# *Aquatic vegetation of Fish Lake*

**2004 to 2011**

ID# 40-0051-00

Le Sueur County, Minnesota

North side of Fish Lake, June 2011.

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## Summary

Fish Lake is a 72 acre, mesotrophic lake in southern Minnesota where relatively high water clarity has been maintained through good shoreland management practices. The aquatic vegetation surveys conducted in June 2004 and June 2011 included lakewide assessments of vegetation and water depths at over 90 sample stations.

Beds of white (*Nymphaea odorata*) and yellow waterlilies (*Nuphar variegata*) formed a nearly continuous band around the entire shoreline, covering about 15 acres and extending to a water depth of about eight feet. Emergent plants, such as wild rice (*Zizania palustris*) and bulrush (*Schoenoplectus* sp.), and submerged plants were often scattered within these plant beds. Submerged plants were found to a depth of 21 feet in 2004 and 22 feet in 2011 and were most frequent in the shore to 10 feet depth zone.

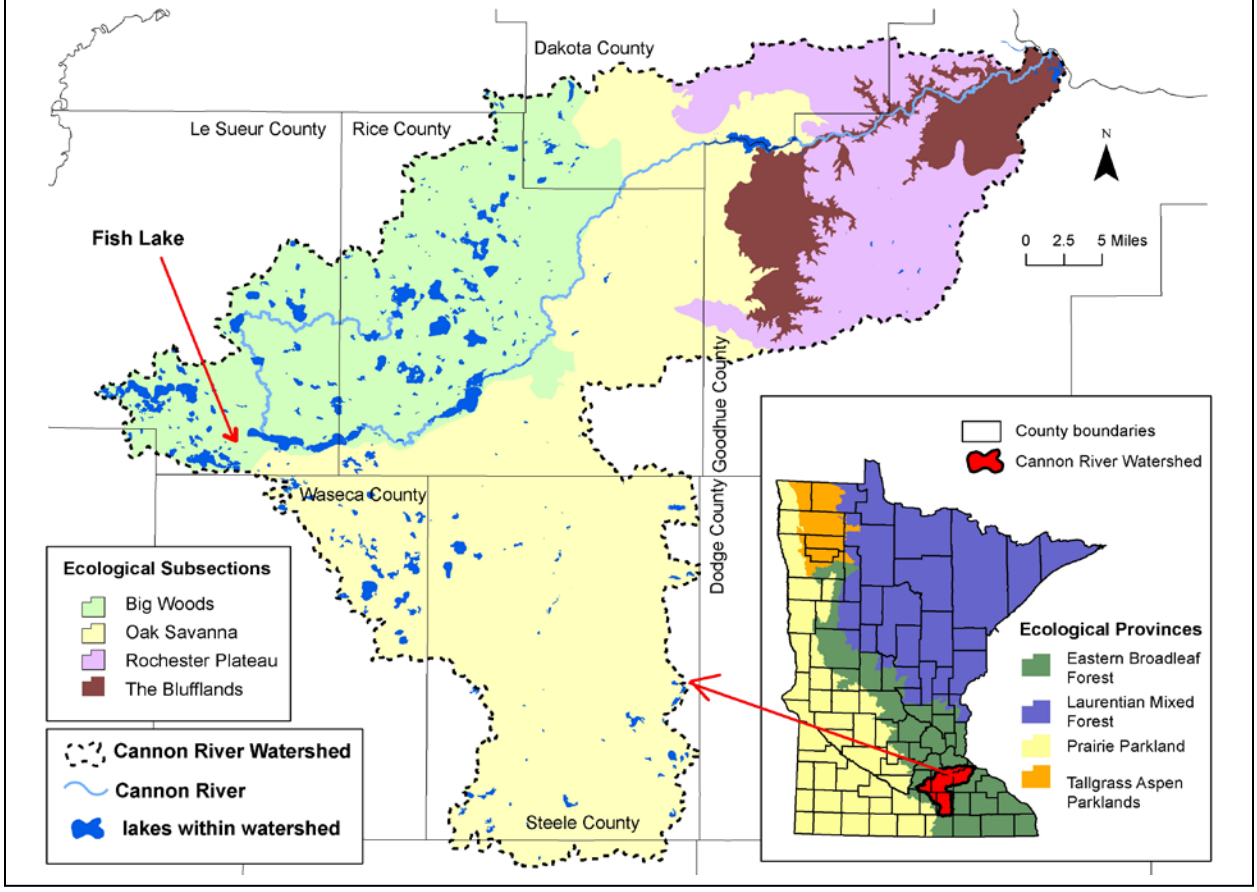
A total of 31 native aquatic plant species were recorded in Fish Lake, making it one of the richest lakes in the watershed in term of plant diversity. Plants observed included five emergent, four floating-leaved, two free-floating and 20 submerged plants. Native submerged plants occurred in 56% of the sample sites and the most frequently occurring species were muskgrass (*Chara* sp.), coontail (*Ceratophyllum demersum*), northern watermilfoil (*Myriophyllum sibiricum*), narrow-leaf pondweed (*Potamogeton* sp.), and flat-stem pondweed (*Potamogeton zosteriformis*).

One non-native submerged plant, curly-leaf pondweed (*Potamogeton crispus*), was documented. This plant was first documented in the lake in 1995 but remains a minor component of the plant community. In 2004 it was found in 34% of all survey sites and in 2011 it was present in only 6% of the sample sites. No known aquatic plant control activity occurs in the lake and the annual variation in curly-leaf pondweed abundance is likely the plant's natural response to annual environmental variations. The diversity of native aquatic plants may help prevent curly-leaf pondweed from dominating the plant community.

## Introduction

Fish Lake is located about 11 miles south of the city of Le Center in Le Sueur County, Minnesota. It occurs in the ecological region known as the Eastern Broadleaf Forest Province and at the western edge of the Cannon River Watershed (Figure 1). Four different land types occur within the watershed and Fish Lake, and the majority of other lakes in the watershed are within the Big Woods Ecological Subsection. The Cannon River drains the watershed to the northeast, but many of the lakes, including Fish Lake, are not directly connected to the river; they are groundwater controlled with no inlets or outlets.

Figure 1. Location of Fish Lake (Le Sueur Co.) within the Cannon River Watershed.

