Aquatic Vegetation of
Norway Lake (DOW 11-0307-00)
Cass County, Minnesota

May 27 and 28, 2008

Pelicans in Norway Lake, Cass County, MN. May 28, 2008.

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Summary

An aquatic vegetation survey of Norway Lake, Cass County, Minnesota, was conducted on May 27 and 28, 2008. Seventeen native aquatic plant taxa were identified including three emergent, two floating-leaved, and twelve submerged plants. The portion of the lake from shore to five feet deep contained the highest number of species.

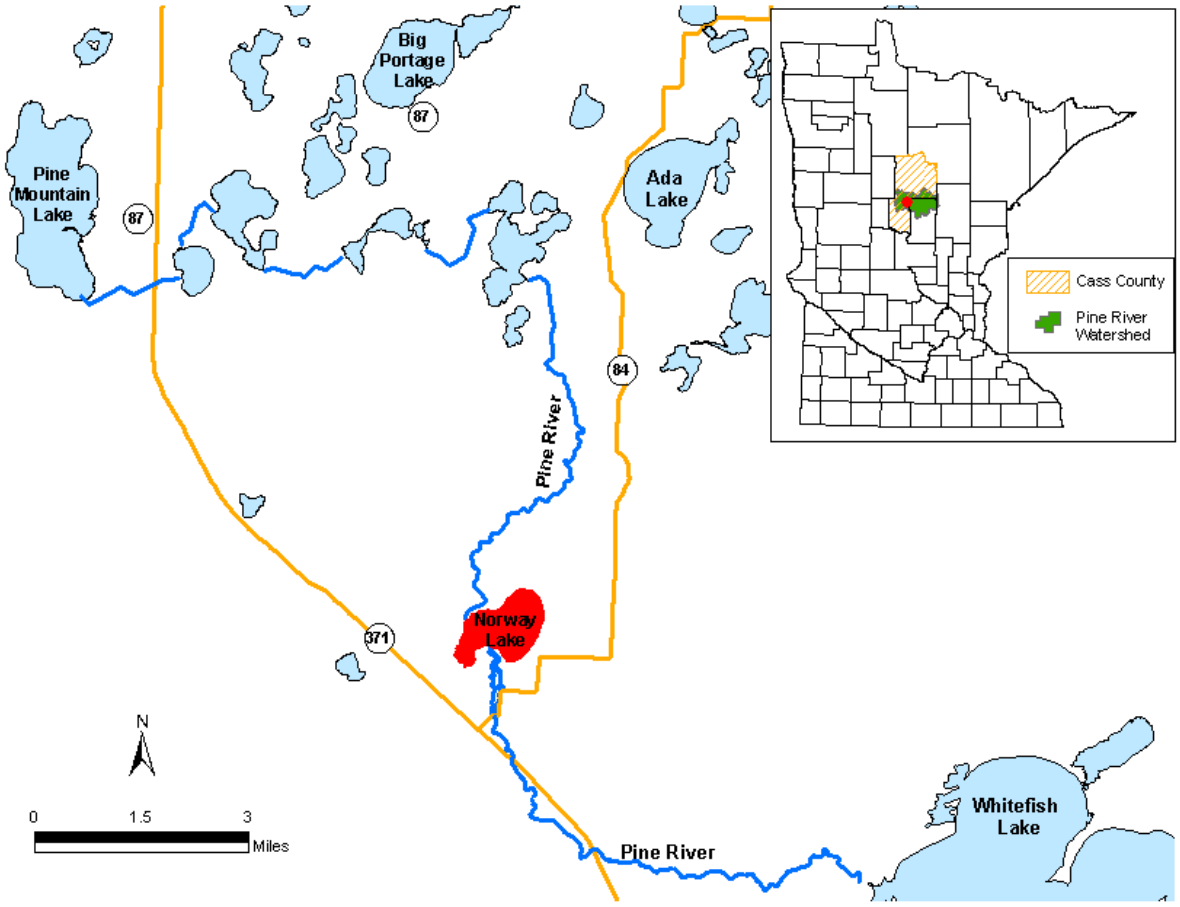
Plants were found distributed throughout the lake basin to a maximum depth of twelve feet and 93% of the sample sites contained vegetation. Extensive beds of wild rice (*Zizania palustris*) occurred along the western shorelines to a depth of about six feet. Submerged plants were found to the maximum depth of twelve feet. The most frequently occurring submerged plants were coontail (*Ceratophyllum demersum*) (found in 84% of the sample sites), flat-stem pondweed (*Potamogeton zosteriformis*) (31%), star duckweed (*Lemna trisulca*) (27%), Canada waterweed (*Elodea canadensis*) (16%), northern watermilfoil (*Myriophyllum sibiricum*) (14%), and muskgrass (*Chara* sp.) (11%).

The non-native species, curly-leaf pondweed (*Potamogeton crispus*) occurred in only one percent of the sample sites. Curly-leaf pondweed was not found in depths greater than five feet and often co-occurred with the common native species.

Introduction

Norway Lake is located in the City of Pine River, in Cass County, north-central Minnesota. The Pine River originates about 14 miles upstream from Norway Lake in Pine Mountain Lake and flows through several lakes before reaching the north end of Norway Lake (Figure 1). Norway Lake is an impoundment on the Pine River, created by a dam at the south end of the lake. Flow continues southeast from Norway Lake to Whitefish Lake and eventually empties to the Mississippi River.

Figure 1. Norway Lake and Pine River inlet and outlet, Cass County, Minnesota.



Norway Lake is a shallow lake with a surface area of 524 acres and max depth of 12 feet (Figure 2). The shoreline is developed with residential homes. There are two public boat launches on Norway Lake and access is also available from the Pine River City Park launch.

