Aquatic Vegetation Survey of Sylvan Lake (DOW 11-0304-00) Cass County, Minnesota

2009

Sylvan Lake, Cass County, MN. June 2008

Report by: Donna Perleberg and Stephanie Loso
Minnesota Department of Natural Resources
Division of Ecological Resources
1601 Minnesota Dr.
Brainerd, MN 56401
Phone: 218.833.8727
Email: donna.perleberg@dnr.state.mn.us

Lakewide sampling (2008): Donna Perleberg, Aquatic Plant Ecologist
Stephanie Loso, Aquatic Biologist
Kevin Mortensen, Student Intern
Mike Kobberdahl, Student Intern
MnDNR Division of Ecological Resources, Brainerd.

Bulrush mapping (2008): Stephanie Loso, MnDNR Division of Ecological Resources, Brainerd.

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Report Review: Kevin Mott and Wayne Mueller
MnDNR Fisheries Aquatic Plant Management Specialists, Brainerd

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Summary

An aquatic vegetation survey of Sylvan Lake (11-0304-00), Cass County, Minnesota, was conducted in June 2008 and included a characterization of shoal substrates, plant species and water depths at over 400 sample stations. Emergent and floating-leaf plant beds were mapped in September 2008.

Aquatic plants occurred around the entire perimeter of Sylvan Lake and were abundant within the protected shallow areas. Approximately six acres of bulrush (*Scirpus* sp.) and nine acres of waterlilies (*Nymphaea odorata* and *Nuphar variegata*) were mapped. Submerged plants were found to a depth of 20 feet (the maximum depth sampled) and 94 percent of the sample sites contained vegetation. This vegetated zone covers about 381 acres, or 47 percent of the lake. Scattered vegetation likely extended beyond the 20 feet depth.

Thirty-five native aquatic plant species were found in the lake. The two most common submerged plant species were low-growing plants: bushy pondweed (*Najas guadalupensis*) (54% occurrence) and muskgrass (*Chara* sp.) (23% occurrence). Other submerged plants included coontail (*Ceratophyllum demersum*), northern watermilfoil (*Myriophyllum sibiricum*), several broadleaf pondweeds (*Potamogeton* spp.) and flat-stem pondweed (*Potamogeton zosteriformis*). No non-native submerged plants were found in Sylvan Lake.

Introduction

Sylvan Lake (DOW 11-0304-00) is located about two miles northeast of the city of Pillager, in Cass County, north-central Minnesota (Figure 1). The lake lies in the southeast corner of the Crow Wing River Watershed. There are about 250 Cass County lakes that are at least 50 acres in size and Sylvan Lake ranks 26th in size with a surface area of 803 acres and 11 miles of shoreline.

Sylvan Lake consists of two basins that are connected by a long, shallow channel. Intermittent flow may enter Sylvan Lake from a small tributary on the southwest basin and from Dade Lake to the northeast (Figure 2). A concrete dam at the southwest end of the lake controls outflow to Little

Figure 1. Sylvan Lake, Cass County, MN

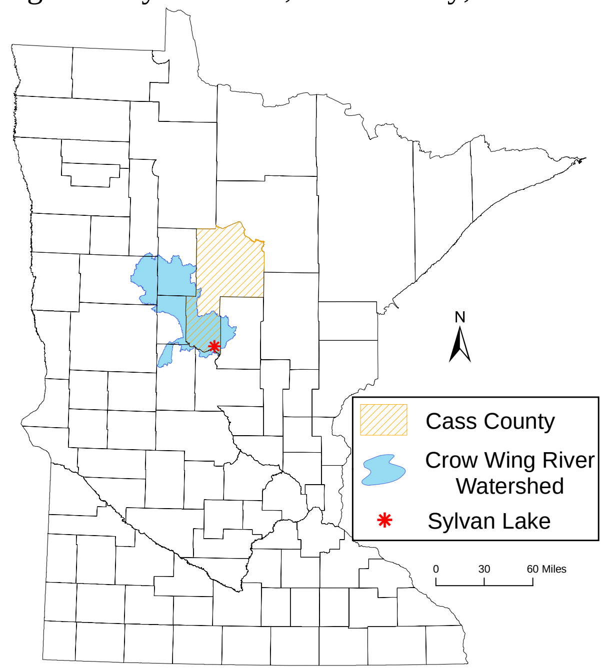
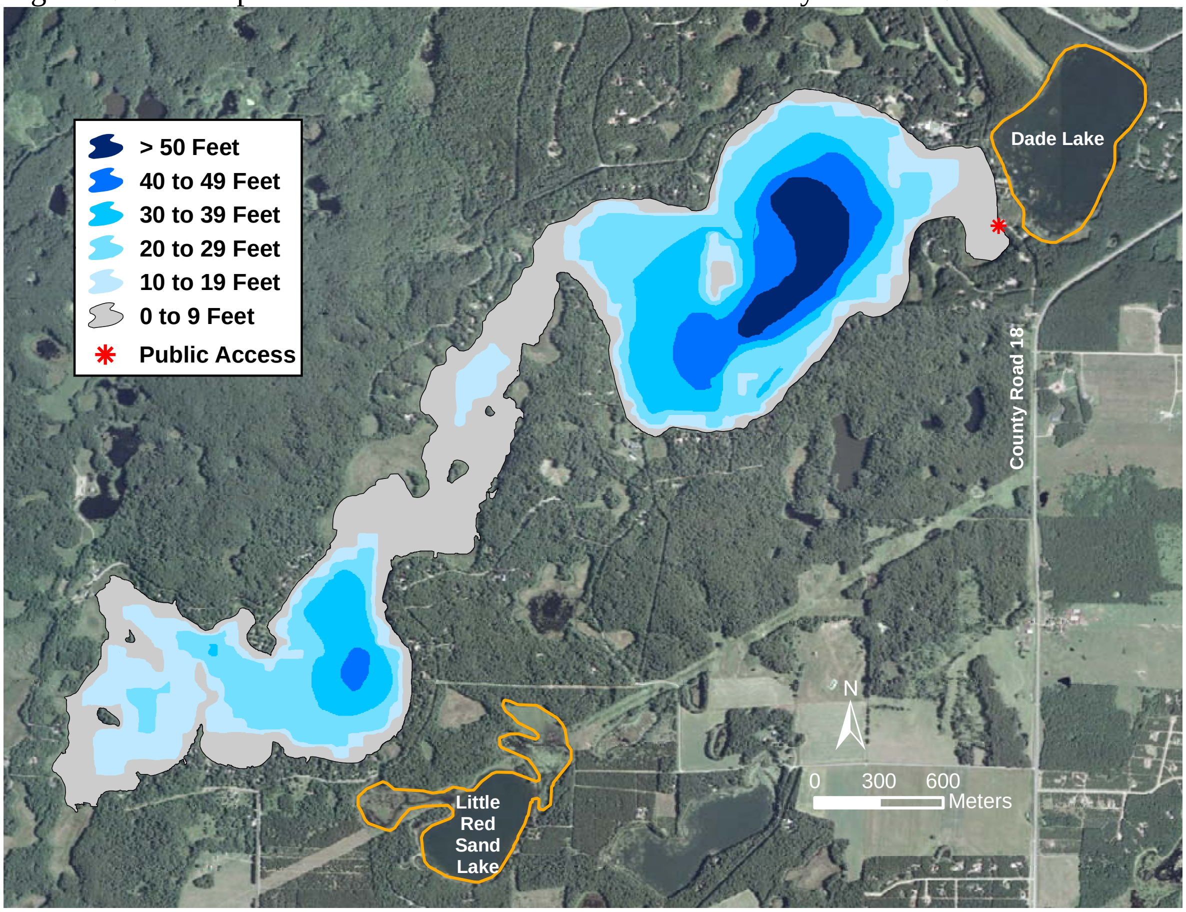


Figure 2. 2008 Depth Contours and flow from Dade Lake to Sylvan Lake.



