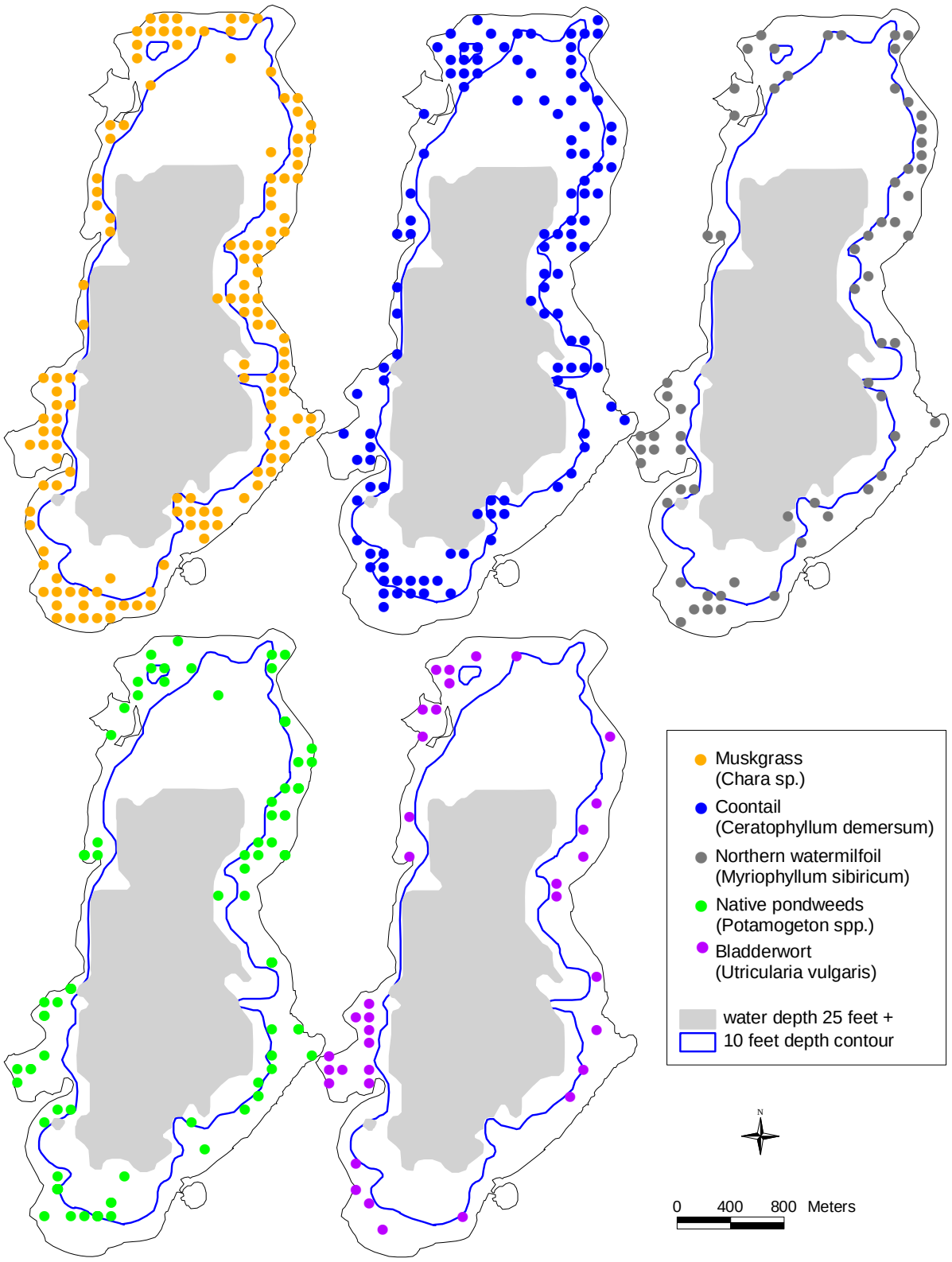


Figure 14. Distribution of common native aquatic plant species in Toad Lake (03-0107-00), August 2004.



spring. Because it is only loosely rooted to the lake bottom it may drift between depth zones (Borman et al. 1997). Coontail provides important cover for young fish, including bluegills, perch, largemouth bass and northern pike. It also supports aquatic insects beneficial to both fish and waterfowl.

Figure 15. Coontail (*Ceratophyllum demersum*).