From 1997 to 2007, water clarity in Norway Lake, as measured by Secchi disc readings, ranged from 7.0 to 9.5 feet with a mean of 8 feet (MPCA 2008). The Secchi disc (Figure 3) transparency measures the depth to which a person can see into the lake and provides an estimate of the light penetration into the water column. As a general rule, sunlight can penetrate to a depth of two times the Secchi depth and aquatic plants can grow to one and a half times the

Figure 2. Depth contours of Norway Lake, Cass County, MN (based on 2008 depth data.).

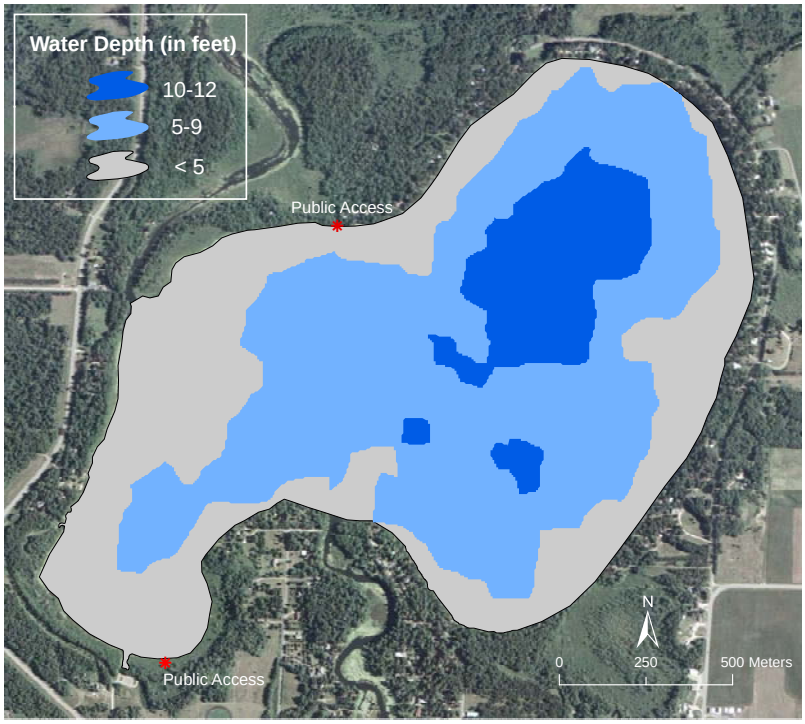


Figure 3. Measuring water clarity with a Secchi disk.

Secchi depth. Based on Secchi disk measurements alone, aquatic plants might be expected to grow to the maximum depth of 12 feet in Norway Lake. Distribution of plants in areas with adequate light may be influenced by substrate types, wind fetch, and plant species composition.

Previous vegetation surveys of Norway Lake were conducted in 1948, 1973, 1988 and 2006 (MnDNR Fisheries Lake Files). In all survey years, surveyors described abundant submerged plant growth throughout Norway Lake. A total of 27 different native aquatic plant species have previously been recorded in the lake including bulrush (*Scirpus* sp.), cattail (*Typha* sp.), white water lily (*Nymphaea odorata*), yellow water lily (*Nuphar variegata*), a variety of pondweeds (*Potamogeton* spp.), muskgrass (*Chara* sp.), coontail (*Ceratophyllum demersum*), and northern watermilfoil (*Myriophyllum sibiricum*).

Objectives

The purpose of this vegetation survey was to provide a quantitative description of the spring 2008 plant population of Norway Lake. Specific objectives included:

1) Describe the shoal sediments of the lakes
2) Record the aquatic plant species that occur in the lakes
3) Estimate the maximum depth of rooted vegetation
4) Estimate the percent of the lake occupied by rooted vegetation
5) Estimate the abundance of common species
6) Develop distribution maps for the common species or species groups

Because this survey was conducted in the spring, before native plants reach maximum growth, the distribution and abundance of some native plant species may be underestimated.

Methods

Norway Lake was surveyed on May 27 and 28, 2008. A Point-intercept survey method was used and followed the methods described by MnDNR (2008) and Madsen (1999). Surveys included two survey crews, each consisting of one boat and two surveyors. Survey waypoints were created using a Geographic Information System (GIS) computer program and downloaded into a Global Positioning System (GPS) receiver. Survey points were spaced 80 meters (262 feet) apart on Norway Lake for a total of 288 sample sites (Figure 4, Table 1).

Figure 4. Vegetation survey sites in Norway Lake, May 2008.