Red Sand Lake (Figure 2), but Sylvan Lake water levels are often below the dam level. The immediate shoreline of Sylvan Lake is privately owned and much of the upland is developed with residential homes. A resort and a private youth camp are located on the northeast basin. There is a public boat launch on the northeast end of the lake.

The southwest basin of Sylvan Lake is shallow with a maximum depth of 44 feet and the northeast basin has a maximum depth of 57 feet. The connecting channel has a maximum depth of about 14 feet. This shallow area is referred to as the littoral zone. Rooted submerged plants are often common in the littoral zone if adequate sunlight reaches the lake bottom.

Sylvan Lake is an oligotrophic lake, or minimally nutrient enriched, with high water clarity. Between 2000 and 2007, water clarity, as measured by Secchi disc readings, averaged about 20 feet in the northeast basin and about 17 feet in the southwest basin (MPCA, 2007). The Secchi disc (Figure 3) transparency measures the depth to which a person can see into the lake and provides a rough 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 a depth of one and a half times the Secchi depth. Based on Secchi disk measurements alone, aquatic plants are expected to grow to about 30 feet in the northeast basin and to about 26 feet in the southwest basin. Other factors that may influence the depth of plant growth include substrate type, wind fetch, and plant species composition.

Figure 3. Measuring Secchi Disc transparency

At least 34 different aquatic plant species have previously been recorded in the Sylvan Lake (DNR Fisheries lake files). Plants that were commonly found include muskgrass (*Chara* sp.), flat-stem pondweed (*Potamogeton zosteriformis*), Illinois pondweed (*Potamogeton illinoensis*), and coontail (*Ceratophyllum demersum*). These previous surveys report vegetation growth to a maximum depth of about 26 feet (MnDNR Fisheries).

Objectives

The purpose of this vegetation survey was to provide a quantitative description of the 2008 plant population of Sylvan Lake. The survey was restricted to water depths of 20 feet and less. Within that depth zone, specific objectives included:

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

Methods

Floating-leaf and emergent vegetation beds

Farm Service Administration (FSA) true color aerial photographs, 2003-2004, were used to delineate beds of floating-leaf vegetation. Ground truthing was conducted in September 2008 to verify plant community composition within major beds. Bulrush (*Scirpus* spp.) beds are difficult to detect on aerial photographs and therefore, surveyors mapped bulrush beds in the field in September 2008. Surveyors motored around the lakeside perimeter of major bulrush beds and recorded locations with a handheld Global Positioning System (GPS) receiver. Field data were uploaded to a computer and a Geographic Information System (GIS) software program was used to estimate acreage.

Lakewide vegetation survey

A lakewide vegetation survey of Sylvan Lake was conducted on June 16 and 17, 2008. A point-intercept survey method was used and followed the methods described by MnDNR (2008) and Madsen (1999). Survey waypoints were created using a GIS computer program. Survey points were placed in a grid pattern between the shore and the 20 feet depth contour and were spaced 65 meters (213 feet) apart. This resulted in about one survey point per acre within the sampled area. A total of 420 points were surveyed (Figure 4, Table 1).

Figure 4. 2008 vegetation survey sites on Sylvan Lake.

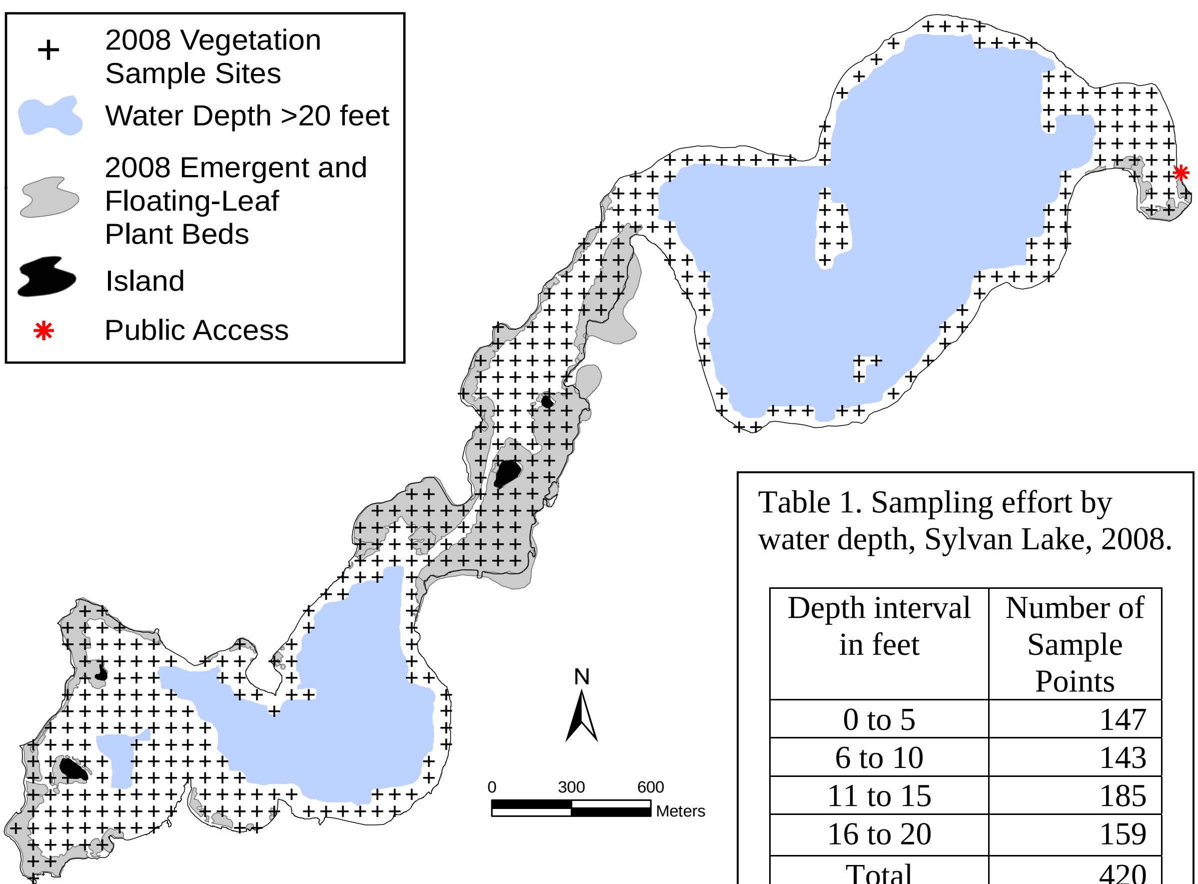


Table 1. Sampling effort by water depth, Sylvan Lake, 2008.

Depth interval in feet	Number of Sample Points
0 to 5	147
6 to 10	143
11 to 15	185
16 to 20	159
Total	420

Figure 5. Plant sampling rake.