Northern watermilfoil (*Myriophyllum sibiricum*) (Fig. 16) occurred in 16 percent of the August 2004 survey sites, nine percent of the June 2005 sites and five percent of the May 2006 sites (Table 1). It was most frequent in depths of six to 15 feet (Figs. 13-14). Northern watermilfoil is a perennial, rooted submerged plant with spike-like flowers that extend above the water surface. The numerous finely divided leaves of this plant provide habitat for aquatic invertebrates and fish. Northern watermilfoil is often mistaken for the non-native invasive Eurasian watermilfoil (*Myriophyllum spicatum*), which was not found in Toad Lake. Northern watermilfoil has 5-10 leaflet pairs compared to 12-21 leaflet pairs for Eurasian watermilfoil. Northern watermilfoil prefers soft sediments of clearer water lakes (Borman et al. 1997).

Figure 16. Northern watermilfoil (*Myriophyllum sibiricum*).

Flat-stem pondweed (*Potamogeton zosteriformis*) (Fig. 17) was the most frequent of 10 different pondweeds (*Potamogeton* spp. and *Stuckenia* spp.) found in Toad Lake. It was found in 11 percent of the survey sites in August 2004, in one percent in June 2005, and in less than one percent in May 2006 (Table 1). Pondweeds are a diverse and important group of submerged plants. These perennial plants include broad-leaf, "cabbage" species as well as narrow-leaf species. Pondweeds are typically submerged but some species also form floating-leaves in shallow water. Each species has a different preference for water depth, substrate and turbidity and flat-stem pondweed can grow in a wider variety of conditions than some of other pondweed species. The presence of many pondweed species in Toad Lake is indicative of higher water clarity and provides a diverse habitat structure for fish, invertebrates and other aquatic life. In Toad Lake, pondweeds, as a group, were most common in water depths of ten feet and less (Figs. 13-14).

Figure. 17. Flatstem pondweed (*Potamogeton zosteriformis*).

Greater bladderwort (Utricularia vulgaris) occurred in nine percent of the August 2004 sites, six percent in June 2005, and two percent in May 2006 (Table 1). It was most common in depths of six to 12 feet of water (Figs. 13-14). Like coontail, this species is

weakly rooted to the substrate and often drifts freely through the water column. Bladderwort is an entirely submerged plant except during bloom when its small, showy yellow flower extends above the water (Fig. 18). 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.

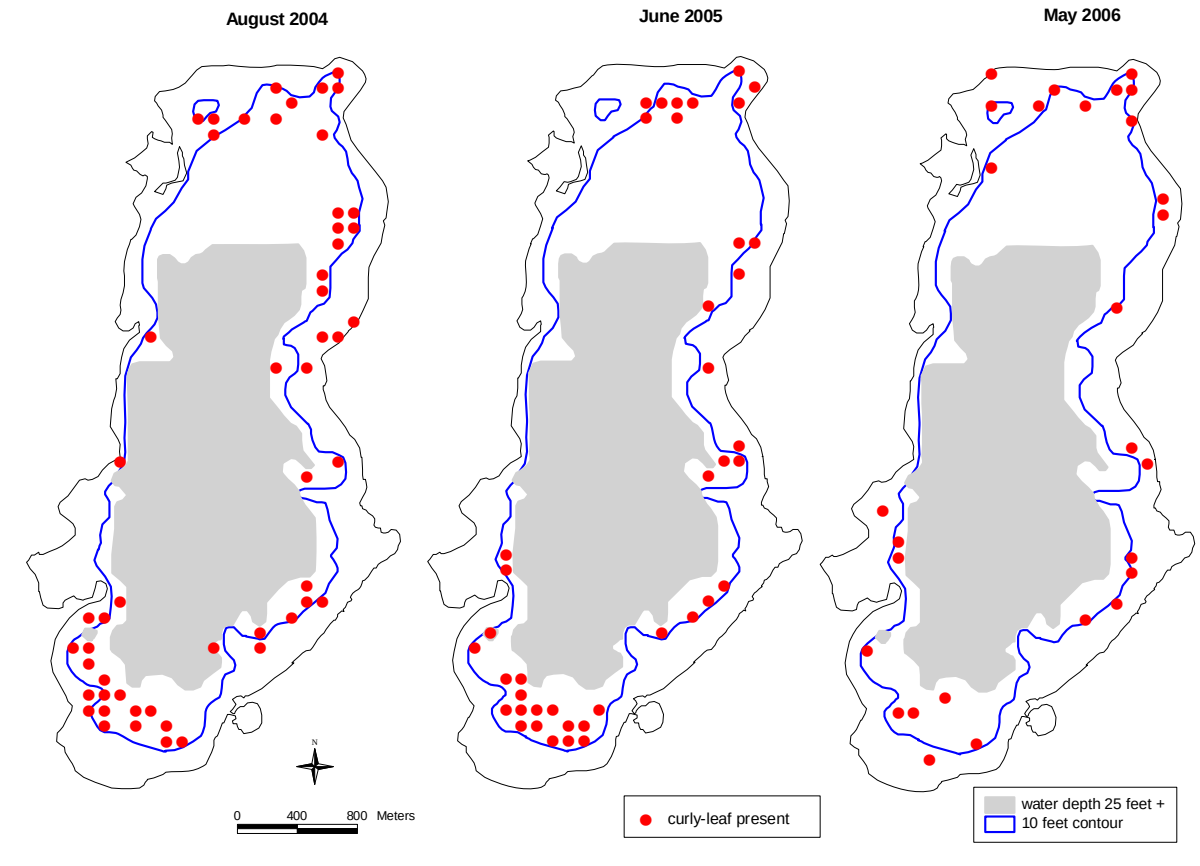
Figure. 18. flowers of Greater bladderwort (*Utricularia vulgaris*).