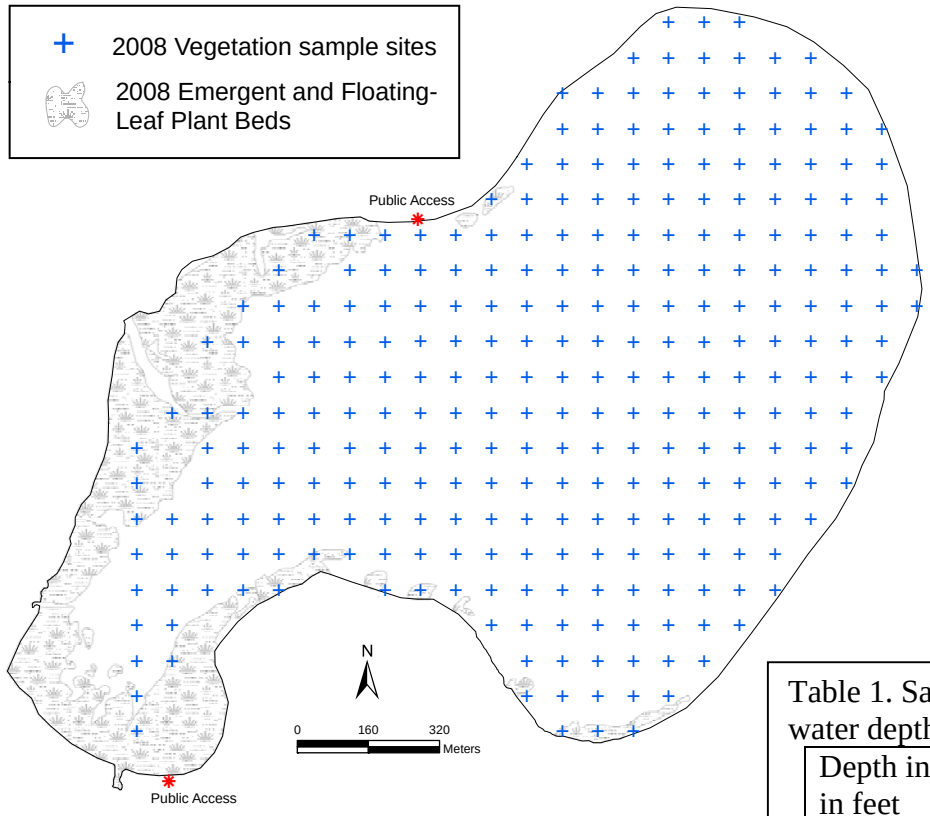


Table 1. Sampling effort by water depth.

Depth interval in feet	Number of sample points
0 to 5	108
6 to 10	164
11 to 12	16
Total sample points	288

The GPS unit was used to navigate the boat to each sample point and one side of the boat was designated as the sampling area. At each site, water depth was recorded in one-foot increments. At each sample site where water depth was six feet or less, surveyors described the bottom substrate using standard substrate classes (Table 2).
A double-headed, weighted garden rake (Figure 5), attached to a rope was used to survey vegetation not visible from the surface. The surveyors recorded all plant species found within a one meter squared sample site at the pre-designated side of the boat.

Plant identification and nomenclature followed Crow and Hellquist (2000). Voucher specimens were collected for most plant species and are stored at the MnDNR office in Brainerd. 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 of occurrence was also calculated for each of the three depth intervals (Table 1).

Example:
In Norway Lake there were 288 samples sites. Coontail occurred in 242 of those sites.
Frequency of coontail =242/288 (*100) = 84 %.

Figure 5. Sampling rake.

Results

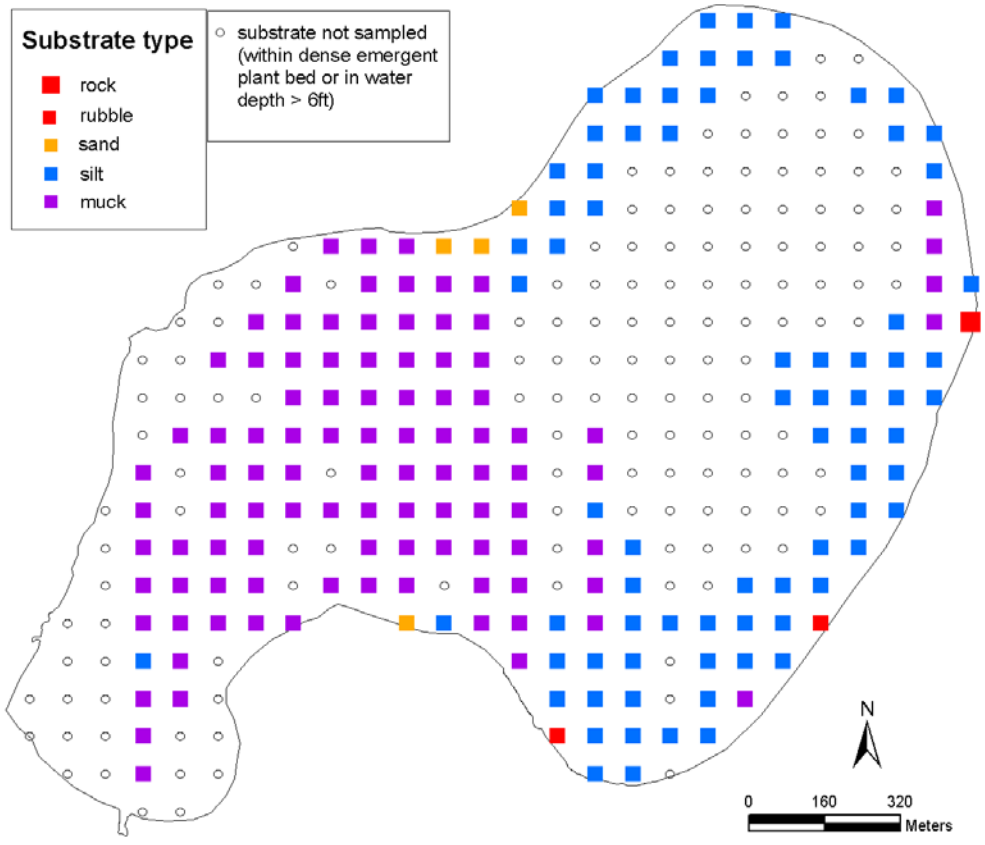
Shoal sediments

The majority of shallow water sites (0 to 6 feet of water) contained soft sediments that were described as silt or muck (Figure 6). A few near-shore locations contained areas of sand, rubble or rock.

Table 2. Substrate classes

muck	decomposed organic material
marl	calcareous material
silt	fine material with little grittiness
sand	Diameter less than 1/8 inch
gravel	Diameter 1/8 to 3 inches
rubble	Diameter 3 to 10 inches
boulder	Diameter over 10 inches

Figure 6. Shoal sediments of Norway Lake, 2008.



Number and types of plant species recorded

A total of 17 native aquatic plant species were recorded in Norway Lake including three emergent, two floating-leaved and 12 submerged species (Table 3). One non-native submerged species, curly-leaf pondweed (*Potamogeton crispus*) was identified.

Table 3. Plant species frequency of occurrence, Norway Lake, May 2008.

