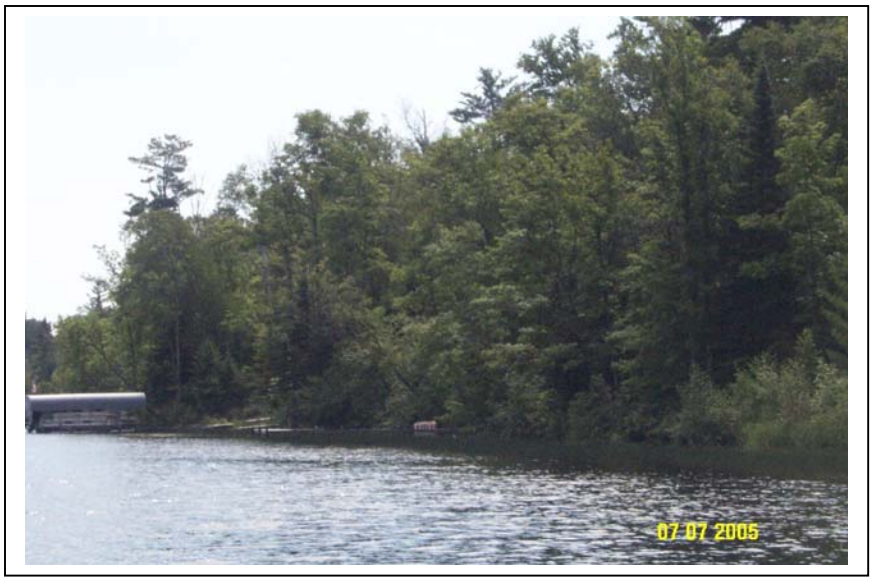
Aquatic Vegetation of
Eagle Lake (DOW 09-0057-00)
Carlton County, Minnesota
July 7, 2005



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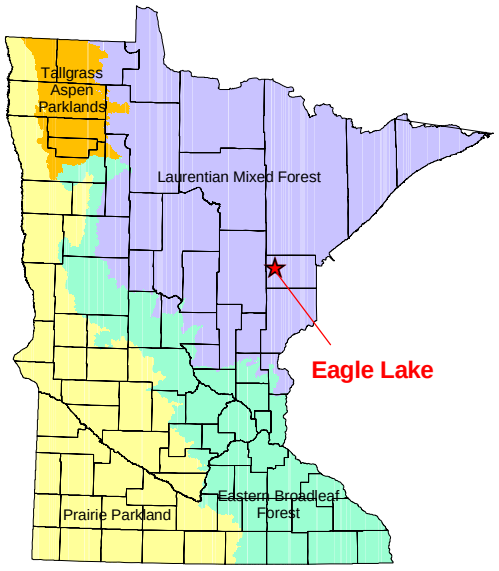
Summary

Eagle Lake aquatic plant community includes a diversity of emergent, floating-leaved and submerged plant species. At total of 23 species were recorded during the July 7, 2005 survey, including several species that are indicative of lower alkalinity lakes. Mid-summer algal blooms may limit the distribution of aquatic plants in the lake. Northern watermilfoil (*Myriophyllum sibiricum*) was commonly found to a depth of ten feet but most species were restricted to depths less than six feet.

Introduction

Figure 1. Location of Eagle Lake (09-0057-00) in Minnesota.



Survey Lake Description

Eagle Lake (09-0057-00) is located about two miles south of the town of Cromwell, Carlton County, Minnesota. The lake occurs within the ecological region called the Laurentian Mixed Forest Province, or the true forested region of the state (Fig. 1).

Eagle Lake occurs within the major watershed of the Grand Rapids branch of the Mississippi River. The lake receives flow from two inlets on the west end of the lake and one in the north. An outlet flows from the north end of the lake to Lower Island Lake, then through a series of lakes to the Tamarack River. The Tamarack River continues to the Prairie River, to Big Sandy River and then north to the Mississippi River (Fig. 2). Previous surveys report that the water level of Eagle Lake remains relatively stable in heavy rain or drought (MnDNR Lake Files). Land use in this portion of the watershed is a mix of upland and lowland deciduous forest, lowland conifer forest, shrubland and open crop and grassland.

Figure 2. Waterflow from Eagle Lake (09-0067-00) through the Mississippi River-Grand Rapids Watershed.