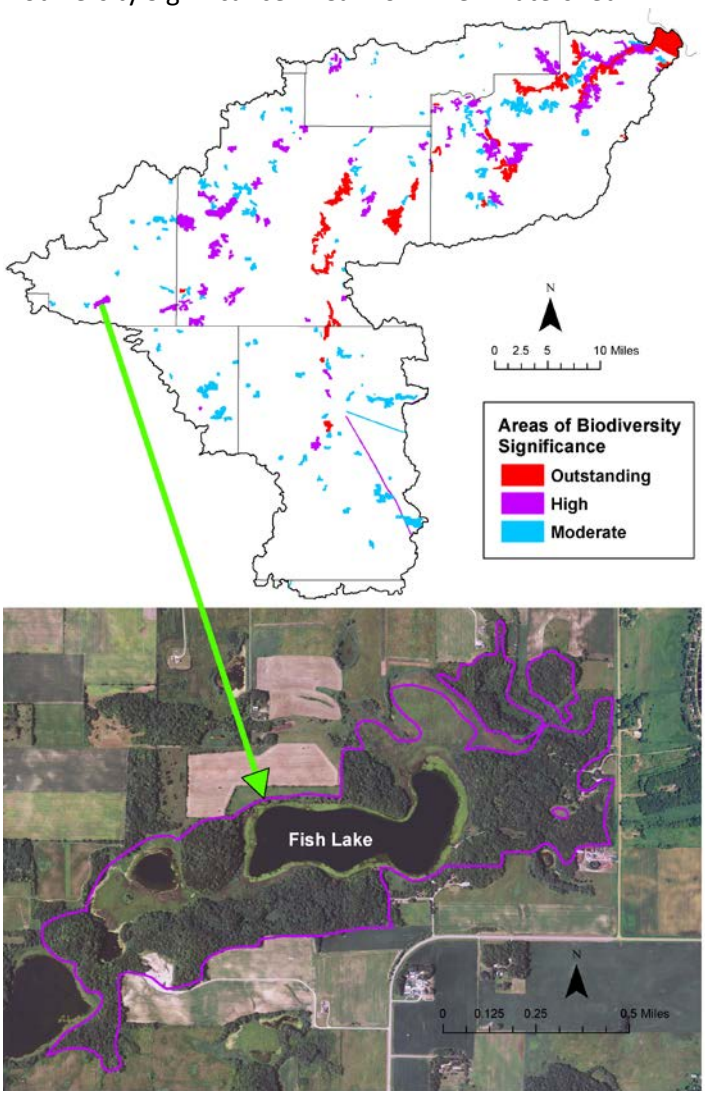



Fish Lake can be described as a seepage lake because it receives most of its flow from precipitation and groundwater flow. Water levels on seepage lakes can fluctuate seasonally and annually because their water level is a reflection of the elevation of the water table, which in turn reflects the amount of rain water and snow melt. Because Fish Lake is not a flow-through lake, it is particularly susceptible to increased nutrient and particle input that may result from poor shoreland management practices.

The "Big Woods" refers to a large block of oak woodland and maple-basswood forest that was present in this region before European settlement. Within the sub-watershed that includes Fish Lake over 70% of the land is classified as agricultural, but, much of shoreland immediately

adjacent to Fish Lake is undeveloped and contains high quality native plant communities. Fish Lake and about 300 acres of adjacent land have been identified as a Site of High Biodiversity Significance (Figure 2) by DNR's Minnesota Biological Survey based on the size and condition of the native plant communities and the presence of several rare species. Uplands include tracts of mature sugar maple forest and oak woodlands and wetlands include rich fens, marshes, Fish Lake and a small pond. Fish Lake is designated as a Natural Environment Lake for shoreland management because of its smaller size and limited development. Most of land surrounding Fish Lake is privately owned and a public access is located on the southeast side of the lake.

Figure 2. Fish Lake and adjacent land are among areas of Biodiversity Significance in Cannon River Watershed.



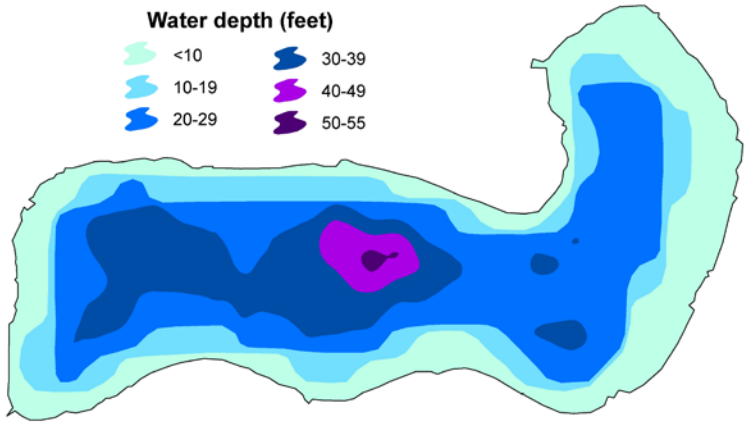

Fish Lake is relatively small with a surface area of 72 acres. It is "L-shaped" in outline and is about a ½ mile in length (east-west) and in most areas is less than a ¼ mile in width (north-south). It has a maximum depth of 55 feet and at least 42% of the lake is less than 15 feet deep (Figure 3).

The lake's trophic, or growth, status is characterized as mesotrophic, based on phosphorus (nutrients), chlorophyll a (algae concentration) and Secchi[1] depth (transparency). Since 1997[2], clarity has ranged from "very good" (6 to < 12 feet) to "excellent" (>12 feet) with a mean summer clarity of 13 feet (Appendix 1). The depth to which rooted aquatic plants grow is

[1] The Secchi disc transparency measures the depth to which a person can see a white disc lowered into the lake and provides an estimate of the light penetration into the water column. Water clarity is influenced by the amount of particles in the water column and can fluctuate seasonally and annually.
[2] Volunteers have recorded open water clarity on Fish Lake since 1997.

largely dependent on water clarity[3]. Based on summer water clarity readings alone, aquatic plants have the potential to reach depths of 16-22 feet in this lake. However, other factors influence how deep plants may grow, including substrate type, wave action and the types of plants present in a lake.

Figure 3. Depth contours of Fish Lake.




## Historic aquatic plant community

Previous aquatic plant surveys of Fish Lake were conducted in 1961, 1979, 1984, 1995, 1998, and 2003 (MnDNR Lake files). These surveys recorded a total of 42 native aquatic plant species: nine emergent, five floating-leaved, five free-floating and 23 submerged species (Appendix 1). Submerged plants included muskgrass (*Chara* sp.), 10 different native pondweeds (*Potamogeton* spp.), coontail (*Ceratophyllum demersum*) and Canada waterweed (*Elodea canadensis*). The non-native submerged plant, curly-leaf pondweed (*Potamogeton crispus*), was first documented in the lake in 1995 but has been present in the watershed for decades.