Two field crews, each consisting of one boat and two surveyors, conducted the survey. Survey points were downloaded into handheld GPS receivers that were used to navigate to each sample point. One side of the boat was designated as the sampling area. At each site, water depth was recorded in one-foot increments using a measuring stick in water depths less than eight feet and an electronic depth finder in depths greater than eight feet.

The surveyors recorded all plant species found within a one-meter square sample site at the pre-designated side of the boat. A double-headed, weighted garden rake, attached to a rope was used to survey vegetation not visible from the surface (Figure 5). If additional species were found outside the sample sites, surveyors recorded them as "present" in the lake but these data were not used in frequency calculations. Plant identification and nomenclature followed Crow and Hellquist (2000). Voucher specimens were collected for most plant species and are stored at the MnDNR in Brainerd.

Data were entered into a database and percent 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 area from shore to 20 feet and sampling points were also grouped by water depth and separated into four depth zones for analysis (Table 1).

Example:
In Sylvan Lake there were 420 samples sites in the zone from shore to the 20 feet depth.
Muskgrass (*Chara* sp.) occurred in 98 of those sites.
Frequency of muskgrass in the shore to 20 feet depth zone = 98/420 (*100) = 23 %

At each sample site where water depths were seven feet and less, surveyors described the bottom substrate using standard substrate classes (Table 2). If a mixture of substrates occurred at a site, surveyors recorded the most abundant type.

Table 2. Substrate classes

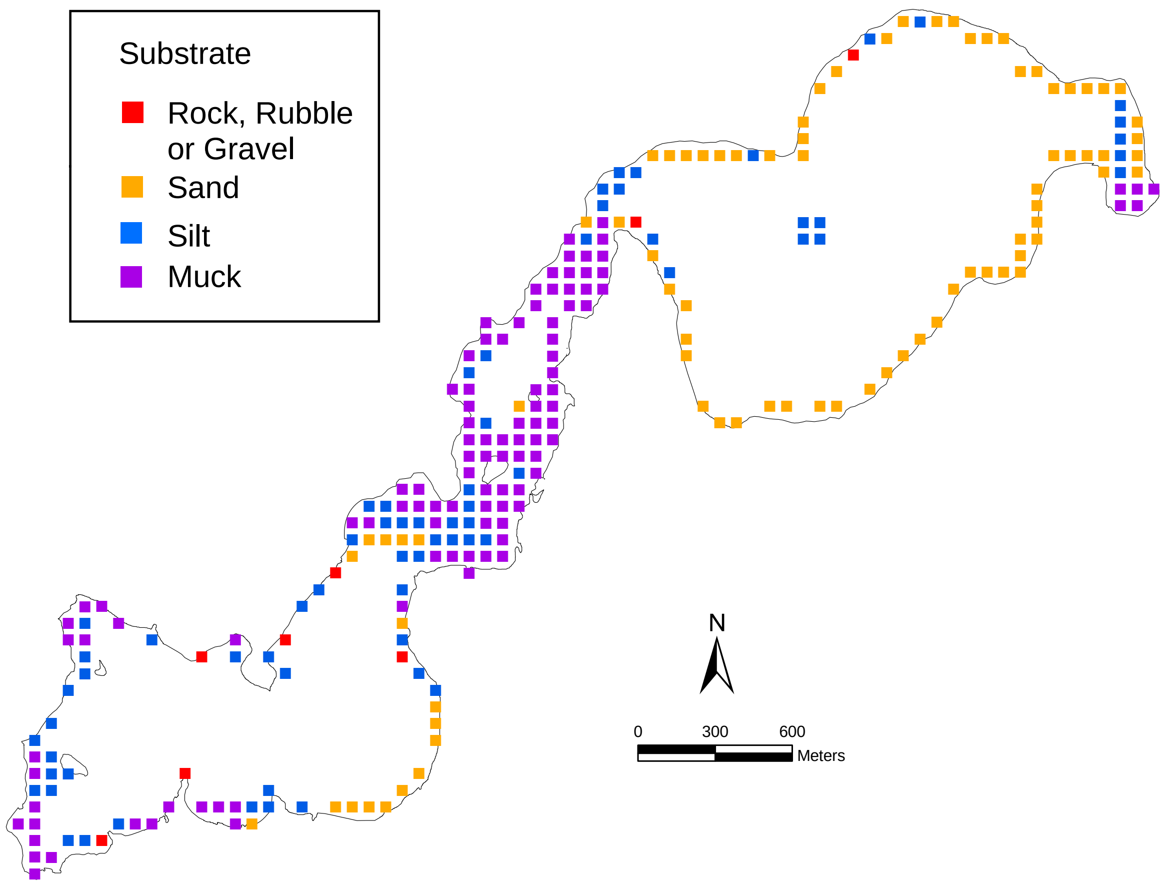
muck	decomposed organic material
marl	calcareous material
silt	fine material with little grittiness
sand	Diameter less than 1/8 inch
gravel	Diameter 1/8 to 3 inches
rubble	Diameter 3 to 10 inches
boulder	Diameter over 10 inches

Results

Shoal substrates

Sand was the most common substrate in shallow waters of the northeast basin and the eastern-most bay of the southwest basin (Figure 6). Soft substrate of muck and silt were found throughout the channel between the two basins, and the west end of the lake (Figure 6).

Figure 6. Shoal substrates of Sylvan Lake, 2008.



Distribution of aquatic plants

Aquatic plants were found around the entire perimeter of each basin and throughout the narrow channel connecting the basins. About 131 acres of emergent and floating-leaf beds were mapped with the largest beds occurring in the channel and the west shore of the southwest basin (Figure 8). Submerged plants occurred to 20 feet (the maximum depth sampled) and 94 percent of the sites contained vegetation. This vegetated zone covered about 381 acres, or 47 percent of the lake. Plants were most frequent from shore to the 15 feet depth and frequency declined with increasing depth (Figure 7). Scattered vegetation likely occurred beyond the 20 feet depth.

Figure 7. Plant occurrence at each water depth interval.