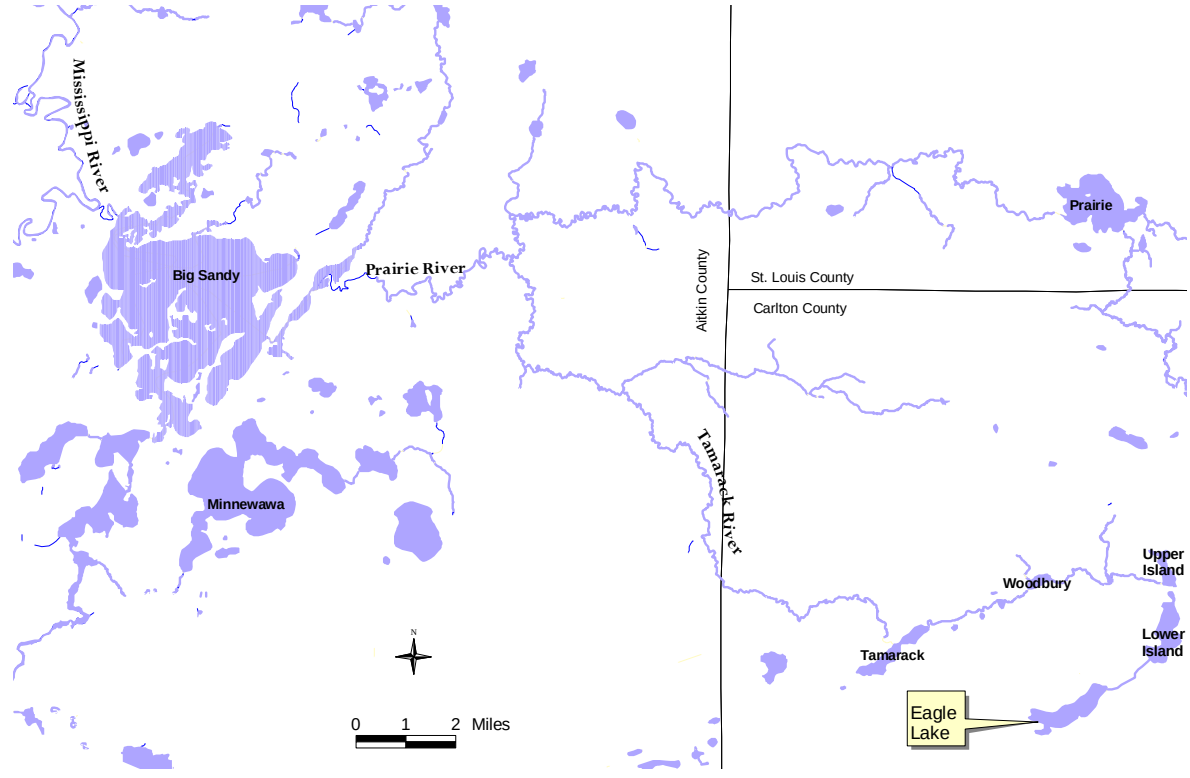
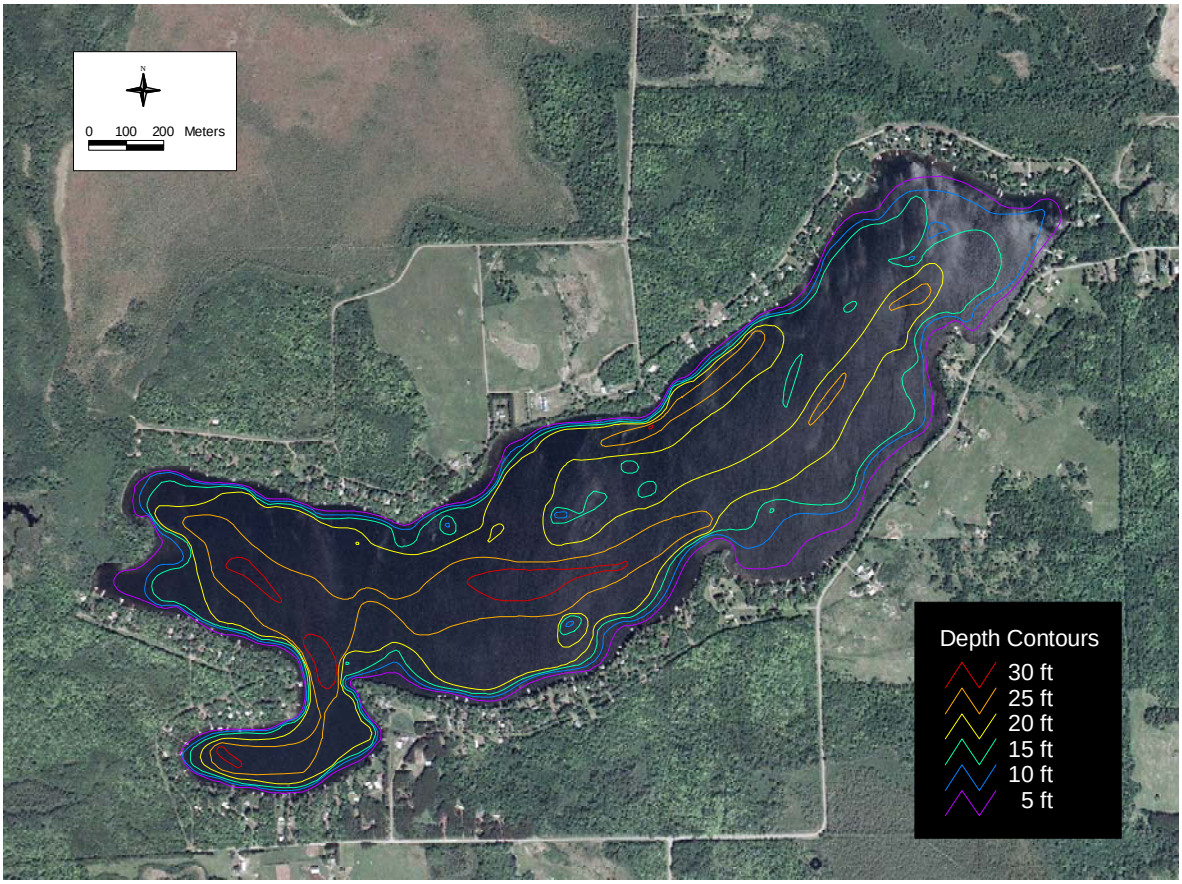