## Fishery

The clear water and abundant plant growth in Fish Lake provide excellent habitat for an abundant bluegill population and several other types of game fish (click here for Fishery Status). Two rare nongame fish species have been also been documented in the lake. The pugnose shiner (*Notropis anogenus*) and least darter (*Etheostoma microperca*) are minnows that have been listed as rare species of Special Concern in Minnesota. These species are extremely intolerant to turbidity and siltation and prefer clear lakes with an abundant submerged plant population.

## Objectives

The purpose of this vegetation survey was to provide a quantitative description of the Fish Lake plant community. Specific objectives included:

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 the abundance of common species
5. Develop distribution maps for the native and non-native species
6. Compare how plant communities may change annually

[3] As a general rule, sunlight can penetrate to a depth of 1.7 times the Secchi depth (Scheffer 1998) and rooted aquatic plant growth is generally limited to that depth range.

# Methods

## Emergent and floating-leaf Plant Bed Delineation

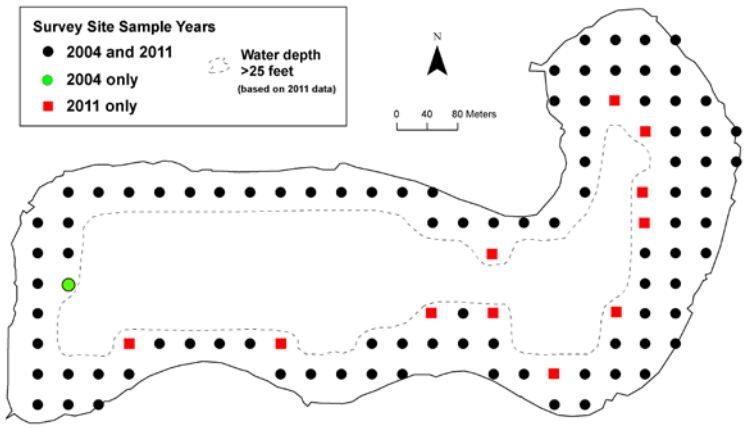
The boundaries of major plant beds were delineated from review of 2003 FSA Color Aerial photographs with in-field verification. This provides a general estimation of plant bed location and size but detailed mapping of plant beds using global positioning system (GPS) was not conducted.

## Lakewide (Point-intercept) vegetation survey

Fish Lake was surveyed on June 17, 2004 and June 16, 2011 using a point-intercept method (Madsen 1999, MnDNR 2009). Because curly-leaf pondweed occurs in the lake and typically dies back by mid-summer, surveys were conducted in mid-June so that both curly-leaf and most native aquatic plants could be assessed.

Survey waypoints were created using a Geographic Information System (GIS) computer program and downloaded into a handheld Global Positioning System (GPS) receiver. Survey points were placed across the entire lake and spaced 40 meters (131 feet) apart, resulting in about one survey point per acre. In 2004, surveyors sampled all sites in depths less than 23 feet for a total of 92 sites. In 2011, surveyors sampled an additional 11 sites in the 22 to 25 feet depth (Figure 4).

Figure 4. Fish Lake 2004 and 2011 vegetation survey sites.




The survey was conducted by boat and a GPS unit was used to navigate to each sample site. At each site, water depth was recorded in one-foot increments using a measured stick in water depths less than seven feet and an electronic depth finder in depths greater than seven feet.

### *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. Plant identification followed Crow and Hellquist (2000) and Flora of North America (1993+) and nomenclature followed MnTaxa (2011).

Figure 5. Survey rake.

Only the 91 sample sites that were surveyed in both years were used in frequency calculations (Table 1). 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 22 feet and sampling points were also grouped by water depth and separated into five depth zones for analysis (see example in Appendix 2).

Table 1. Survey effort by depth interval.

| Water depth (feet) | Number of sample sites | |
|---|---|---|
| | 2004 | 2011 |
| 0 to 5 | 39 | 36 |
| 6 to 10 | 7 | 11 |
| 11 to 15 | 6 | 9 |
| 16 to 20 | 25 | 21 |
| 21 to 22 | 14 | 14 |
| Number of sites surveyed in both years | 91 | 91 |
| 23 to 25 | 1 | 11 |
| Total | 92 | 102 |

### *Substrate sampling*

In 2011, in water depths of seven feet and less, surveyors evaluated lake bottom substrate at the sample station by tapping a pole into the lake bottom. Soft substrates were brought to the surface on the pole for evaluation. Surveyors used standard substrate classes (Table 2) to describe substrates and 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 depths 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

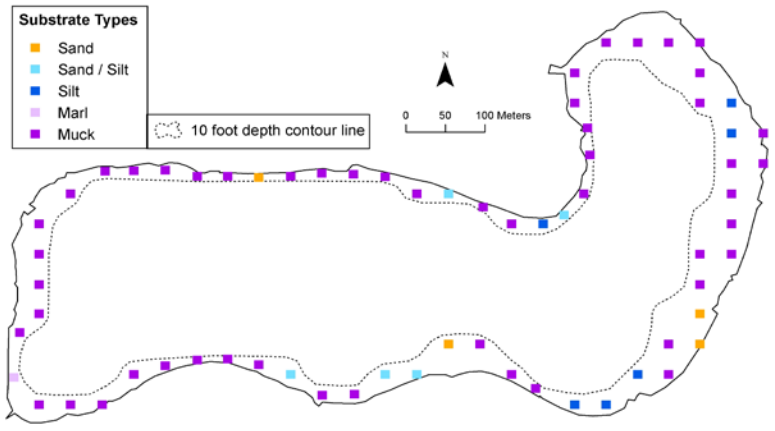
| | |
|---|---|
| boulder | diameter >10 inches |
| rubble | diameter 3 - 10 inches |
| gravel | diameter 1/8 - 3 inches |
| sand | diameter < 1/8 inch |
| silt | fine material with little grittiness |
| marl | calcareous material |
| muck | decomposed organic material |

## Results and Discussion

### Shoal Substrates

The shoal substrates of Fish Lake were primarily soft substrates of muck, silt and marl with sand occurring in patches (Figure 6).

Figure 6. 2011 shoal substrates.