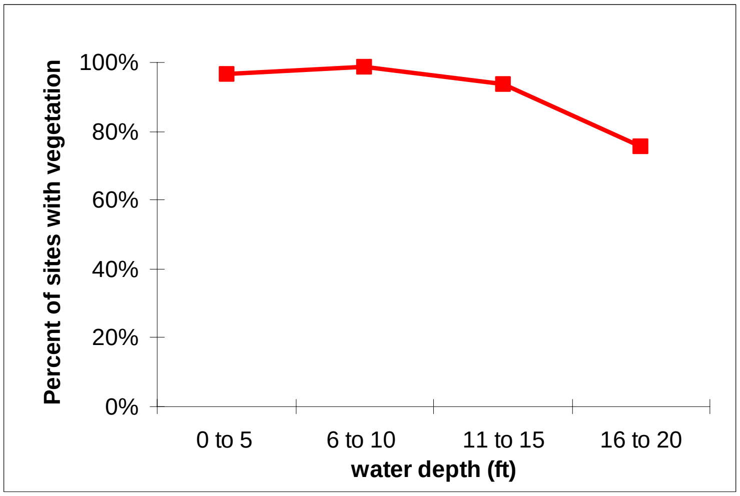
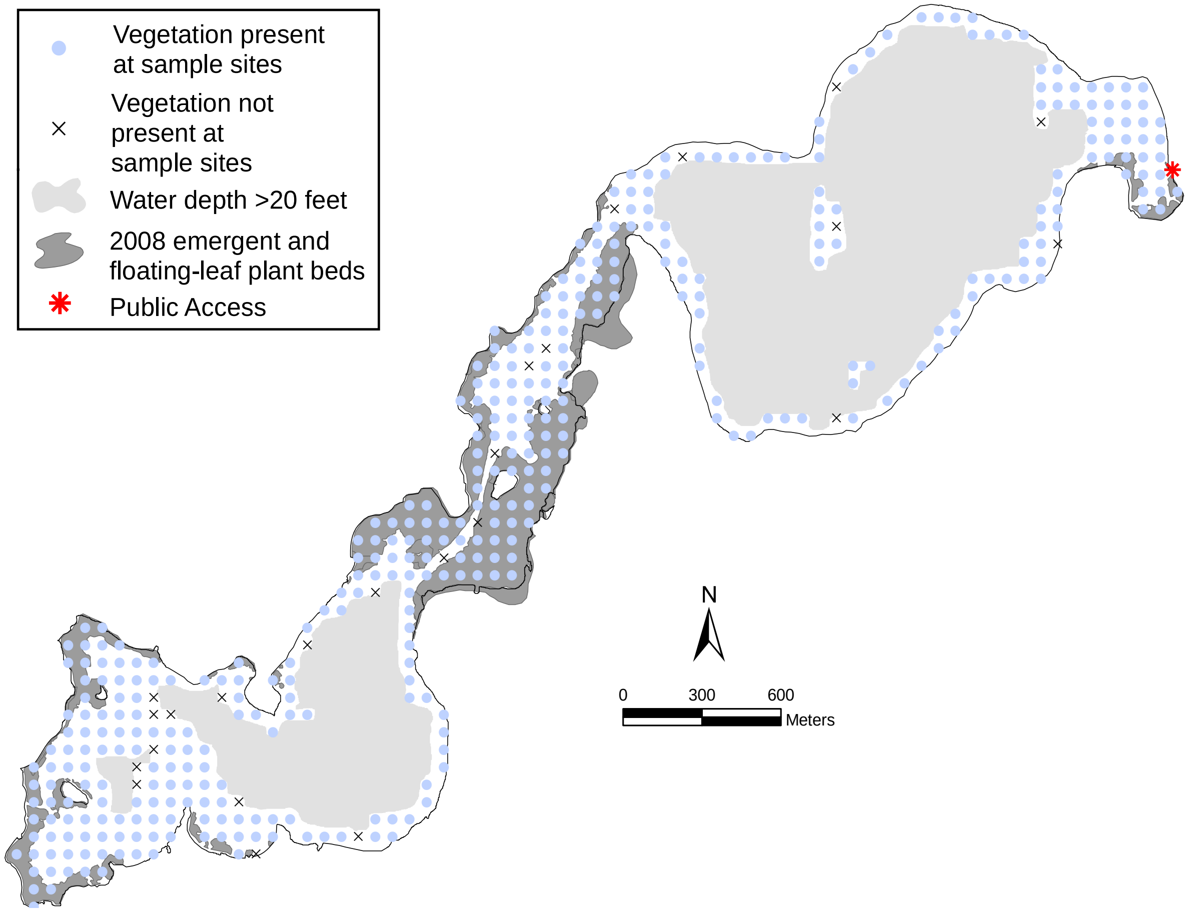


Figure 8. Distribution of aquatic plants in Sylvan Lake, 2008.



Number and types of plants recorded and distribution by water depth

A total of 35 native aquatic plant species were recorded in Sylvan Lake including six emergent, four floating-leaved, six free-floating and 19 submerged plants (Table 3). Emergent and floating-leaf plants were restricted to water depths of six feet and less. Submerged and free-floating plants were found to 20 feet (the maximum depth sampled) but only nine species occurred in depths greater than 15 feet (Figure 9). Only four species were found in depths greater than 18 feet.

The number of plant species found at each one-meter square site ranged from zero to eleven with a mean of three species per meter squared. Sites with the highest number of species occurred in the channel and the southern end of the lake, where a mixture of emergent, floating-leaved and submerged plants was found (Figure 10). In the shore to five feet zone, the mean number of species per site was four, while in depths greater than 15 feet, the mean number of species per site was one.

Table 3. Frequency of aquatic plants in Sylvan Lake Point-intercept survey, June 2008.
(Frequency is the percent of sample sites in which a plant taxon occurred within the shore to 20 ft water depth.)
420 sample sites

Life Forms		**Common Name**	**Scientific Name**	**Frequency**
SUBMERGED and FREE-FLOATING These plants grow primarily under the water surface. Upper leaves may float near the surface and flowers may extend above the surface. Plants may or may not be anchored to the lake bottom.	Small-leaved plants	Bushy pondweed	*Najas guadalupensis*	54
		Star duckweed	*Lemna trisulca*	18
		Canada waterweed	*Elodea canadensis*	15
	Algae and Mosses	Muskgrass	*Chara sp.*	23
		Water moss	*Not identified to genus*	9
		Stonewort	*Nitella sp.*	3
	Dissected leaved Plants	Northern watermilfoil	*Myriophyllum sibiricum*	21
		Coontail	*Ceratophyllum demersum*	19
		Greater bladderwort	*Utricularia vulgaris*	6
		Lesser bladderwort	*Utricularia minor*	6
		Flat-leaved bladderwort	*Utricularia intermedia*	5
		White water buttercup	*Ranunculus aquatilis*	3
		Water marigold	*Megaladonta beckii*	1
		Milfoil species	*Myriophyllum sibiricum*	1
		Humped bladderwort	*Utricularia gibba*	1
	Grass-leaved plants	Flat-stem pondweed	*Potamogeton zosteriformis*	15
		Robbin's pondweed	*Potamogeton robbinsii*	5
		Narrow-leaf pondweed	*Potamogeton sp.*	3
		Water stargrass	*Zosterella dubia*	2
		Sago pondweed	*Stuckenia pectinata*	1
		Water bulrush	*Scirpus subterminalis*	1
		Wild celery	*Vallisneria americana*	Present
	Broad-leaved plants	Large-leaf pondweed	*Potamogeton amplifolius*	10
		Illinois pondweed	*Potamogeton illinoensis*	6
		White-stem pondweed	*Potamogeton praelongus*	5
		Variable pondweed	*Potamogeton gramineus*	<1
FLOATING These plants are rooted in the lake bottom and have leaves that float on the water surface.		Watershield	*Brasenia schreberi*	11
		White waterlily	*Nymphaea odorata*	11
		Yellow waterlily	*Nuphar variegata*	6
		Floating-leaf pondweed	*Potamogeton natans*	6
EMERGENT These plants extend well above the water surface and are usually found in shallow water, near shore.		Wild Rice	*Zizania palustris*	12
		Bulrush	*Scirpus sp.*	1
		Spikerush	*Eleocharis sp.*	1
		Broadleaf arrowhead	*Sagittaria latifolia*	<1
		Needlegrass	*Eleocharis sp.*	<1
		Burreed	*Sparganium sp.*	<1

"Present" indicates plant was observed in the lake but did not occur within any of the sample sites

Figure 9. Number of species found at each water depth interval.