Figure 3. Hydrologic contour map Eagle Lake (09-0067-00) (photo source: Farm Service Admin 2003)



Eagle Lake has a surface area of approximately 380 acres and a maximum depth of about 35 feet. About 30 percent of the lake is shallow, with depths less than 15 feet (Fig. 3). The majority of the shoreline is developed with residential homes and a public access is located on the northeast side of the lake.

Based on 1998 water quality data, Eagle Lake's total phosphorus concentration was higher than that found for most other lakes in the region (Klang and Heiskary 1999) and the lake is classified as eutrophic. Water clarity, as measured by mean summer Secchi Disc readings from 1995 through 2005, was about eight feet (MPCA 2005) and algal blooms have been reported in late summer (MnDNR Fisheries Lake Files).

Historically, emergent vegetation has been reported around the lake perimeter with concentrations in the northern and southwestern bays and submerged vegetation has been restricted to depths of six feet or less with most plants found along the western shore (MnDNR Fisheries Lake Files).

Vegetation Survey Objectives
The purpose of the 2005 survey of Tamarack Lake 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 maps of the distribution of the common species

Methods

Point-Intercept Survey
A Point-Intercept vegetation survey of Eagle Lake was conducted on July 7, 2005 following the methodology described by Madsen (1999). Sample points were established with Geographic Information System (GIS) software using a 60 meter by 60 meter grid across the lake surface. After the survey points were generated in the GIS, they were uploaded into a Global Positioning System (GPS) unit, which was used to navigate the boat to each sample point.

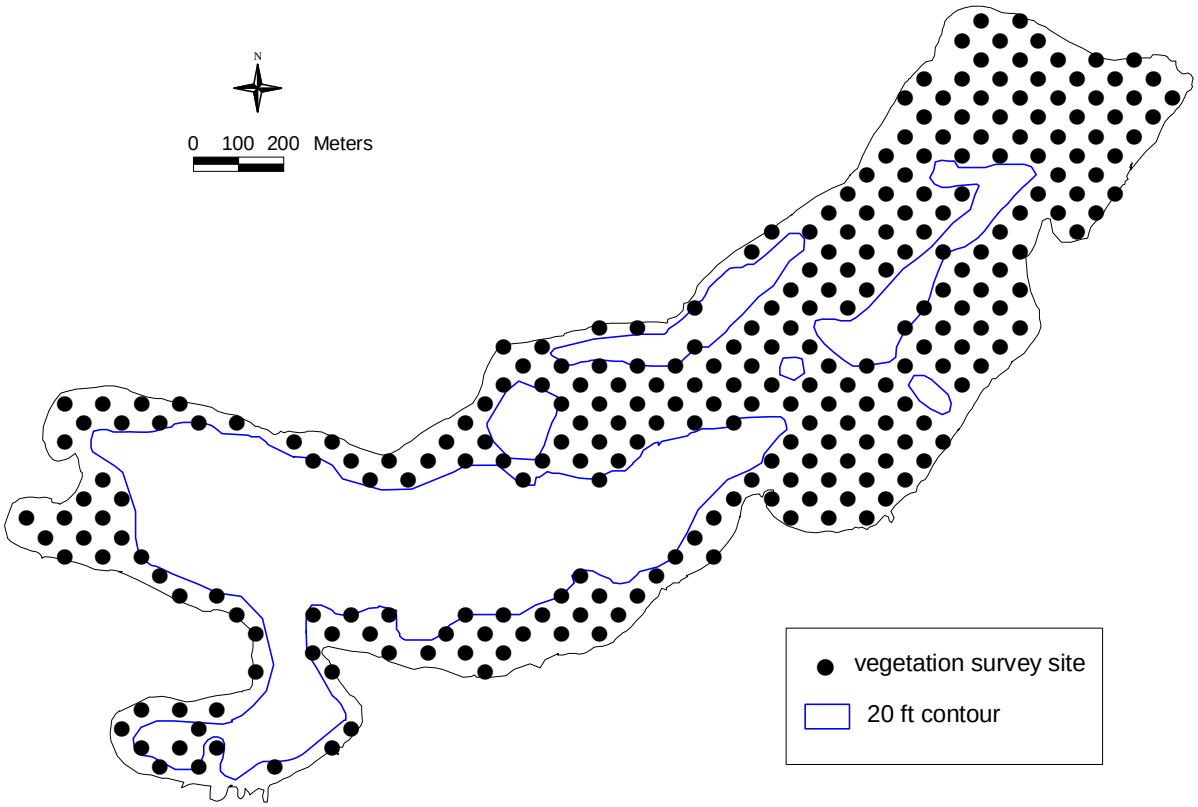
Figure 4. Rake used to sample vegetation.