Plant Type	Common name	Scientific name	**Frequency** of occurrence (n= 288)
Native Submerged	Coontail	*Ceratophyllum demersum*	84
	Flatstem pondweed	*Potamogeton zosteriformis*	31
	Star Duckweed	*Lemna trisulca*	27
	Canada waterweed	*Elodea canadensis*	16
	Northern watermilfoil	*Myriophyllum sibiricum*	14
	Muskgrass	*Chara* sp.	11
	Greater Bladderwort	*Utricularia vulgaris*	8
	Watermoss	Not identified to genus	5
	White-stem pondweed	*Potamogeton praelongus*	2
	White Water Buttercup	*Ranunculus aquatica*	1
	Water stargrass	*Heteranthera dubia*	1
	Fries pondweed	*Potamogeton friesii*	<1
Non-native submerged	Curly-leaf pondweed	*Potamogeton crispus*	1
Floating-leaved	White water lily	*Nymphaea odorata*	2
	Yellow water lily	*Nuphar variegata*	1
Emergent	Wild rice	*Zizania palustris*	9
	Bulrush	*Scirpus acutus*	<1
	Cattail	*Typha* sp.	present

Distribution and maximum depth of plant growth

Plants were found to a depth of 12 feet, the maximum depth in Norway Lake but plant occurrence was greatest from shore to a water depth of 10 feet, where vegetation was found in 94% of the sample sites (Figure 7). In depths greater than 10 feet, only 16% of sites were vegetated.

Most of the plant species (17 of 18) were found in shallow water, less than 6 feet deep, while only two species were sampled in the 11 to 12 feet depth zone (Figure 8).

Figure 7. Plant abundance vs. water depth. Norway Lake. May 2008

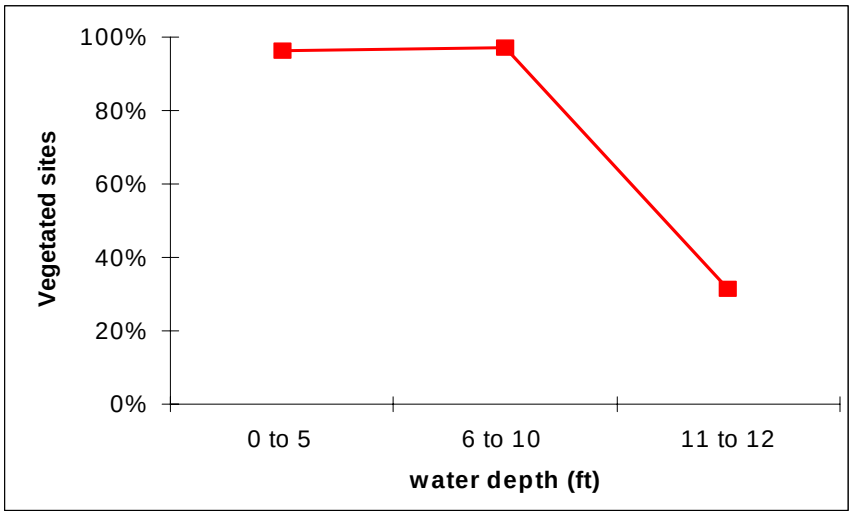
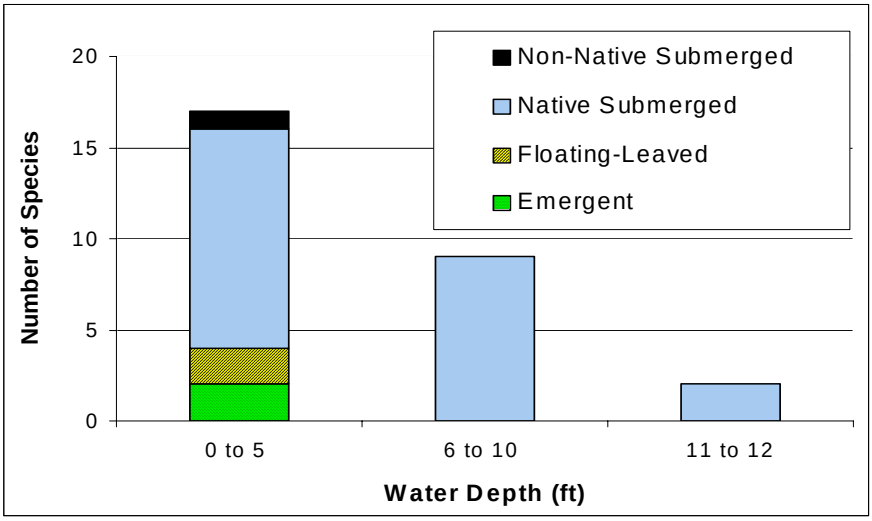


Figure 8. Plant types by water depth. Norway Lake, May 2008.