Curly leaf pondweed in Toad Lake

Curly-leaf pondweed (*Potamogeton crispus*) was the fourth-most frequent species found in Toad Lake, but occurred at low frequency in all years: 13 percent in August 2004, 10 percent in June 2005 and seven percent in May 2006 (Table 1). It was found to a maximum depth of 20 feet during the August 2004 survey and in all years was most frequent in 11 to 15 feet depth zone (Figs. 13 and 19).

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

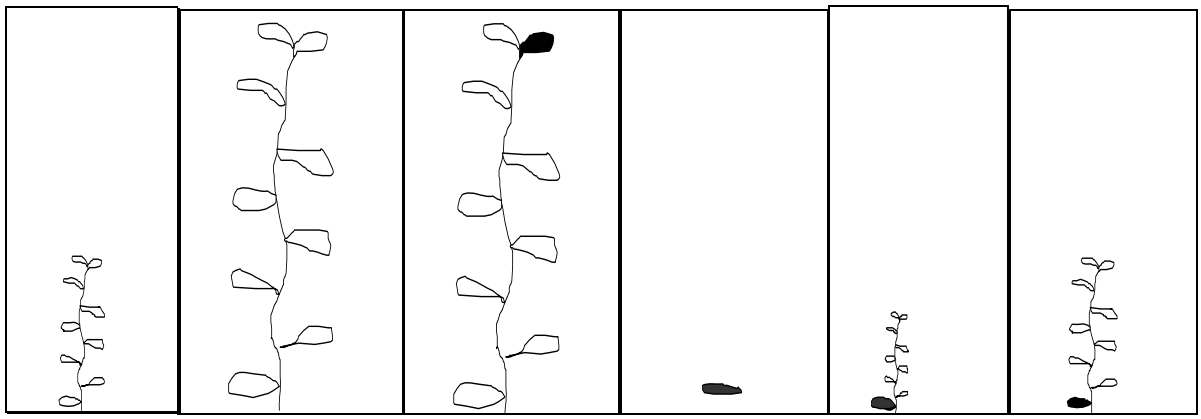
Figure 19. Distribution of curly-leaf pondweed (*Potamogeton crispus*) in Toad Lake (03-0107-00) August 2004, June 2005 and May 2006.



(Invasive Species Program 2005). It was first reported in Toad Lake in 1959, but until the August 2004 survey, little information was available on its abundance and distribution in the lake.

Like many native submerged plants, curly-leaf pondweed is perennial but it has a unique life cycle which may provide a competitive advantage over native species. Curly-leaf pondweed is actually dormant during summer and begins new growth in late summer and early fall (Fig. 20). 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 many native plants are not fully

Figure 20. 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 begin to die back and form turions	Turions remain dormant	Turions germinate	Newly sprouted plants continue growth

mature. In late spring and early summer, curly-leaf plants form structures called "turions" (Fig. 21) 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). Turions may also remain in the lake sediment and germinate in later years. It is not known how long turions may remain viable (Invasive Species Program 2005).

Figure 21. Turions forming at tips of curly-leaf pondweed (*Potamogeton crispus*) plants.