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. A double-headed, weighted garden rake, attached to a rope was used to survey vegetation not visible from the surface (Fig. 4). The surveyors recorded all plant species found within a one meter squared sample site at the pre-designated side of the boat.

Nomenclature followed Crow and Hellquist (2000). Voucher specimens were collected for most plant species and are stored at the MnDNR in Brainerd. After initial field sampling, surveyors decided not to sample in depths greater than 20 feet because they were consistently not finding vegetation beyond that depth. A total of 273 points were sampled in Eagle Lake and 270 of these points fell within the shore to 20 feet zone and 72 occurred within the shore to 10 feet zone (Fig. 5).

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. Frequency values were calculated for the entire sampled area (shore to 20 feet) and for the shore to 10 feet zone. Data were also grouped into four depth zones for analysis: 0 to 5 feet, and 6 to 10 feet, 11 to 15 feet, and 16 to 20 feet.

Figure 5. 2005 Vegetation survey sites on Eagle Lake (09-0067-00). (No survey in depths > 20 ft).



Example 1:
On Eagle Lake, there were 270 sample sites within the shore to 20 feet zone.
Northern milfoil occurred 28 of those sites.
Frequency of northern milfoil in shore to 20 ft zone of Eagle Lake = 28 /270 = 10%

Example 2:
On Eagle Lake, there were 73 sample sites within the shore to 10 feet zone.
Northern milfoil occurred 26 of those sites.
Frequency of northern milfoil in shore to 10 ft zone of Eagle Lake = 26 /72 = 36%

Emergent and floating-leaf bed mapping

Major beds of emergent and floating-leaf vegetation were mapped by digitizing images from 2003 Farm Service Administration color aerial photography and from field notes. These beds were not mapped in the field using GPS and are intended only as an estimate of distribution. Further field work would be required to better estimate the locations of these vegetation stands.

Results / Discussion

Distribution of vegetation with water depth

Aquatic plants occurred to a maximum depth of 11 feet in Eagle Lake, however plants were sparse at that depth. Plants were most frequent from shore to the five feet depth where 91 percent of all of the sample sites contained vegetation. Plant occurrence declined with increasing water depths and in depths from six to ten feet, only 59 percent of the sites were vegetated (Fig. 6). Beyond the ten feet depth, only one sample site contained vegetation.

Figure 6. Distribution of aquatic vegetation vs. water depth in Eagle Lake (09-0057-00) July 7, 2005.

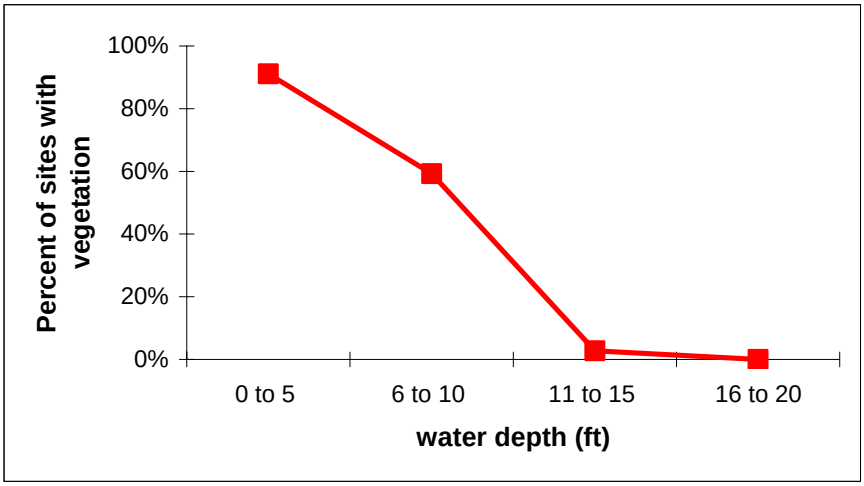
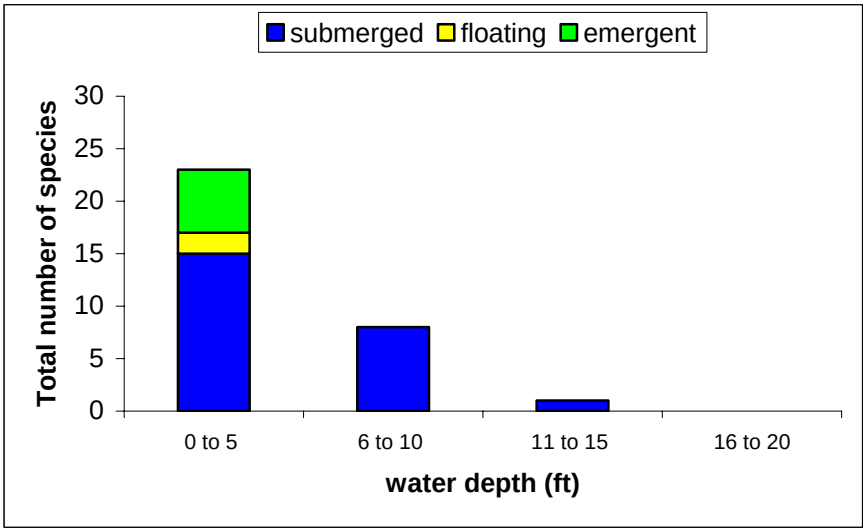