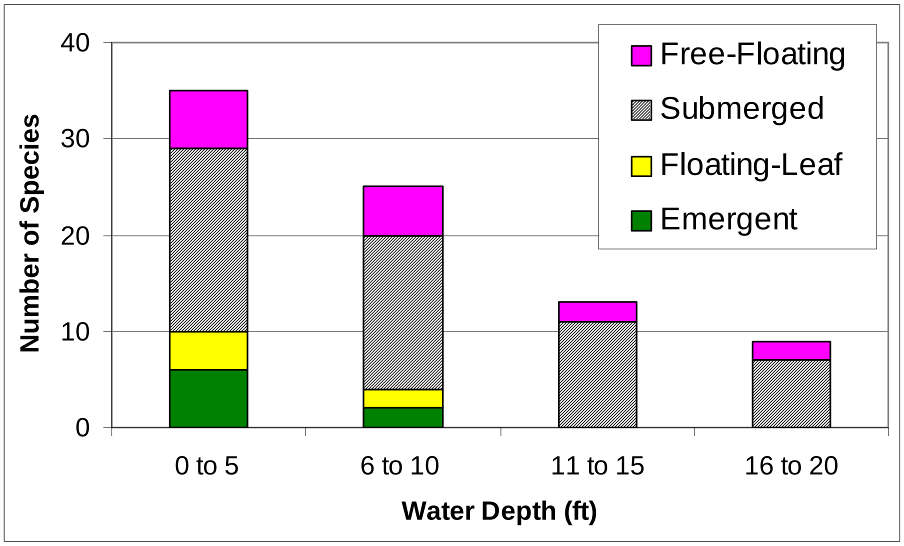


Figure 10. Number of plant species found at each sample site. Sylvan Lake, 2008

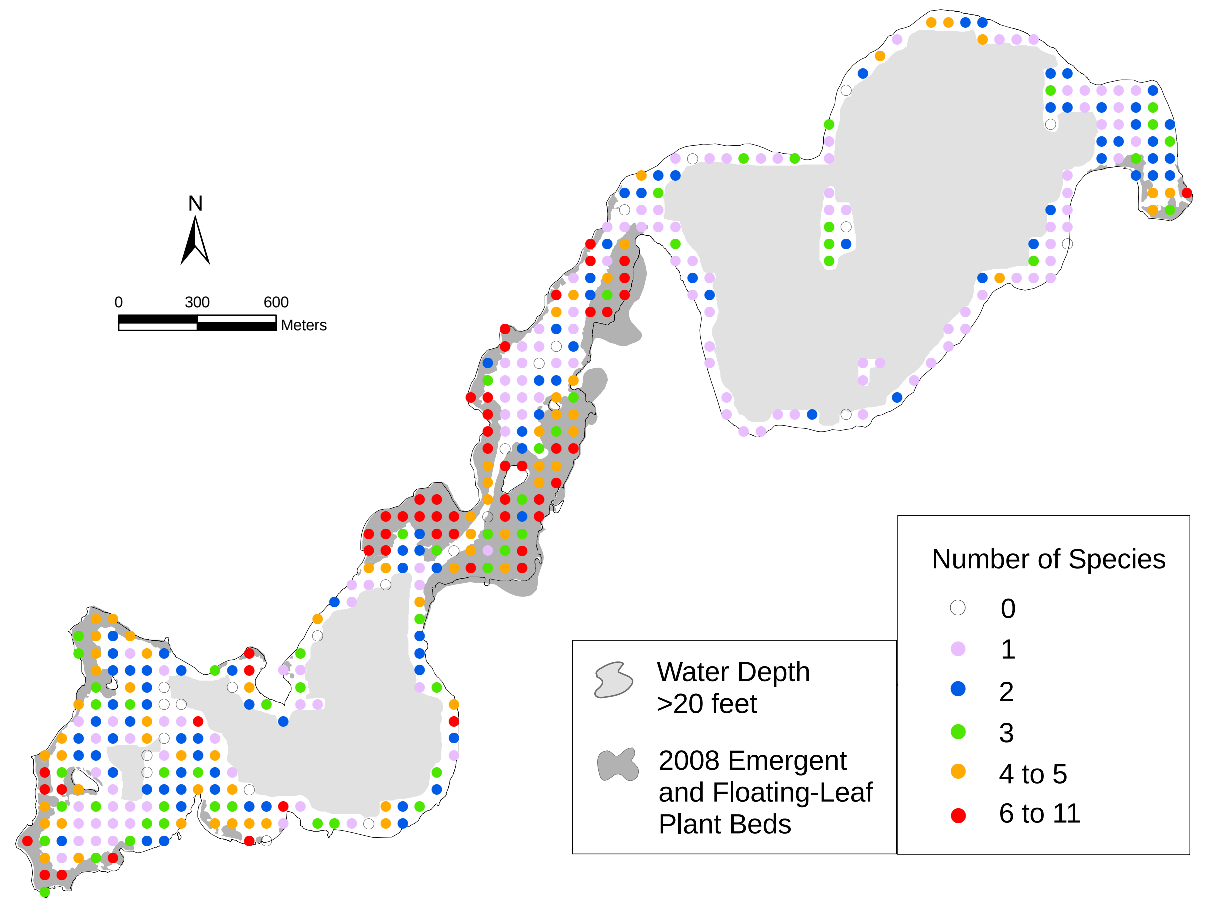
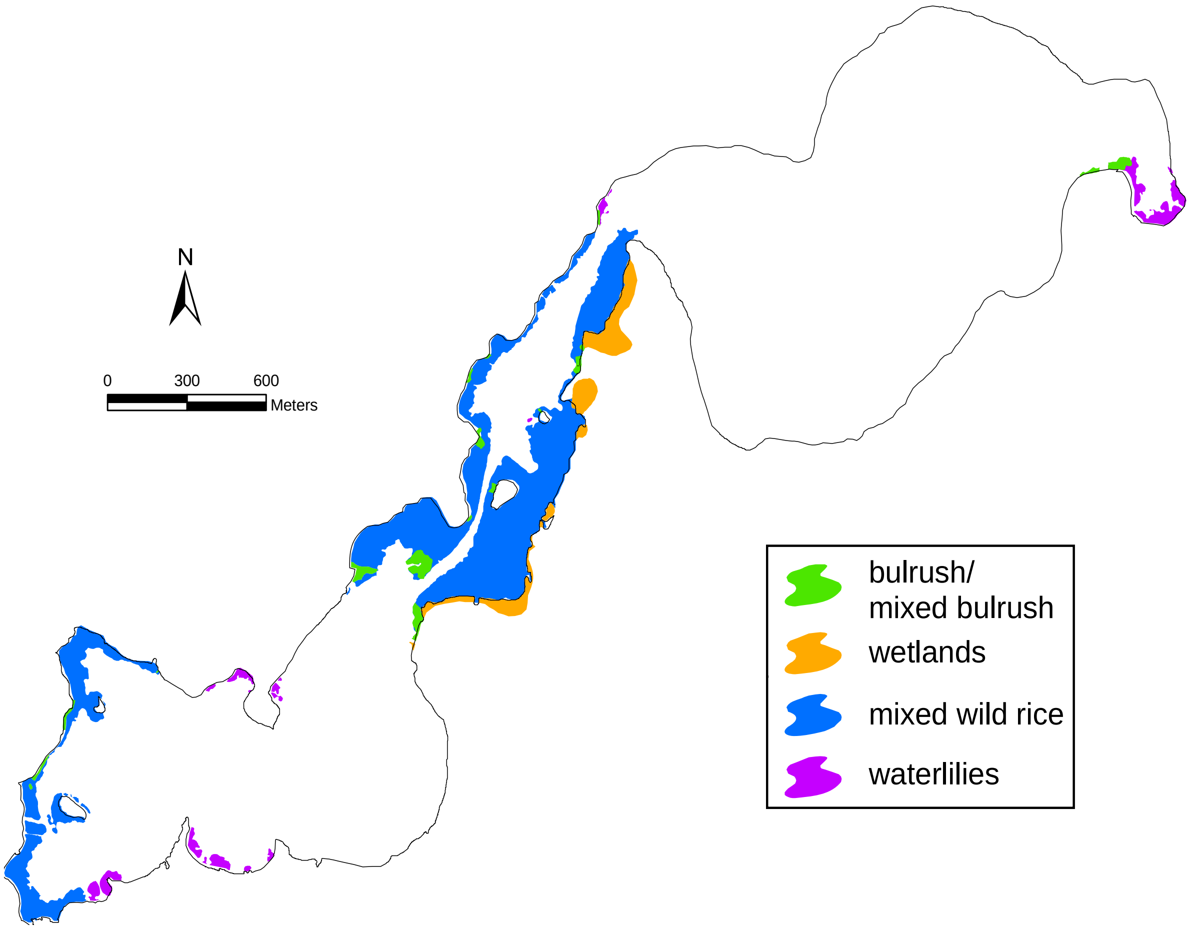