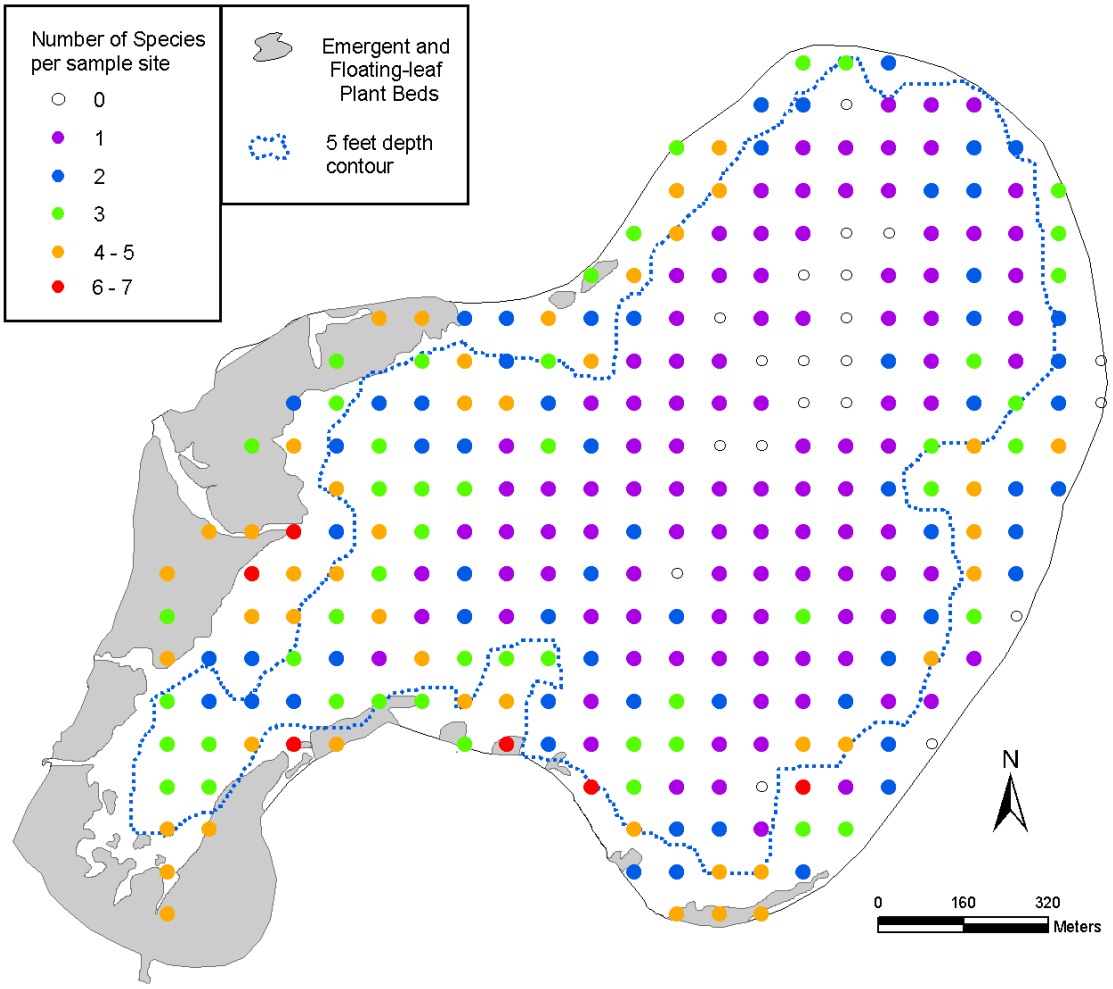
Distribution of aquatic plants

Aquatic plants occurred throughout all depths of Norway Lake and 93% of all survey sites contained vegetation. The number of different species found at each survey site ranged from zero to seven (Figure 9) and the mean number of species found per site was two.

Emergent and floating-leaved species

About 21 acres of emergent and floating-leaf plant beds were mapped from aerial photography and the most extensive beds occurred along the western shore (Figure 9).

Figure 9. Number of species found at each sample site. Norway Lake, May, 2008.



Wild rice (*Zizania palustris*) (Figure 10) was the most common emergent plant found in Norway Lake. Wild rice is an annual aquatic plant that grows as a floating-leaf plant in early spring and then as an emergent plant in summer and fall. During the June 2008 field survey, wild rice was primarily in the early floating-leaf stage. It occurred in 25% of sites between shore and the five feet depth. This likely underestimates the actual occurrence of wild rice in Norway Lake because surveyors did not sample dense areas of wild rice in order to avoid unnecessary damage to the plants.

Figure 10. Floating stage of wild rice.

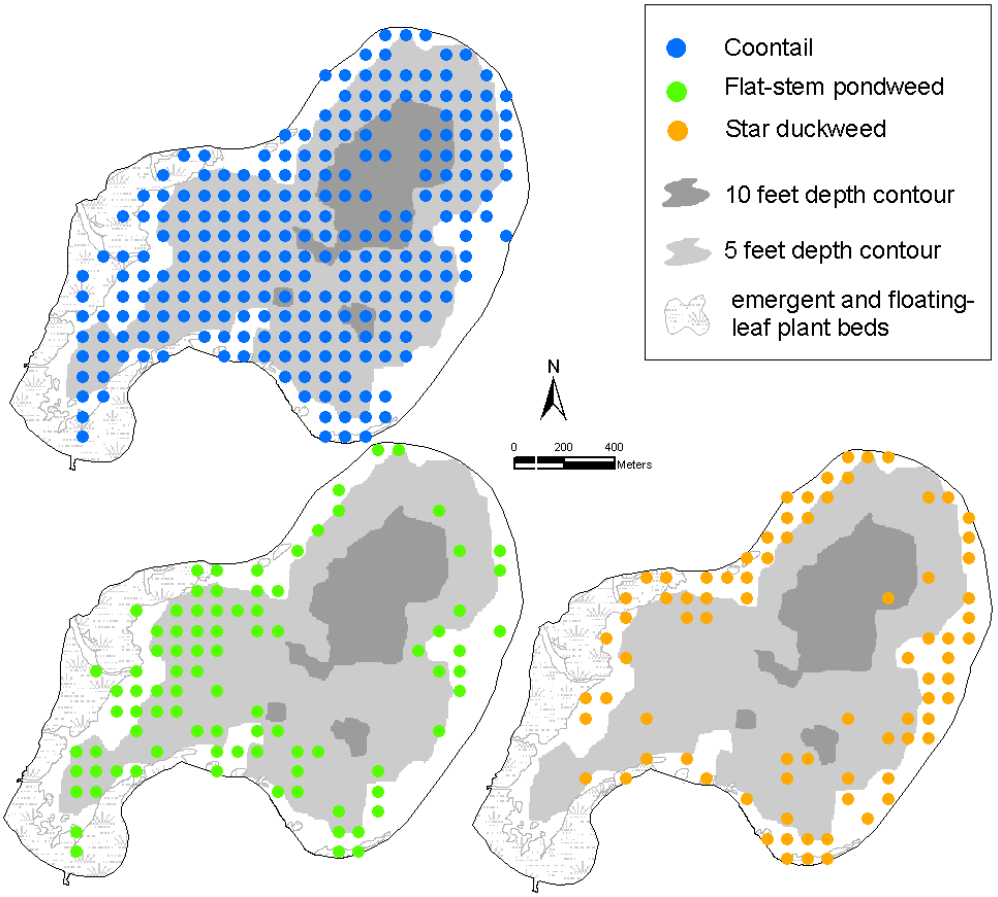
Hardstem bulrush (*Scirpus acutus*) and cattail (*Typha* sp.) were other emergent plants sampled during the spring survey. Floating-leaf plants found included white waterlily (*Nymphaea odorata*) and yellow waterlily (*Nuphar variegata*). Emergent and floating-leaf plants help buffer the shoreline from wave action and their root systems stabilize the lake bottom. Wild rice, bulrush and other emergent aquatic plants offer shelter for insects and young fish as well as food,