Figure 7. Types of plants in each water depth zone in Eagle Lake (09-0057-00) July 7, 2005.



Types of aquatic plants found

During the surveys of Eagle Lake, a total of 23 aquatic plant species were found, including six emergent, two floating-leaved, and 15 submerged (Table 1). No non-native aquatic plant species were observed during the survey. All species occurred in the zone from shore to a depth of five feet and only eight species occurred beyond that depth (Fig. 7).

Emergent and floating-leaved plants

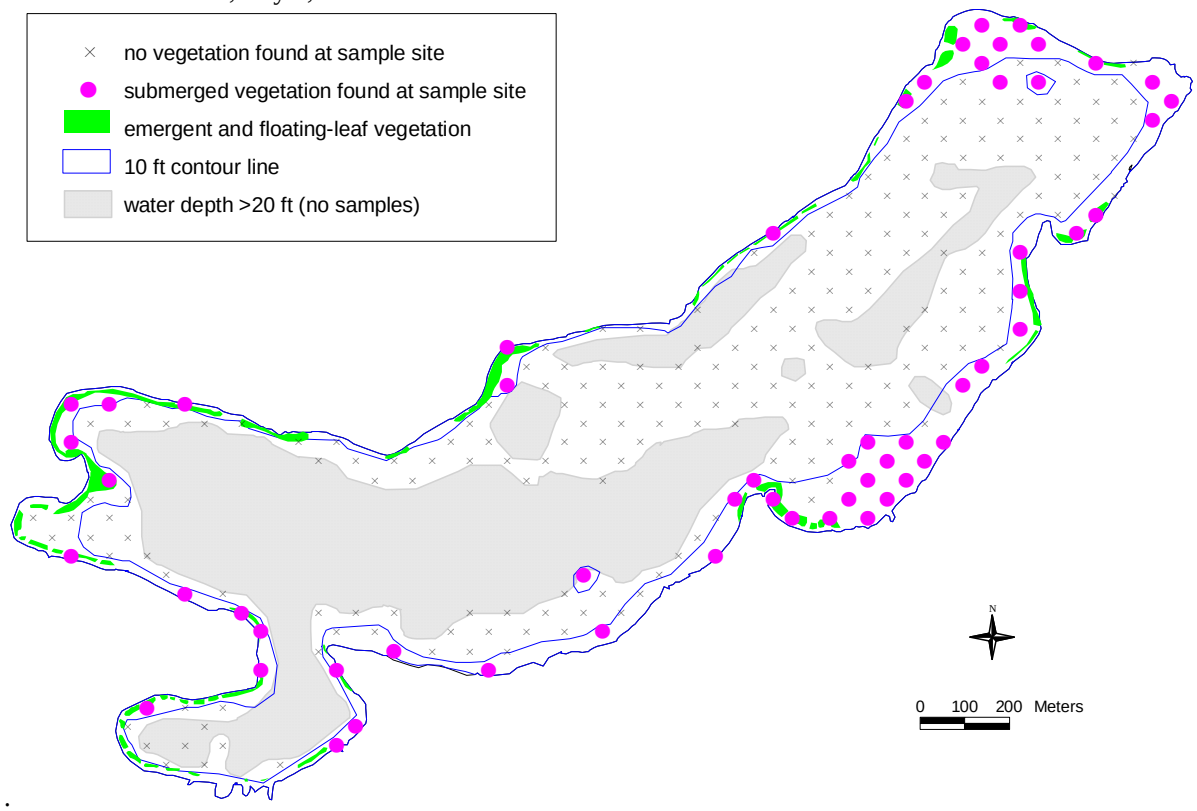
Emergent and floating-leaved species were restricted to depths less than six feet (Fig. 7) and within this zone, 24 percent of the sample sites contained at least one emergent or floating-leaf species. Emergent and floating-leaved species were most common in the shallow areas at the west and north ends of the lake and scattered areas along the south shore (Fig. 8).