Figure 11. Major emergent and floating-leaf beds



Wetlands adjacent to lake

About 14 acres of emergent wetlands occurred adjacent to the Sylvan Lake channel (Figure 11). These wetlands were not surveyed extensively but included cattail (*Typha* sp.) (Figure 12) and a variety of other emergent species such as sedges (*Carex* spp.) and arrowhead (*Sagittaria* spp.). These wetlands act as filters for pollutants, fertilizers, silt and sediments and reduce the amount that enters into the adjacent lake. Wetlands can store water during heavy rainfalls, effectively implementing flood control. This water may be released at other times during the year to recharge the groundwater. Wetlands also provide valuable habitat for many wildlife species. Birds use wetlands for feeding, breeding, and nesting areas as well as migratory stopover areas. Fish may utilize wetlands for spawning and shelter. Numerous plants will grow only in the specific conditions provided by wetlands. Finally, wetlands provide a variety of recreational opportunities, including fishing, hunting, boating, photography, and bird watching.

Figure 12. Mallard Chicks in Cattails (*Typha* spp.), Sylvan Lake 2008.

In-lake emergent and floating-leaf plants

Between the shore and five feet depth zone, 61 percent of the survey sites contained at least one emergent or floating-leaf plant. Wild rice, bulrush and waterlily beds were the most common type mapped.

Figure 13. Wild rice (*Zizania palustris*)

Wild rice (*Zizania palustris*) (Figure 13) was the most common emergent plant in Sylvan Lake and was found in 12 percent of all sites (Table 3) and in 35 percent of the sites within the shore to five feet depth. About 102 acres of wild rice were mapped, including beds of wild rice mixed with bulrush, other emergent vegetation, and/or waterlilies. The most extensive beds of wild rice were in the channel and along the western shore (Figure 11).

Wild rice is an annual plant that germinates each year from seed that fell to the lake bottom the previous fall. It prefers soft substrates (Lee 1986, Nichols 1999) and generally requires moving water for growth (MnDNR 2008b). The plant begins growth underwater and then forms a floating-leaf stage before becoming fully emergent. Wild rice is susceptible to disturbance from storms and motorboats 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 2008b). This valuable plant is increasingly threatened by factors such as lakeshore development and increased water recreational use.

Figure 14. Emergent bulrush (*Scirpus*) beds in Sylvan Lake

Hard-stem bulrush (*Scirpus acutus*) (Figure 14) is an emergent plant that was found in less than one percent of the Sylvan Lake sites but beds of bulrush occupied about six acres in the lake (Figure 11). Narrow bands of bulrush occurred at the south end of the channel and on some sandbars at the east and west ends of the lake. Bulrush was usually found in sand and was sometimes associated with spikerush. Spikerush (*Eleocharis* sp.) is an emergent plant that is similar to bulrush but shorter in height. Bulrush plants are rooted in the lake bottom and the narrow stems may extend several feet above the water. Bulrush is a perennial plant that can spread by rhizomes in shallow water. Restoration of bulrush beds can be very difficult, making established beds particularly unique and valuable.

Floating-leaf plant beds provide similar benefits as emergents and also provide shade for fish and frogs. About nine acres of waterlily beds were mapped (Figure 11) and included beds dominated by waterlilies with emergent plants interspersed (Figure 15). Common species included watershield (*Brasenia schreberi*), yellow waterlily (*Nuphar variegata*), floating-leaf pondweed (*Potamogeton natans*) and white waterlily (*Nymphaea odorata*). Waterlily beds were often associated with muck substrates.

These in-lake emergent and floating-leaf plant beds protect shorelines against erosion by buffering the wave action and by holding soil in place. They offer shelter and shade for insects and young fish as well as food, cover and nesting material for waterfowl, marsh birds and muskrats.