### Types of plants recorded

In 2004 and 2011, a total of 31 native aquatic plant species (types) were recorded in Fish Lake

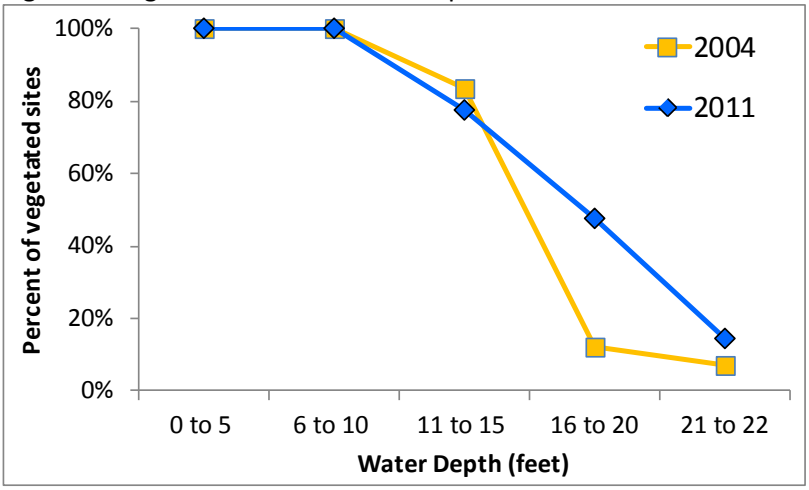
(Appendix 1), making it one of the richest lakes in the watershed in terms of number of plant species. About 80 other lakes in the watershed have been surveyed for aquatic plants and the average number of plant species found in those lakes was 11.

The Fish Lake plant community includes five emergent, four floating-leaved, two free-floating and 20 submerged plants (Appendix 1). Submerged plants included macroalgae and a diversity of rooted, flowering plants that can be grouped by leaf shape and size: dissected, small, narrow, broad and grass-leaved plants. All but one of the Fish Lake plant species are native to Minnesota. The non-native submerged plant, curly-leaf pondweed (*Potamogeton crispus*) was present during both surveys.

## Plant distribution and abundance

In 2004, 60% of sites contained plants compared to 73% in 2011. Plants were found to a maximum depth of 21 feet in 2004 and to 22 feet in 2011 but in both survey years, plants were most frequent in the 0-15 feet depth zone, where at least 95% of sites contained plants (Figure 7). Plant abundance declined with increasing water depth and in depths greater than 20 feet, only one or two sample sites contained plants.

Figure 7. Vegetated sites vs. water depth.

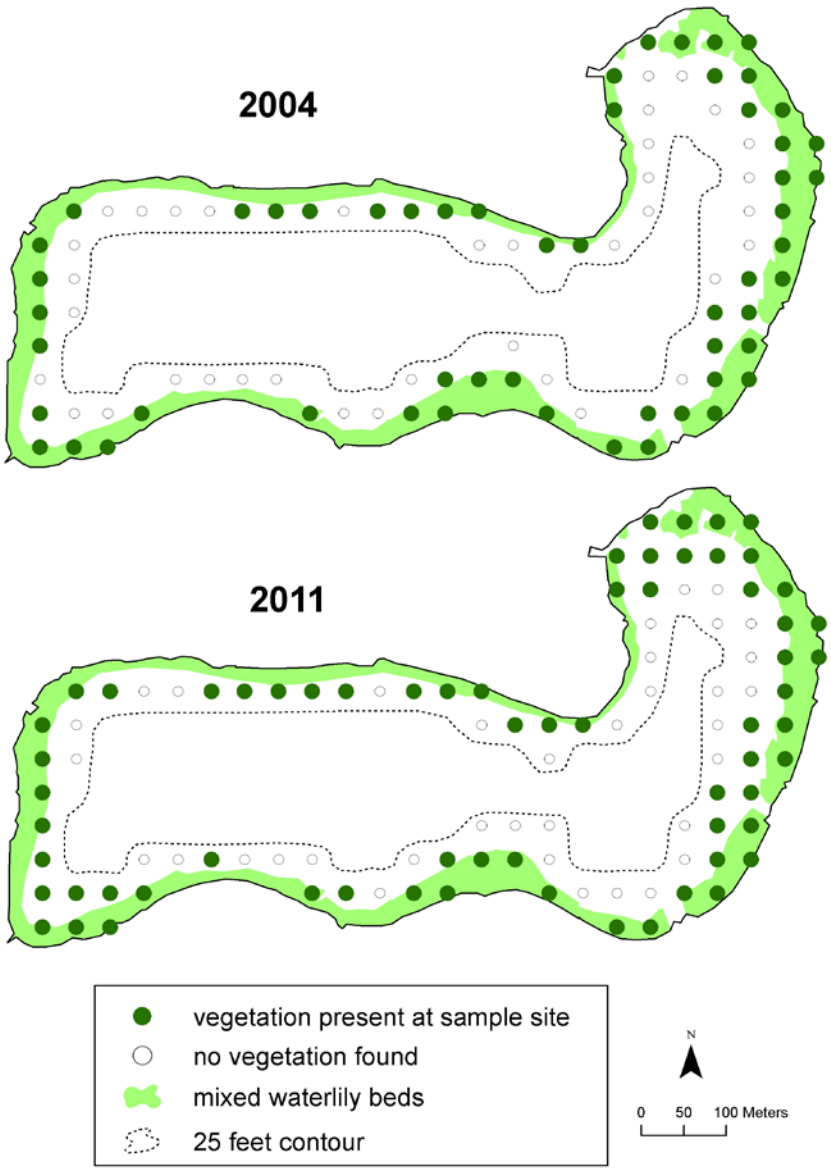



Aquatic plants were distributed in a ring around the Fish Lake shoreline (Figure 8) and extended from about 30 meters to 50 meters from shore, depending on how rapidly the shoreline sloped. For example, the narrowest zone of vegetation was found along the north shore where water depths increase rapidly from shore.

### *Floating-leaf and emergent plants*

Descriptions of the general types of plants found in Minnesota lakes are provided in Appendix 2. Beds of white and yellow waterlilies formed a nearly continuous band around the entire shoreline of Fish Lake, covering about 15 acres and extending to a water depth of about eight

Figure 8. Distribution of aquatic plants in Fish Lake, 2004 and 2011.




feet. Emergent plants, such as wild rice and bulrush, and submerged plants were often scattered within these plant beds.