Table 1. Aquatic Plants of Eagle Lake, Carlton County (DOW 09-0057-00), July 7, 2005

			FREQUENCY = percent of sites in which species occurred	
Life Forms	**Common Name**	**Scientific Name**	**Shore to 20 ft (270 sites)**	**Shore to 10 ft (72 sites)**
SUBMERGED These plants grow primarily under the water surface. Upper leaves may float near the surface and flowers may extend above the surface. Plants are usually rooted or loosely anchored to the lake bottom.	Northern water milfoil	*Myriophyllum sibiricum.(v)*	0.10	0.36
	Variable pondweed	*Potamogeton gramineus (v)*	0.05	0.19
	Wild celery	*Vallisneria americana (v)*	0.05	0.18
	Water marigold	*Megaladonta beckii(v)*	0.03	0.11
	Clasping-leaf pondweed	*Potamogeton richardsonii (v)*	0.03	0.10
	Large-leaf pondweed	*Potamogeton amplifolius (v)*	0.01	0.06
	Bushy pondweed	*Najas flexilis (v)*	0.01	0.06
	Water stargrass	*Zosterella dubia*	0.01	0.06
	Narrow-leaf pondweed	*Potamogeton sp. (v)*	0.01	0.03
	Flatstem pondweed	*Potamogeton zosteriformis*	0.01	0.03
	White-stem pondweed	*Potamogeton praelongus (v)*	0.01	0.03
	White water buttercup	*Ranunculus sp. (v)*	<0.01	0.01
	Muskgrass	*Chara sp.*	<0.01	0.01
	Quillwort	*Isoetes sp. (v)*	<0.01	0.01
	Star duckweed	*Lemna trisulca*	<0.01	0.01
FLOATING These plants are rooted in the lake bottom and have leaves that float on the water surface.	Yellow waterlily	*Nuphar variegata(v)*	0.01	0.06
	Floating-leaf burreed	*Sparganium sp. (v)*	present	present
EMERGENT These plants extend well above the water surface and are usually found in shallow water, near shore.	Spikerush	*Eleocharis sp. (v)*	0.01	0.06
	Bulrush	*Scirpus sp. (v)*	0.01	0.04
	Horsetail	*Equisetum fluviatile (v)*	0.01	0.01
	Giant burreed	*Sparganium eurycarpum (v)*	present	present
	Arrowhead	*Sagittaria sp. (v)*	present	Present
	Calla lily	*Calla palustris (v)*	Present	Present
	Cattail	*Typha sp.*		

(v) = voucher specimen collected
present = species was found in lake but did not occur in sample sites

Figure 8. Distribution of submerged, floating-leaf and emergent vegetation in Eagle Lake (09-0057-00) Carlton Co., July 7, 2005



Emergent and floating-leaf beds along undeveloped shores were often continuous while those along developed shores were broken by cuts created perpendicular to shore for boat access and other recreational use.

Common emergent species found in Eagle Lake included spikerush (*Eleocharis* sp.), Bulrush (*Scirpus sp*.), horsetail (*Equisetum fluviatile)*, and giant burreed (*Sparganium eurycarpum*). Yellow waterlily (*Nuphar variegata*) and floating-leaved burreed (*Sparganium* sp.) were the common floating-leaved species present.

Figure 9. Stand of emergent horsetail (*Equisetum fluviatile*) in Eagle Lake (09-0057-00), July 7, 2005.