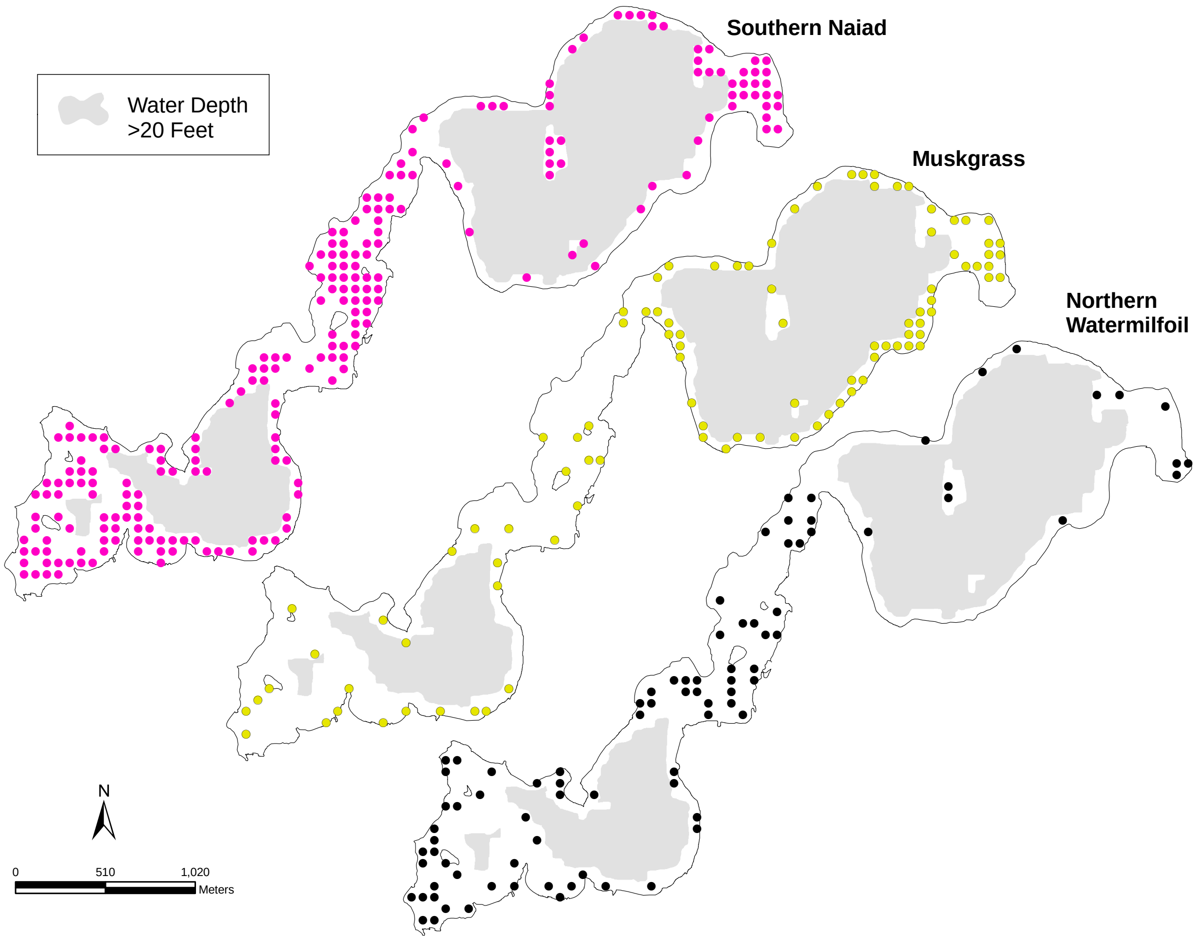
Submerged plants

Submerged plants occurred in 93 percent of the Sylvan Lake sample sites between shore and the 20 feet depth. A mixture of plant types was found including plants that form low carpets on the lake bottom and taller, leafy plants that may reach the water surface. Some submerged plants are strongly-rooted in the lake bottom while others are weakly anchored and may be more easily moved by water currents.

The three most frequently occurring submerged species were southern naiad (*Najas guadalupensis*), muskgrass (*Chara* sp.), and northern watermilfoil (*Myriophyllum sibiricum*). All of the species were found in both basins and in the connecting channel (Figure 16).

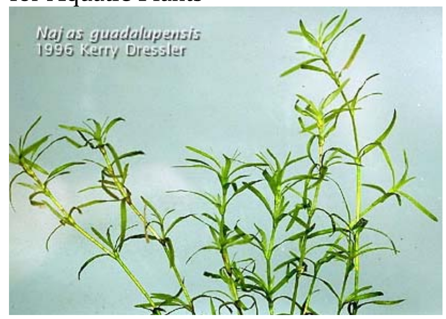
Figure 15. Waterlilies (*Nymphaea odorata*) mixed with wild rice. Sylvan Lake, 2008.

Figure 16. Distribution of southern naiad (*Najas guadalupensis*), muskgrass (*Chara* sp.) and northern watermilfoil (*Myriophyllum sibiricum*) in Sylvan Lake, 2008.



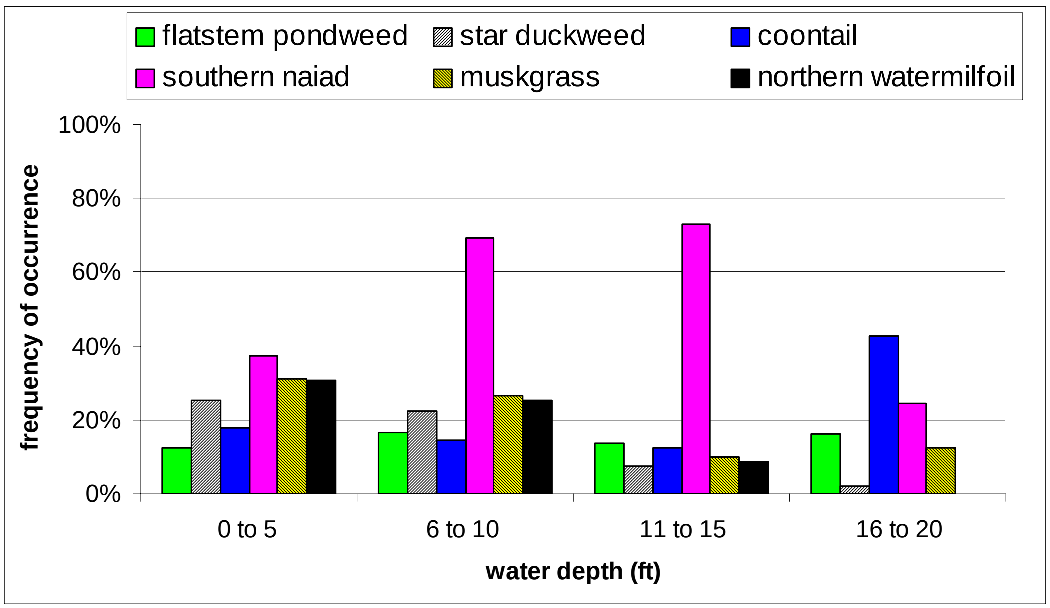
Southern naiad (*Najas guadalupensis*) (Figure 17) was the most common submerged plant in Sylvan Lake and occurred in 54 percent of the sample sites (Table 3). It was frequently found throughout the littoral zone (Figure 16). It was the most common plant in the shore to 15 feet depth zone and in depths of six to15 feet it was found in more than 60 percent of the survey sites (Figure 18).

Figure 17. Southern naiad (*Najas guadalupensis*). Photo: Kerry Dressler ©1996 Univ. of Florida Center for Aquatic Plants



This species has not been reported in many Minnesota lakes but it is native to the state. It closely resembles a related species, bushy pondweed (*Najas flexilis*) and it can be difficult to distinguish the two species. Southern naiad is a perennial plant that grows low in the water column. The seeds and foliage of this plant are an important duck food and beds of this plant provide good fish cover.

Figure 18. Frequency of common submerged plants by water depth interval. Sylvan Lake, 2008.



Muskgrass (*Chara* sp.) occurred in 23 percent of the sample sites (Table 3) and occurred at all depths sampled but was most frequent in depths less than 11 feet (Figure 18). This macroscopic, or large, algae (Figure 19) is common in many hard water Minnesota lakes. It has a brittle texture and a characteristic "musky" odor. Algae do not form true stems and therefore, 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

Figure 19. Muskgrass (*Chara* sp.) photo by Vic Ramey ©2001 Univ of Florida

and is often the first plant 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.

Northern watermilfoil (*Myriophyllum sibiricum*) (Figure 20) is a rooted, perennial submerged plant with finely dissected leaves. It may reach the water surface, particularly in depths less than ten feet and its flower stalk extends 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. This native plant provides fish shelter and insect habitat. It was found in 21 percent of the sample sites (Table 3). and was scattered throughout Sylvan Lake but was most often found in water depths less than 11 feet (Figure 16).

Figure 20. Northern watermilfoil. (*Myriophyllum sibiricum*)

Three other species were common in Sylvan Lake but primarily found in the channel and southwest basin (Figure 21).

Figure 21. Distribution of coontail *(Ceratophyllum demersum)*, star duckweed *(Lemna trisulca)*, and flat-stem pondweed *(Potamogeton zosteriformis)*.