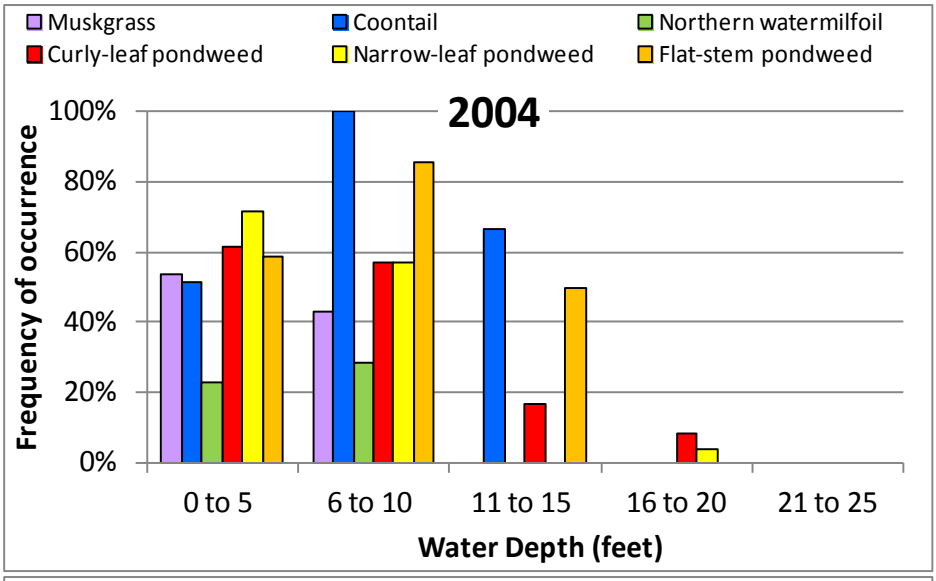
## Commonly occurring submerged plant species

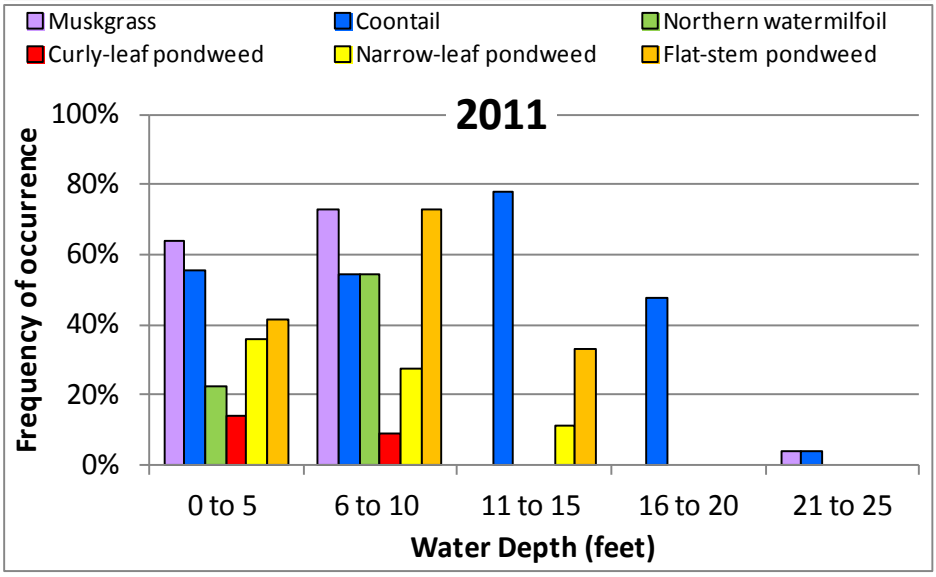
Native plant species that were common[4] in Fish Lake were coontail (*Ceratophyllum demersum*), flat-stem pondweed (*Potamogeton zosteriformis*), narrow-leaf pondweeds (*Potamogeton* spp.), muskgrass (*Chara* sp.) and northern watermilfoil (*Myriophyllum sibiricum*). Descriptions of

[4] For this report, commonly occurring species are defined as those that occurred in more than 10% of the sample sites in at least one year.

these plants are provided in Appendix 4. Coontail, flat-stem pondweed and narrow-leaf pondweed were commonly found throughout the 0-15 feet depth zone while muskgrass and northern watermilfoil were mostly restricted to shallower waters (Figure 9).

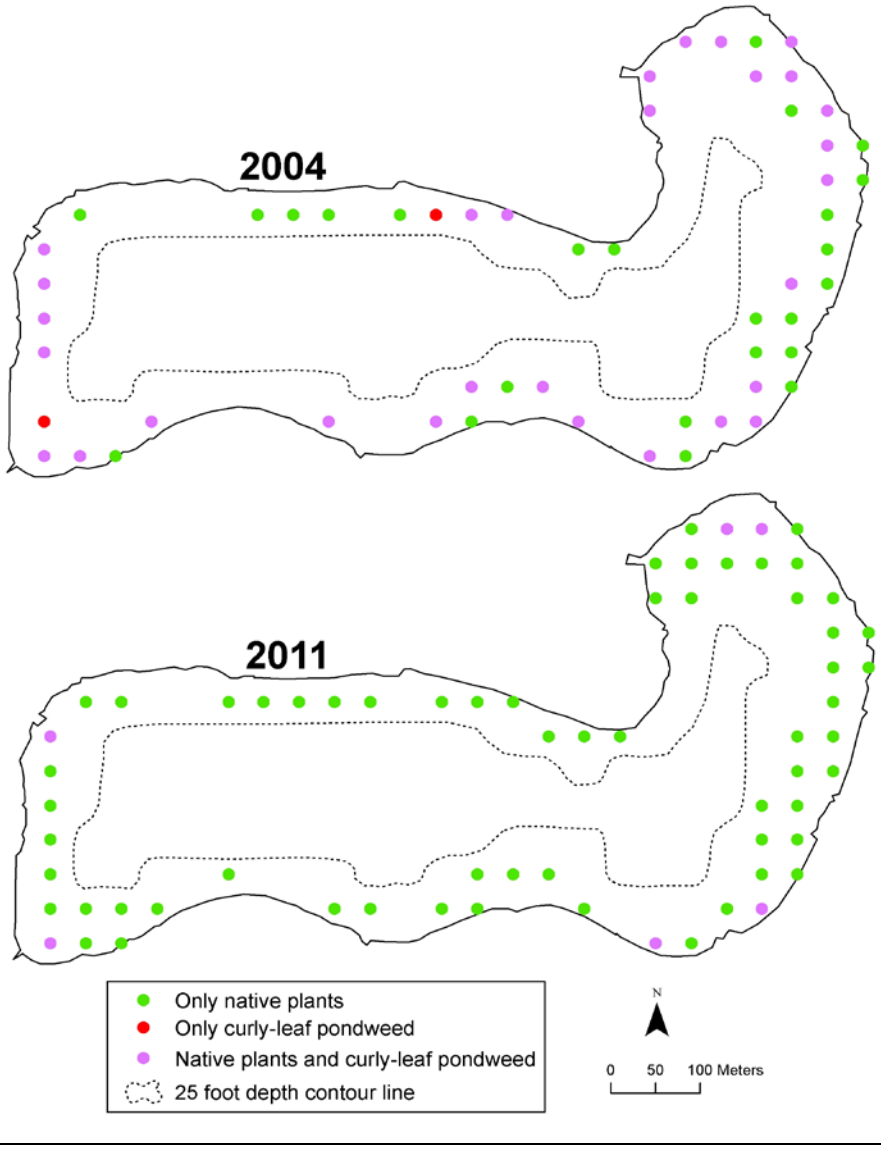
Figure 9. Frequency of common submerged plants by water depth interval.