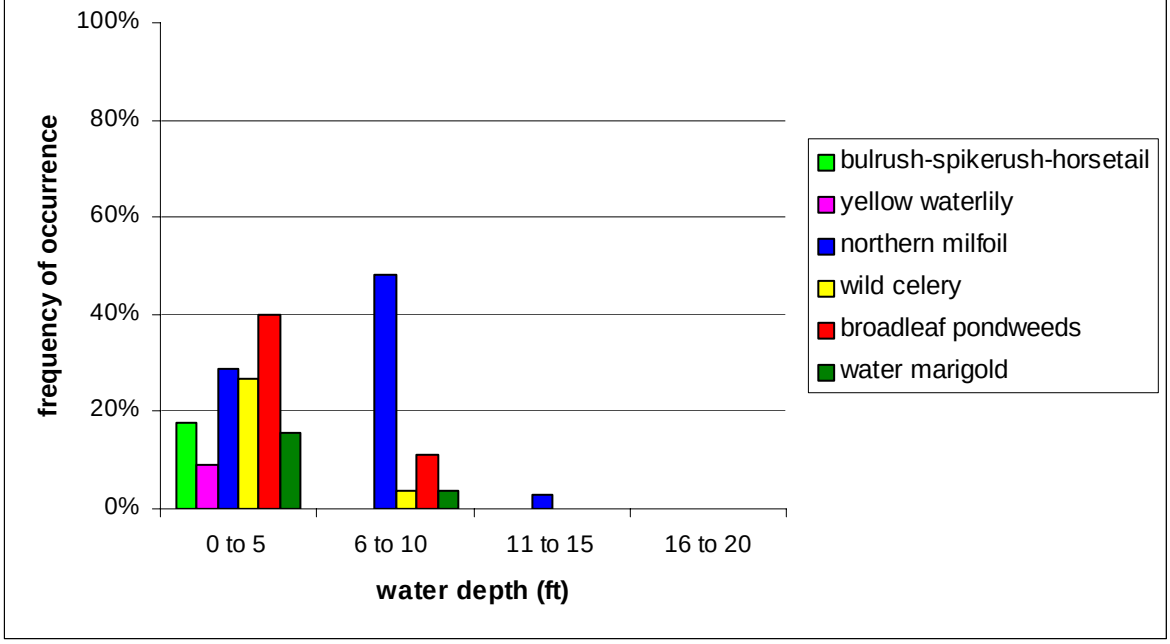
Submerged plants

Submerged plants were the most abundant type of vegetation in

Eagle Lake but were present in only 20 percent of all sites surveyed. Most submerged species were restricted to depths less than six feet (Fig. 7) and submerged plant growth was mostly in the zone from shore to ten feet where 79 percent of sites contained submerged plants.

Northern watermilfoil (*Myriophyllum sibiricum*) was the most frequently occurring submerged species and was present in 36 percent of the sites from shore to 10 feet. It was the species with the greatest depth range and was the only species found to the maximum depth of 11 feet. It was most common in depths from six to 10 feet where it occurred with a frequency of 48 percent (Fig. 10). Northern water milfoil was most often found in the east half of the lake (Fig. 11).

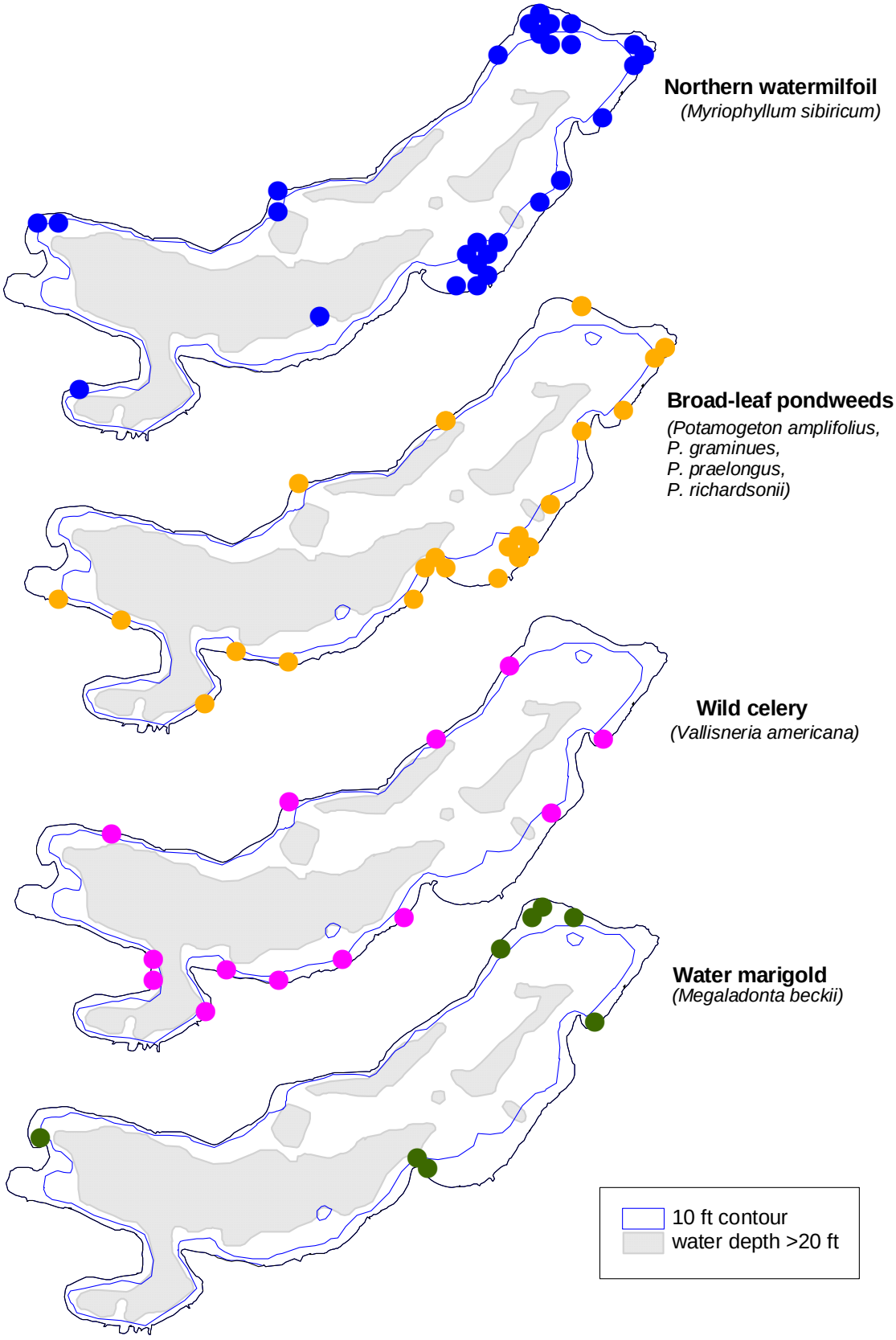
Figure 10. Frequency of common aquatic plant species by depth zone in Eagle Lake (09-0057-00) Carlton County, MN July 7, 2005.