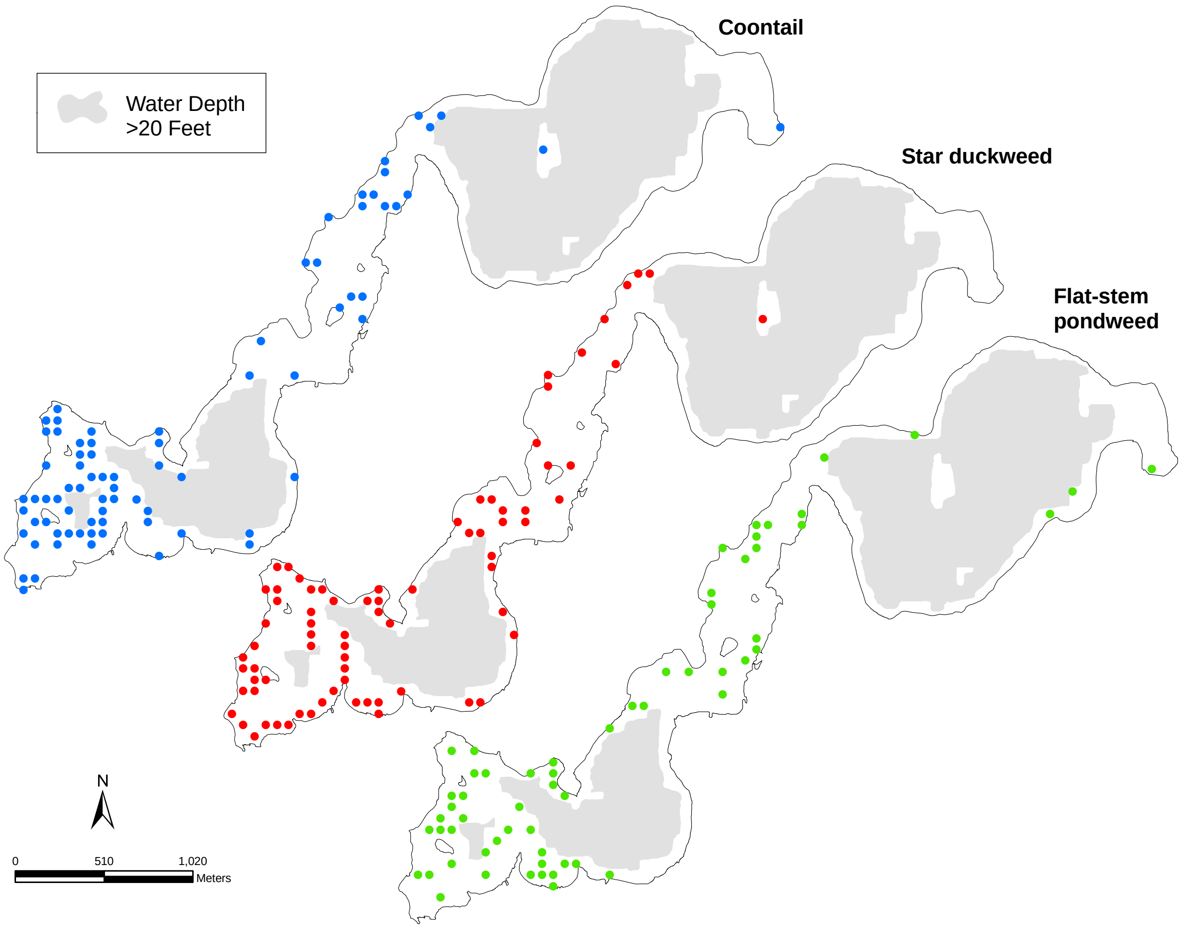


Figure 22. Coontail (*Ceratophyllum demersum*)

Coontail (*Ceratophyllum demersum*) (Figure 22) is a submerged plant that was found in 19 percent of the Sylvan Lake sites (Table 3) and was most common in depths of 15 to 20 feet (Figure 18, 21). Coontail grows entirely submerged and is adapted to a broad range of lake conditions, including turbid water. Coontail is perennial and can over winter 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. The finely divided leaves of this plant provide a home for insects valuable as fish food.

Figure 23. Star duckweed (*Lemna trisulca*) photo by Robert Freckman-Univ of WI – Stevens Point

Star duckweed (*Lemna trisulca*) (Figure 23) is a free-floating species that often occurs submerged near the lake bottom but it does not anchor to the substrate and can float freely with the current. This plant was present in 18 percent of the Sylvan lake survey sites (Table 3). It was most common in the southwest basin of Sylvan Lake (Figure 21) and was most often found in water depths of ten feet and less (Figure 18).

Figure 24. Flat-stem pondweed (*Potamogeton zosteriformis*)

Flat-stem pondweed (*Potamogeton zosteriformis*) (Figure 24) occurred in 15 percent of the sites (Table 3, Figure 21). It was found to a depth of 18 feet but had a similar frequency at all depths. Flat-stem pondweed is named for its flattened, grass-like leaves. Flat-stem pondweed is a perennial plant that is anchored to the lake bottom by underground rhizomes. Depending on water clarity and depth, these plants may reach the water surface and may produce flowers that extend above the water. These pondweeds are anchored to the lake bottom by rhizomes and over winter by winter buds.

Figure 25. Broadleaf pondweed (*Potamogeton amplifolius*)

Other important submerged plants in Sylvan Lake include broadleaf pondweeds: large-leaf pondweed (*Potamogeton amplifolius*), variable pondweed (*P. gramineus*), Illinois pondweed (*P. illinoensis)*, and white-stem pondweed (*P. praelongus*). These rooted, perennial plants with wide leaves are often called "cabbage" plants by anglers. These plants are primarily submerged but many will form floating leaves in shallower water (Figure 25). Large-leaf pondweed was the most abundant broadleaf pondweed in Sylvan Lake and was found in 10 percent of all sample sites (Table 3).

In addition to the commonly occurring plants in Sylvan Lake, there were several unique plants located during the survey including water bulrush (*Scirpus subterminalis*), and several species of bladderworts (*Utricularia* spp.). These species are not widespread in Minnesota but are usually associated with undisturbed areas in clear water lakes of northern Minnesota.

Discussion

Sylvan Lake supports an abundant and diverse native aquatic plant community that includes extensive beds of emergent and floating-leaf plant beds near shore and submerged plant beds to depths of 20 feet and greater. The high number of plant species found in Sylvan Lake is a reflection of the high water clarity. Many of the plants found require clear water and are not found in lakes with higher turbidity. Another reason for the high diversity of plant types is that Sylvan Lake has a variety of sediment types and a mix of protected bays and open water sites. Plant species with different habitat requirements can exist within this system. Aquatic vegetation provides critical habitat for fish and invertebrates, buffers the shoreline from wave action, and stabilizes sediments and utilizes nutrients that would otherwise be available for algae. (Click here for more information on: value of aquatic plants).

A review of past vegetation surveys indicates that, over the past 50 years, the general aquatic plant community has not likely changed greatly in Sylvan Lake. In all survey years, a relatively high number of native plants have been recorded and rooted plants remain well distributed throughout the bays. Data collected in 2008 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 Sylvan Lake decreases, submerged vegetation may be restricted to shallower water.
- 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
  Non-native submerged species have not been documented in Sylvan Lake but if they invade the lake, they may directly or indirectly impact the native plant community. Non-native

plant species, such as Eurasian watermilfoil (*Myriophyllum spicatum*) or curly-leaf pondweed (*Potamogeton crispus*) may form dense surface mats that 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 abundance
  Many submerged plants are perennial and re-grow in similar locations each year. However, a few species such as wild rice (*Zizania palustris*) 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 aquatic plant species.

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