In 2004, the non-native plant, curly-leaf pondweed, was one of the top five most frequent species, occurring in 34% of the sites. In 2011, it occurred in only 7% of the sample sites. In both years, curly-leaf did not dominate at any depth zone and was usually found in mixed stands with native plants. In 2004, 57% of the vegetated sites contained only native plants and in 2011, this percentage increased to 63% (Figure 10).

Figure 10. Curly-leaf pondweed versus native submerged plants, Fish Lake, 2004, 2011.




## Aquatic plant community dynamics

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. Within any given year, the composition and/or abundance of the plant community can vary in response to water clarity, water depth, and other environmental factors. Individual growth patterns of species also vary. Determining why plant communities change can be complicated because multiple factors may be involved.

No aquatic plant management activities have been permitted on Fish Lake and plant community dynamics are largely influenced by environmental changes and species growth

patterns. However, understanding these changes is further complicated because data on monthly water clarity, snowfall and ice-out dates are limited. It is also important to note that the 2004 through 2011 surveys were conducted in mid June and native plant communities in particular may have increased in abundance through the course of the summer.

Water clarity is one of the primary factors contributing to differences in lake plant communities. Fish Lake has relatively high clarity compared to many other lakes in the watershed. This allows many species that are not tolerant of turbidity to grow in Fish Lake.

Even if summer clarity does not fluctuate in Fish Lake, the amount of snow and ice cover on the lake can impact the amount of sunlight reaching the lake in winter months and in turn, can affect plant growth beneath the ice. Aquatic plant species differ in their strategies for surviving winter and therefore respond differently to changes in snow and ice cover. Curly-leaf pondweed, in particular, can be actively growing at low temperatures under the ice and can be negatively impacted by reduced winter light.

Because no large-scale control work is planned for Fish Lake, it provides an opportunity to continue to monitor annual changes in both native and curly-leaf pondweed populations. Patterns observed in this lake may help predict changes in plant populations of similar lakes within this Ecoregion.

## Literature Cited

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.

Flora of North America Editorial Committee, eds. 1993+. Flora of North America north of Mexico. 12+ vols. New York and Oxford. www.efloras.org

Invasive Species Program. 2011. Invasive Species of Aquatic Plants and Wild Animals in Minnesota: Annual Report for 2010. Minnesota Department of Natural Resources, St. Paul, MN. http://www.dnr.state.mn.us/eco/pubs_invasives.html

Lee, P. F. 1986. Ecological relationships of wild rice, *Zizania aquatica*. 4. Environmental regions within a wild rice lake. Canadian Journal Botany 64:2037-2044.

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. http://el.erdc.usace.army.mil/elpubs/pdf/apcmi-02.pdf

MnDNR Fisheries Lake Files. Minnesota Department of Natural Resources. Division of Fish and Wildlife, Section of Fisheries, Lake Survey Program. 500 Lafayette Rd., St. Paul, MN 55155.

MnDNR. 2008. Natural wild rice in Minnesota. A wild rice study document submitted to the Minnesota Legislature by the Minnesota Department of Natural Resources, February 15, 2008. 117 pp.
http://files.dnr.state.mn.us/aboutdnr/reports/legislative/20080215_wildricestudy.pdf

MnDNR. 2009. Minnesota's Sensitive Lakeshore Identification Manual: a conservation strategy for Minnesota lakeshores (version 2). Division of Ecological and Water Resources, Minnesota Department of Natural Resources.

MnTaxa. 2011. Minnesota State checklist of vascular plants. Minnesota Department of Natural Resources, Division of Ecological and Water Resources, St. Paul. Updated April 2011. Available on Internet: http://www.dnr.state.mn.us/eco/mcbs/plant_lists.html

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.

MPCA. 2011. Minnesota Pollution Control Agency. St. Paul, MN. Lake Water Quality Assessment Program. Lake Water Quality Data Search website: http://www.pca.state.mn.us/water/lkwqSearch.cfm (accessed April 2012)

Nichols, S.A. 1999. Distribution and habitat descriptions of Wisconsin lake plants. Wisconsin Geological and Natural History Survey. Bulletin 96. Madison. 266 pp.

Scheffer, M. 1998. Ecology of shallow lakes. Klluwer Academic Publisheres, Dordrecht.

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.

Emergent, floating-leaved and submerged plants on Fish Lake, 2004

## Appendix 1. Historical and current aquatic plants of Fish Lake, Le Sueur County

### *Submerged plants*

| Type | Common Name | Scientific Name | 1961 | 1979 | 1984 | 1995 | 1998 | 2003 | 2004 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|
| Macroalgae and moss | Muskgrass | *Chara* sp. | | A | A | X | | X | 26 | 35 |
| | Watermoss | *Not identified to genus* | | | | | | | 1 | |
| Fine-leaved plants | Water bulrush | *Schoenoplectus subterminalis* | | | | | | | | 2 |
| | Needlegrass | *Eleocharis acicularis* | | | | | X | | | |
| Small-leaved plants | Canada waterweed | *Elodea canadensis* | | | | X | X | X | 10 | 7 |
| | Bushy pondweed | *Najas flexilis* | | | | | | X | 3 | |
| | Southern naiad | *Najas guadalupensis* | | | | | X | | | |
| Narrow-leaf pondweeds | Fries' pondweed | *Potamogeton friesii* | | | | X | | | 1 | |
| | Small pondweed | *Potamogeton pusillus* | | | | | X | | | X |
| | Snail-seed pondweed | *Potamogeton spirillus* | | C | C | | | | | |
| | Straight-leaved pondweed | *Potamogeton strictifolius* | | | | | X | | | |
| | Narrow-leaf pondweed | *Potamogeton* sp. | | | | X | X | X | 36 | 19 |
| | Sago pondweed | *Stuckenia pectinata* | O | | | | X | X | | 1 |
| Intermediate size, ribbon-leaved plants | Water star-grass | *Heteranthera dubia* | | | | | X | X | 1 | 1 |
| | Wild celery | *Vallisneria americana* | | | | | X | X | | |
| | Flat-stem pondweed | *Potamogeton zosteriformis* | O | | | | X | X | 35 | 29 |
| Broad-leaf pondweeds | Large-leaf pondweed | *Potamogeton amplifolius* | O | C | C | X | X | X | 9 | 1 |
| | Illinois pondweed | *Potamogeton illinoensis* | | | | | X | | 3 | 1 |
| | River pondweed | *Potamogeton nodosus* | | | | | | X | | |
| | White-stem pondweed | *Potamogeton praelongus* | | | | | X | X | 5 | 4 |
| | Clasping-leaf pondweed | *Potamogeton richardsonii* | C | A | A | X | | | 2 | |
| | Curly-leaf pondweed (I) | *Potamogeton crispus* | | | | X | X | X | 34 | 7 |
| Plants with dissected leaves | Water marigold | *Bidens beckii* | | | | | X | X | 2 | 1 |
| | Coontail | *Ceratophyllum demersum* | O | O | O | X | X | X | 34 | 48 |
| | Northern watermilfoil | *Myriophyllum sibiricum* | A | | | X | X | X | 12 | 15 |
| | White water buttercup | *Ranunculus aquatilis* | | | | X | | | 7 | 3 |
| | Greater bladderwort | *Utricularia vulgaris* | | | | | | [G]X | 3 | 3 |
| | | **Total** | 6 | 5 | 5 | 10 | 17 | 16 | 18 | 17 |

I = introduced
[G] = plant only identified to the genus level during this survey.