Broad-leaf pondweeds are a group that includes variable pondweed (*Potamogeton gramineus*), clasping-leaf (*Potamogeton richardsonii*), large-leaf (*Potamogeton amplifolius*), and white-stem pondweed (*Potamogeton praelongus*). These species are sometimes referred to as "cabbage" because of their broad submerged leaves. In Eagle Lake, this group of species was most common in depths less than six feet (Fig. 10) and was widespread around the lake in shallow water (Fig. 11). The most common species in this group was variable pondweed, which was found in 19 percent of the shallow water (shore to 10 feet) sample sites (Table 1).

Wild celery (*Vallisneria americana*) occurred in 18 percent of the sites from shore to 10 feet (Table 1). It was found to a depth of seven feet but was most abundant in depths less than six feet (Fig. 10). Wild celery prefers hard substrates and was found at several locations around the lake, usually at sites where northern milfoil was absent (Fig. 11).

Figure 11. Distribution of common aquatic plant species in Eagle Lake (09-0067-00), July 7, 2005.



Water marigold (*Megaladonta beckii*) was primarily found in the east half of the lake (Fig. 10). This species was present in 11 percent of the sites from shore to 10 feet and was restricted to depths less than six feet (Fig. 9)

All other species were found in less than 10 percent of all surveyed sites (Table 1). Some species found in Eagle Lake are associated are associated with low alkalinity waters of northeastern Minnesota lakes. These include quillwort (*Isoetes* sp.) and floating-leaf burreed (*Sparganium* sp.).

The aquatic plant community of Eagle Lake includes a diversity of species and their different life forms provide valuable habitat for fish and wildlife, (Click here for more information on: value of aquatic plants). Low water clarity in mid-summer likely prevents much plant growth beyond the depth of ten feet. Some species, such as the broad-leaf pondweeds and water marigold, are very intolerant of turbidity or low light and are even further restricted to shallow water.

The 2005 vegetation survey of Eagle Lake gives a "snapshot" of the aquatic plant community. Data collected during the 2005 survey can be compared to future quantitative surveys of this lake to better estimate how the plant community may be changing. Monitoring changes in aquatic plant communities can help reflect changes in the overall water quality of the lake and watershed.

Factors that may lead to change in the aquatic plant community of Eagle Lake include:

- **Change in water clarity**
  Light availability is a significant factor limiting plant distribution and abundance. The amount of light available to submersed aquatic plants is typically dependent on both water clarity and depth. Excess nutrients, such as elevated phosphorus levels, that result in higher algal levels, can lead to lower water clarity. If water clarity decreases, submerged vegetation may be less common.
- **Water level fluctuations**
  Most aquatic plants are adapted to minor changes in water levels, but large fluctuations may result in changes in plant distribution and species composition.
- **Snow cover**
  Many submerged plants 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, some submerged plants may increase in abundance.
- **Water temperatures / length of growing season**
  In years with cool spring temperatures, submerged plant growth may be less dense than in years with early springs and prolonged warm summer days.
- **Natural fluctuation in plant species.**
  Many submerged plants are perennial and grow in similar locations each year. However, a few species, such as bushy pondweed (*Najas flexilis*), are annuals and are dependant on the previous years seed set for regeneration.
- **Herbivores**
  Native wildlife, such as muskrats and native crayfish, as well as non-native species like carp and rusty crayfish, can cause declines in aquatic plant communities.
- **Human 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. The shallow zone where most aquatic plant growth occurs is also the area most likely to be impacted by shoreland development and recreational use. 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.

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