cover and nesting material for waterfowl, marsh birds and muskrats. Waterlily beds provide similar benefits and also provide shade for fish and frogs.

Submerged plants

Submerged plants were common throughout Norway Lake and included large algae, grass-leaved plants, plants with finely dissected leaves, broad-leaved plants and narrow-leaved plants. Submerged species that occurred in at least 25% of sample sites were coontail (*Ceratophyllum demersum*), star duckweed (*Lemna trisulca*) and flat-stem pondweed (*Potamogeton zosteriformis*) (Table 3, Figure 11).

Figure 11. Distribution of coontail, flat-stem pondweed and star duckweed in Norway Lake, 2008.

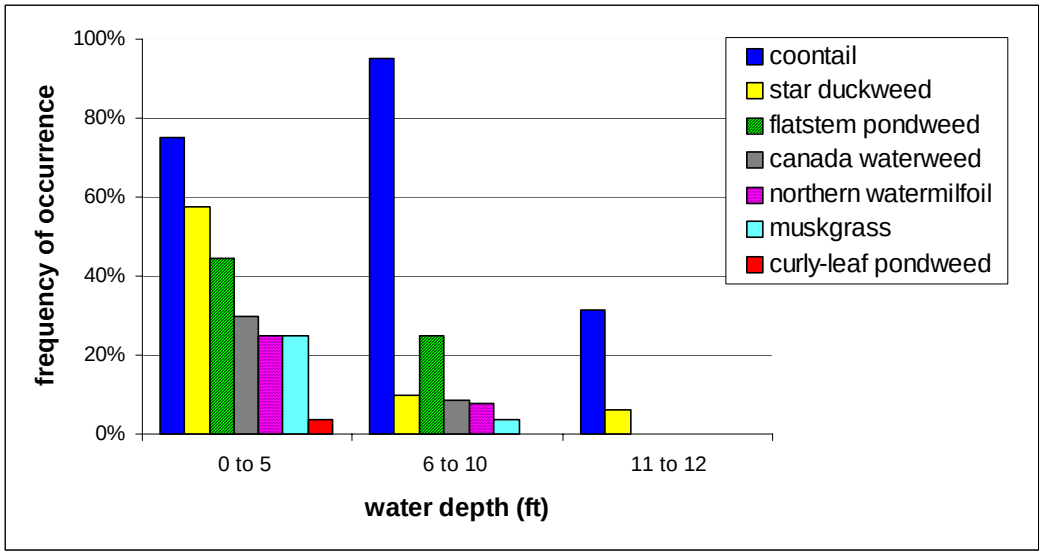


Coontail (Figure 12) was the most common plant in Norway Lake and was found in 84% of sample sites (Table 3, Figure 12). Coontail grows entirely submerged and is adapted to a broad range of lake conditions, including turbid water. It is perennial and can overwinter as a green plant under the ice and then begins new growth early in the spring. It is loosely rooted to the lake bottom and spreads primarily by stem fragmentation.

Figure 12. Coontail

The finely divided leaves of this plant provide a home for insects valuable as fish food. Coontail was the most frequently occurring species at each water depth zone and was most common in depths of six to 10 feet (Figure 13). Coontail and star duckweed were the only species found in depths greater than 10 feet.

Figure 13. Distribution of common species vs. water depth, Norway Lake, May 2008



Flat-stem pondweed (Figure 14) occurred in 31% of the Norway Lake sites (Table 3, Figure 11). Its name refers to its flattened, grass-like leaves. Depending on water clarity and depth, flat-stem pondweed leaves may reach the water surface and it may produce flowers that extend above the water. It overwinters by rhizome and winter buds and can be important for waterfowl food as well as fish habitat. In Norway Lake, it occurred to a depth of nine feet but was most frequent in depths less than six feet (Figure 13).