## Appendix 1. (cont'd) Historical and current aquatic plants of Fish Lake, Le Sueur County

| | Common Name | Scientific Name | 1961 | 1979 | 1984 | 1995 | 1998 | 2003 | 2004 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Floating-leaved plants** | Watershield | *Brasenia schreberi* | C | | | X | X | X | 3 | 13 |
| | White waterlily | *Nymphaea odorata* | A | A | A | X | X | X | 23 | 19 |
| | Yellow waterlily | *Nuphar variegata* | A | C | A | X | X | X | 23 | 16 |
| | Floating-leaf pondweed | *Potamogeton natans* | A | C | C | X | X | X | 15 | 1 |
| | Floating-leaf burreed | *Sparganium* sp. | | | | X | | | | |
| | | **Total** | 4 | 3 | 3 | 5 | 4 | 4 | 4 | 4 |

| | Common Name | Scientific Name | 1961 | 1979 | 1984 | 1995 | 1998 | 2003 | 2004 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Free-floating plants** | Star duckweed | *Lemna trisulca* | | | | | X | X | | |
| | Turion-forming duckweed | *Lemna turionifera* | | | | | X | [G]X | [G]X | |
| | Greater duckweed | *Spirodela polyhriza* | | | | | X | X | 1 | |
| | Spotted watermeal | *Wolffia borealis* | | | | | X | | | |
| | Watermeal | *Wolffia columbia* | | | | | X | | | |
| | | **Total** | 0 | 0 | 0 | 0 | 5 | 3 | 2 | 0 |

| | Common Name | Scientific Name | 1961 | 1979 | 1984 | 1995 | 1998 | 2003 | 2004 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Emergent plants** | River bulrush | *Bolboschoenus fluviatilis* | | | | | | X | | |
| | Spikerush | *Eleocharis palustris* | R | | | | X | X | | |
| | Arum-leaved | *Sagittaria cuneata* | | [G]C | [G]C | [G]X | X | [G]X | 4 | [G]X |
| | Broad-leaf arrowhead | *Sagittaria latifolia* | | | | | X | | | |
| | Stiff-leaved arrowhead | *Sagittaria rigida* | | | | | X | | | |
| | Bulrush | *Schoenoplectus* sp. | C | A | A | X | X | X | 4 | 5 |
| | Giant burreed | *Sparganium eurycarpum* | | | | | X | [G]X | | [G]X |
| | Broad-leaved cattail | *Typha latifolia* | | A | A | | | | | |
| | Cattail | *Typha* sp. | O | | | | | | X | X |
| | Wild rice | *Zizania aquatica* | O | A | O | | X | X | 15 | 8 |
| | | **Total** | 4 | 4 | 4 | 2 | 7 | 6 | 4 | 5 |

| | Common Name | Scientific Name | 1961 | 1979 | 1984 | 1995 | 1998 | 2003 | 2004 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Shoreline wetland plants** | Sedge | *Carex* sp. | C | | | | | | X | |
| | Blue flag iris | *Iris versicolor* | | | | | | | 1 | X |
| | Reed canary grass (I) | *Phalaris arundinaceae* | O | O | O | | | | | |
| | Giant cane | *Phragmites australis* | | | | | | | X | |
| | | **Total** | 2 | 1 | 1 | 0 | 0 | 0 | 3 | 1 |

I = introduced [G] = plant only identified to the genus level during this survey.

## Appendix 1. (cont'd) Historical and current aquatic plants of Fish Lake, Le Sueur County

Sources:
1961 (July 5-7): Earl Huber (crew leader), MnDNR Division of Fish and Wildlife
1979 (July 11): Craig Berberich (crew leader), MnDNR Division of Fish and Wildlife
1984 (June 25): Craig Berberich (crew leader), MnDNR Division of Fish and Wildlife
1995 (June 22): MnDNR Division of Fish and Wildlife
1998 (August 17): Karen Myhre, MN Biological Survey, MnDNR Division of Ecological Resources
2003 (June 18): MnDNR Division of Fish and Wildlife
2004 (June 17): Donna Perleberg, Joe Backowski, MnDNR Division of Ecological Resources
2011 (June 16): Stephanie Simon, Michelle Dickson, MnDNR Division of Ecological and Water Resources

## Appendix 2: Frequency of Occurrence

Frequency of occurrence was calculated as the percent of sites, within a specific depth zone, where a plant species was detected. Unless otherwise noted, frequency values were calculated for the 0-22 feet depth zone.

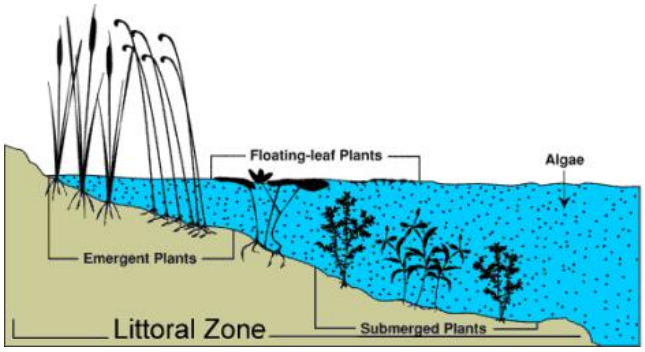
Example:
In Fish Lake there were 91 sample sites in the 0-22 feet depth zone in 2011.
Coontail occurred in 44 sites.
Frequency of Coontail in 0-22 feet zone = (44/91)*100 = 48%.