In late spring or early summer, curly-leaf pondweed may forms dense mats at the water surface. The extent and locations of these mats vary with individual lakes but they usually occur in water depths less than 15 feet. During the August 2004, June 2005 and May

2006 Toad Lake surveys, curly-leaf plants were present but did not form surface mats.

Value of aquatic vegetation

Aquatic vegetation provides critical habitat for fish, waterfowl and invertebrates, buffers the shorelines from wave action, and stabilizes sediments and utilizes nutrients that would otherwise be available for algae. A mix of emergent, floating-leaf and submerged plants can provide a variety of habitat structure for a diverse group of fish and wildlife species. In general, native vegetation provides a higher quality of habitat because native plants have coevolved in Minnesota lakes with native fish and wildlife. Non-native species, like curly-leaf pondweed, may displace native plants and/or contribute to lower clarity that in turn harms native plants. Nevertheless, non-native vegetation can provide some benefits to a lake, particularly if native vegetation has already declined. Monitoring changes in aquatic plant communities can provide information on the amount and quality available fish and wildlife habitat and may provide clues to changes in the overall water quality of the lake and watershed.

Annual change in Toad Lake plant community

Data from the 2004 and 2005 vegetation surveys of Toad Lake can be used to monitor annual changes in the native and non-native plant species composition. To analyze change in the native plant community, this survey should be repeated in late summer and results compared to the August 2004 survey. Detecting change in the curly-leaf population may be more complicated. It is often impossible to know whether a decline in curly-leaf is due to environmental conditions, or due to management activities, or a combination of both. Because curly-leaf pondweed reaches peak biomass in late spring, a spring survey is appropriate to estimate its distribution and abundance in the lake. However, in lakes where early season herbicide applications occur, it is not possible to survey curly-leaf pondweed during its peak biomass. Therefore, repeat spring vegetation surveys should be conducted as close to the spring herbicide treatment date as possible.

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

- Change in water clarity
  If Toad Lake clarity increases, submerged vegetation may be more common at depths greater than 15 feet. Similarly, if water clarity declines, the maximum depth at which vegetation grows may decline.
- Snow cover
  Curly-leaf pondweed, in particular, may fluctuate in abundance in response to snow cover. Many native submerged plants also have the ability to grow under the ice, particularly if there is little snow cover and sunlight reaches the lake bottom. In years following low snow cover, curly-leaf and some native submerged plants may increase in abundance.
- Shoreland development
  Development along shorelines can directly impact aquatic plants if they are removed or damaged. Development may indirectly impact aquatic plants if nutrient and/or sediment loadings to the lake are increased, leading to lower water clarity. Click here for more information on shoreline best management practices.
- 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 shallow, vegetated areas can be particularly harmful for species such as wild rice, waterlilies, and bulrush. 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.

Literature Cited

Borman, S. R. Korth, J. Tempte. 1997. Through the Looking Glass: a field guide to aquatic plants. Wisconsin Lakes Partnership. 248 pp.

Catling, P.M. and I. Dobson. 1985. The biology of Canadian weeds. 69. *Potamogeton crispus* L. Canadian Journal of Plant Science 65:655-668.

Crow, G.E. and C.B. Hellquist. 2000. Aquatic and wetland plants of Northeastern North America. 2 volumes. The University of Wisconsin Press.

Invasive Species Program. 2005. Invasive Species of Aquatic Plants and Wild Animals in Minnesota: Annual Report for 2004. Minnesota Department of Natural Resources, St. Paul, MN. http://files.dnr.state.mn.us/ecological_services/invasives/annualreport.pdf

Madsen, J. D. 1999. "Point intercept and line intercept methods for aquatic plant management." *APCRP Technical Notes Collection* (TN APCRP-M1-02). U.S. Army Engineer Research and Development Center, Vicksburg, MS. www.wes.army.mil/el/aqua

Myhre, K.M. 2003. List of plant species observed at Toad Lake. August 18, 2003. Minnesota Dept. of Natural Resources, Division of Ecological Services, County Biological Survey Program. 500 Lafayette Rd., St. Paul, MN 55155.

Minnesota Dept. of Natural Resources. Division of Fisheries Lake files. 500 Lafayette Rd., St. Paul, MN 55155.

MPCA. 2003. Minnesota Pollution Control Agency website. Lake Water Quality Assessment Program. http://www.pca.state.mn.us/water/clmp/clmpSearchResult.cfm?lakeid=03-0107

Moyle, J.B. and N. Hotchkiss. 1945. The aquatic and marsh vegetation of Minnesota and its value to waterfowl. Minnesota Department of Conservation. Technical Bulletin 3. 122 pp.

Wehrmeister and Stuckey. 1978. The life history of *Potamogeton crispus* with emphasis on its reproductive biology. Ohio Journal of Science. 78 (April program and abstract) supplement: 16.