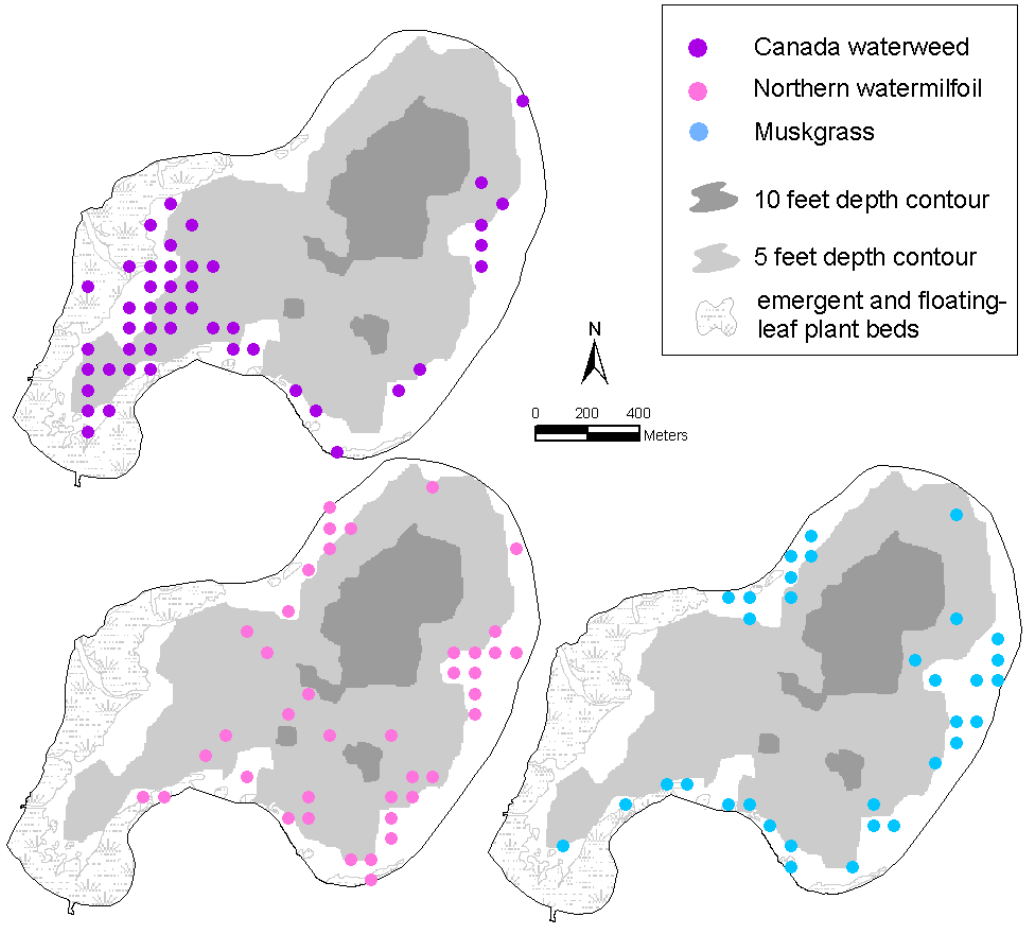
Figure 14. Flat-stem pondweed

Star duckweed (Figure 15) was present in 27% of the Norway Lake sample sites (Table 3, Figure 11). This species often occurs submerged near the lake bottom but does not anchor to the substrate and can float freely with the current. The leaves of this plant are arranged in groups of three and resemble stars. In Norway Lake, star duckweed occurred at all depths but was most often found in depths less than six feet (Figure 13).

Figure 15. Star duckweed (Photo: Robert Freckman, Univ. of Wisconsin).

Other submerged species that occurred in at least 10% of the survey sites were Canada waterweed (*Elodea canadensis*), northern watermilfoil (*Myriophyllum sibiricum*) and muskgrass (*Chara* sp.) (Figure 16).

Figure 16. Distribution of Canada waterweed, northern watermilfoil and muskgrass in Norway Lake, 2008.



Canada waterweed (Figure 17) was present in 16% of the Norway sites (Table 3, Figure 16). This rooted, perennial submerged species is tolerant of low light and prefers soft substrates. It was most common on the west side of Norway Lake where bottom type was characterized as silt and muck. Canada waterweed can overwinter as an evergreen plant and spreads primarily by fragments. Its foliage provides important cover for fish and invertebrates.

Figure 17. Canada waterweed (*Elodea canadensis*)
(photo by Vic Ramey, Univ of Florida)

Northern watermilfoil (*Myriophyllum sibiricum)* (Figure 18) occurred in 14% of the sample sites (Table 3, Figure 17). It is also a rooted, perennial submerged plant but is not tolerant of turbidity and grows best in clear water lakes. It may reach the water surface, particularly in depths less than 10 feet and its flower stalk may extend above the water surface. Northern watermilfoil spreads

primarily by stem fragments and overwinters by hardy rootstalks and winter buds. The finely dissected leaves of this plant provide fish shelter and insect habitat.

Figure 18. Northern watermilfoil.

Muskgrass (*Chara* sp.) (Figure 19) is a macroscopic, or large, algae that is common in many hard water Minnesota lakes. It has a brittle texture and a characteristic "musky" odor. Because this species does not form true stems, it is a low-growing plant, often found entirely beneath the water surface where it may form low "carpets" on the lake bottom. Muskgrass is adapted to variety of substrates and is often the first species to colonize open areas of lake bottom where it can act as a sediment stabilizer. Beds of muskgrass can provide important habitat for fish spawning and nesting. In Norway Lake, muskgrass occurred in 11% of all survey sites (Table 3). It was most common on the east side of the lake (Figure 17) and in depths less than six feet (Figure 13).

Figure 19. Muskgrass

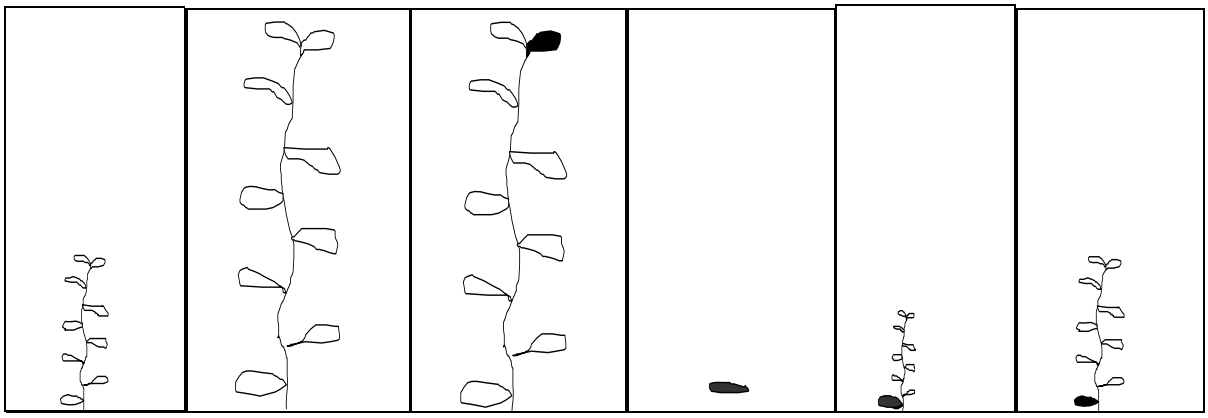
All other native submerged species occurred in less than 10% of the sample sites (Table 3).