## Appendix 3: Amounts and types of aquatic plants in Minnesota lakes

Within a lake, types and amounts of aquatic plants are influenced by a variety of factors including water clarity, water chemistry, water depth, substrate, and wave activity. Deep or wind-swept areas may lack aquatic plant growth, whereas sheltered shallow areas may support an abundant and diverse native aquatic plant community. The annual abundance, distribution and composition of aquatic plant communities may change due to environmental factors, predation, the specific phenology of each plant species, introductions of non-native plant or animal species and human activities in and around the lake.

Aquatic plants can be divided into four groups or "life forms" based on whether the main portion of the plant occurs above, on, or below the water surface. These life forms: emergent, floating-leaved, free-floating and submerged plants (Figure 1), often favor certain water depth zones around the lake but overlap occurs with one life form grading into another. Each life form group has unique functions and values.

Figure 1. Forms of aquatic plants found in Minnesota lakes.




Emergent plants, like cattails and bulrush, are rooted in the lake bottom with most of their leaves and stems extending above the water surface. Floating-leaf plants, such as waterlilies, are also anchored in the lake bottom with leaves and flowers that float on the water surface. Root systems of these plants form extensive networks that take up nutrients and help consolidate and stabilize bottom substrate. Beds of floating-leaf and emergent plants also help buffer the shoreline from wave action, offer shelter for insects and young fish, and provide shade for fish and frogs. These beds also provide food, cover and nesting material for waterfowl, marsh birds and muskrat. Floating-leaf and emergent plants are most often found in shallow water to depths of about 6 feet and may extend lake-ward onto mudflats and into adjacent wetlands.

Submerged plants have stems and leaves that primarily grow underwater but they may also form flowers, fruits and some leaves that emerge above or float on the water surface. Submerged plants are typically anchored to the lake bottom but some species do drift freely with the currents. This group includes non-flowering plants such as large algae, mosses, and fern-like plants, and flowering plants that may produce flowers above or below the water surface. Submerged plants may form low-growing mats or may grow several feet in the water column with leaf shapes that include broad ovals, long and grass-like, or finely dissected. Submerged plants release oxygen into the water column, compete for nutrients with microscopic algae, and provide food and shelter for a variety of invertebrates, fish, amphibians and other wildlife.

Free-floating plants are the smallest of Minnesota's lake plants and include small flowering plants that are commonly known as "duckweeds" as well as microscopic algae. Different survey methods are required to assess microscopic algae and they are not included in this report. Duckweeds are present in many Minnesota lakes and if present in sufficient amounts, they can accumulate into mats and create a shade barrier along protected shorelines. As their name implies, they are also an important food source for waterfowl.

Plant species richness is a term used to describe the total number of plant species present in a lake and it can be used to help describe the general health of the waterbody. In Minnesota, plant species richness can range from zero (un-vegetated lakes) to more than 40 species in a lake[5]. Species richness is generally higher in high clarity lakes than in turbid lakes and more species are usually found in moderately fertile lakes than in nutrient poor lakes. Therefore, lakes of north central Minnesota are often among the "richest" in terms of numbers of plant species. Water quality changes that result in lower clarity may also result in the loss of some plant species, or lower species richness. However, caution must be used when comparing historical and present survey data because of differences in how the surveys were conducted. For example, if a current MnDNR plant survey locates more species than found during an historical "one-day" survey, it may be due to the more extensive sampling that occurs during current surveys. If fewer species are located during current surveys, it may indicate a true decline in the plant species richness of the lake.

[5] These values are from a review of MNDNR lake vegetation surveys.

## Appendix 4: Description of Plants commonly found in Fish Lake

### Emergents

Wild rice (*Zizania palustris*) prefers soft substrates (Lee 1986, Nichols 1999) and generally requires moving water for growth (MnDNR 2008). Wild rice is an annual plant that germinates each year from seed that fell to the lake bottom in the previous fall. The plant begins growth underwater and then forms a floating-leaf stage before becoming fully emergent (Figure 1). Wild rice is susceptible to disturbance because it is weakly rooted to the lake bottom. In addition to its ecological value as habitat and food for wildlife, wild rice has important cultural and economic values in Minnesota (MnDNR 2008). This valuable plant is increasingly threatened by factors such as lakeshore development and increased water recreational use (MnDNR 2008).

Figure 1. Emergent form of wild rice

Bulrushes (*Schoenoplectus* sp.) are emergent, perennial plants that are rooted in the lake bottom with narrow stems that may extend several feet above the water (Figure 2). 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 these plant beds can be very difficult, making established beds particularly unique and valuable.

Figure 2. Bulrush

### Floating-leaf plants

White and yellow waterlilies can be found in lakes in both northern and southern Minnesota. White waterlily (*Nymphaea odorata*; Figure 3) has showy white flowers and round leaves with radiating veins. Yellow waterlily (*Nuphar variegata*; Figure 4) has smaller yellow flowers and oblong leaves with parallel veins. These species often co-occur in mixed beds but yellow waterlily is generally restricted to depths less than seven feet and white waterlily may occur to depths of 10 feet (Nichols 1999).

Figure 3. White waterlily

Figure 4. Yellow waterlily

## Submerged

Coontail (Figure 5) grows entirely submerged and may float freely or be 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 and as dormant plant tips 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.

Figure 5. Coontail

Muskgrass (*Chara* sp.) is a freshwater macroalgae[6] 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 (Figure 6). 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.

Figure 6. Muskgrass

Pondweeds (*Potamogeton* spp.) are a group of aquatic plants that are primarily submerged but some will also form floating leaves. There are about 28 different native species of pondweeds in Minnesota and they can be described by their leaf shapes and sizes. These are perennial plants that are anchored to the lake bottom by rhizomes. Pondweeds can overwinter as dormant vegetative shoots. They form cigar-shaped flowers that extend above the water surface. Flat-stem pondweed (*Potamogeton zosteriformis;* Figure 7) is named for its flattened, grass-like leaves. White-stem pondweed (*Potamogeton praelongus*; Figure 8) is a 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.

Figure 7. Flat-stem pondweed

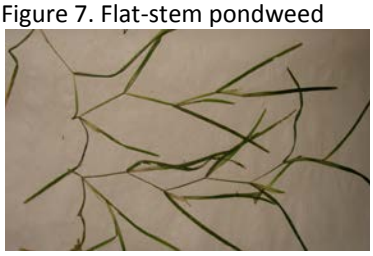


Figure 8. White-stem pondweed

Curly-leaf pondweed (*Potamogeton crispus*; Figure 9) is closely related to native pondweeds a non-native, submerged plant that

[6] 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 9. Curly-leaf pondweed

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 2011).

Like many submerged plants, curly-leaf pondweed is perennial but it has a unique life cycle that may provide a competitive advantage over native species. This plant 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).

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

Figure 10. Northern watermilfoil

Northern watermilfoil (Figure 10) 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.