Curly-leaf pondweed (*Potamogeton crispus*) (Figure 20) is a non-native, submerged plant that has been present in Minnesota since at least 1910 (Moyle and Hotchkiss 1945) and is now found in at least 700 Minnesota lakes (Invasive Species Program 2005). Like many native submerged plants, it is perennial but it has a unique life cycle that may provide a competitive advantage over native species. Curly-leaf pondweed is actually dormant during late summer and begins new growth in early fall (Figure 21). 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).

Figure 20. Curly-leaf pondweed

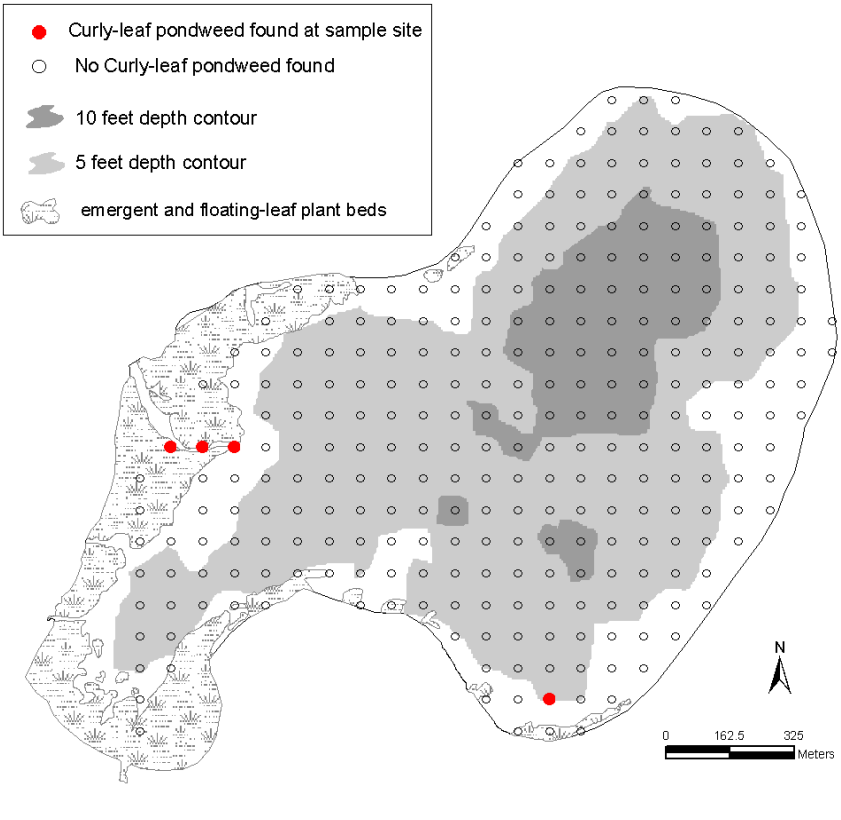
The foliage of curly-leaf pondweed does provide some fish and wildlife habitat, but it may also create problems in some lakes, or in areas of some lakes. During its peak growth in spring, curly-leaf may reach the water surface at certain depths and create dense mats. These dense growths may compete with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

Figure 21. Life cycle of Curly-leaf pondweed (*Potamogeton crispus*).



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

Figure 22. Distribution of curly-leaf pondweed.



Discussion

The types and amounts of aquatic vegetation that occur within a lake are influenced by a variety of factors including water clarity and water chemistry. Norway Lake supports an abundant native aquatic plant community that in turn, provides critical fish and wildlife habitat and other lake benefits. (Click here for more information on: value of aquatic plants).

Data collected during the May 2008 survey can be used to monitor finer-scale changes that may occur, such as an increase in a particular species or a change in the depths at which individual species occur. Monitoring change in the aquatic plant community can be helpful in determining whether changes in the lake water quality are occurring and for estimating the quality of vegetation habitat available for fish and wildlife communities.

In general, factors that may lead to change in the aquatic plant communities include:

- Change in water clarity
  If water clarity in Norway Lake decreases, rooted submerged vegetation may decline and be replaced by algal blooms.
- Change in water level
  Many aquatic plants are adaptable to water level fluctuations and in low water years, aquatic plants may expand in distribution. The extent and duration of these distribution changes can be difficult to predict.
- Snow and ice 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, and/or a reduced ice-over period, some submerged plants may increase in abundance.
- Water temperatures / length of growing season
  In years with cool spring temperatures, submerged plants may be less abundant than in years with early springs and prolonged warm summer days.
- Invasive species
  To date, curly-leaf pondweed is the only non-native species documented in Norway Lake and in 2008 it was not an important part of the plant community. If non-native plant species become abundant and form dense surface mats, they may shade out native plants. The impact of these invasive species varies among lakes but the presence of a healthy native plant community may help mitigate the harmful effects of these exotics.
- 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*) 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, click here: MnDNR APM Program or contact your local DNR office. Motorboat activity in vegetated areas can be particularly harmful for species such as bulrush and wild rice. Shoreline and watershed development can also indirectly influence aquatic plant growth if it results in changes to the overall water quality and clarity. Herbicide and mechanical control of aquatic plants can directly impact the

aquatic plant community. Limiting these types of activities can help protect native fish and wildlife habitat.

Norway Lake, May 2008.

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